

The Singapore FETP Enterprise



Communicable Diseases Control

Editors: PL Ooi, I Boudville, M Chan, N Tee

Featuring Artwork by **Kelly Foo**

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Edited for

The Singapore FETP Enterprise

by

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Dedicated to the people who have chosen to serve on the frontlines of field epidemiology and communicable diseases work in these extraordinary times when medical and public health systems are stressed by pressures from without and within.

Finding Inspiration in Extraordinary Times

You can have flaws, be anxious, and even be angry, but do not forget that your life is the greatest enterprise in the world. Only you can stop it from going bust. Many appreciate you, admire you and love you. Remember that to be happy is not to have a sky without a storm, a road without accidents, work without fatigue, relationships without disappointments. To be happy is to find strength in forgiveness, hope in battles, security in the stage of fear, love in discord. It is not only to enjoy the smile, but also to reflect on the sadness. It is not only to celebrate the successes, but to learn lessons from the failures. It is not only to feel happy with the applause, but to be happy in anonymity.

Being happy is not a fatality of destiny, but an achievement for those who can travel within themselves. To be happy is to stop feeling like a victim and become your destiny's author. It is to cross deserts, yet to be able to find an oasis in the depths of our soul. It is to thank God for every morning, for the miracle of life. Being happy is not being afraid of your own feelings. It's to be able to talk about you. It is having the courage to hear a "no". It is confidence in the face of criticism, even when unjustified. It is to kiss your children, pamper your parents, to live poetic moments with friends, even when they hurt us. To be happy is to let live the creature that lives in each of us, free, joyful and simple. It is to have maturity to be able to say: "I made mistakes". It is to have the courage to say "I am sorry". It is to have the sensitivity to say, "I need you". It is to have the ability to say "I love you".

May your life become a garden of opportunities for happiness ... That in spring may it be a lover of joy. In winter a lover of wisdom. And when you make a mistake, start all over again. For only then will you be in love with life. You will find that to be happy is not to have a perfect life. But use the tears to irrigate tolerance. Use your losses to train patience. Use your mistakes to sculptor serenity. Use pain to plaster pleasure. Use obstacles to open windows of intelligence. Never give up Never give up on people who love you. Never give up on happiness, for life is an incredible show.

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Foreword



CONFIDENT AND OPTIMISTIC FOR THE FUTURE

We are pleased at the timely introduction of this handy reference manual with unique Singapore perspectives on communicable diseases control for the medical and public health community.

COVID-19 has taught us that ours is a time of unprecedented challenges in global health security and the emergence of pandemic diseases, with urgent need for investment in public health. Recent events in the global surge of measles and importation of monkeypox have also attested to this. Today, almost 18 years after the SARS experience, our best asset is the close collaboration on public health matters that exists across all sectors. The terms communicable disease and infectious disease are synonymous and, despite our national disease burden shifting more towards diseases of an ageing population, the threats from infectious disease remain real.

Today, a vital tripartite partnership exists between the National Centre for Infectious Diseases, the Saw Swee Hock School of Public Health, and the Ministry of Health. From the purpose-built facility where clinical inpatient and outpatient services are integrated with public health laboratory, epidemiology and research units, and working with the Ministry to protect the country from emerging disease threats, the national public health school enhances our ability to respond effectively to emergencies through

the Singapore FETP (field epidemiology training programme) enterprise and network as a national resource for skills-building and continuing professional development of medical and public health officers.

Achieving our mission to safeguard Singapore from outbreaks would not be possible without the collective contribution of our healthcare colleagues in hospitals, clinics and nursing homes. This reference on clinical management and public health measures against communicable diseases helps serve as a useful guide for those manning the frontlines as doctors, nurses, laboratory scientists and allied healthcare workers. The contents cover infections that any healthcare professional today may encounter in the form of emerging and re-emerging pathogens, including bioterrorism threats.

Ensuring our health security clearly extends beyond human health to involve good hygiene, sanitation, environmental health, animal health, food safety and social resilience. Under the One Health framework, we have invested heavily in building the field epidemiology capacity of our country to detect abnormalities and trigger alerts to facilitate timely response to emergencies. Public health practitioners investigate into issues and also help create a detailed profile of community health, which in turn provides important clues to the at-risk groups in need of targeted interventions.

Many cohorts of committed people over the years have exemplified collegiality and worked tirelessly behind the scenes to make high standards of public health a reality. With such dedication, we are confident and optimistic for the future.

Assoc Prof (Dr) Kenneth Mak and
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Preface

SAFEGUARDING OUR COLLECTIVE FUTURE

Greetings from Singapore FETP! 2020 marks our field epidemiology training programme's tenth anniversary with the publication of this book for you in extraordinary times.

You will find here a disease control primer and reference for our medical and public health practitioners in three sections. The front section scopes out the Singapore FETP enterprise with selected essays on nine distinct themes by our subject specialists. Next comes the main section which covers communicable diseases of public health importance from A-Z, describing the epidemiological, clinical, and microbiological features of each disease with bibliography. Our back section adds useful resources on disease notification, post-exposure prophylaxis, global health risk assessment, and information sources.

As the landscape of infectious threat constantly changes, our publication will periodically update chapters online at the National Centre for Infectious Diseases website for easy access and downloading by users. Emerging diseases such as COVID-19, unwelcome as they are, occur from time to time and represent valuable opportunities for us to learn about the host, agent and environmental circumstances upon which outbreaks can be controlled. With precious insights gained from decades of nation-building as a tropical island city-state, Singapore has successfully created the built environment that can sustain the comfort and public health of millions.

We share herein our Singapore experience in dealing with public health emergencies, not just the causative agent and treatment, but also how we put in place a strong legal, policy, clinical and laboratory framework to prepare for and manage such emergencies. Effective outbreak prevention and control relies on proper public health systems, political support, and good teamwork. Safeguarding our collective future in urban modernity demands consistent work, to trace the sources of infection and modes of transmission as well as upstream measures that can prevent a recurrence.

This publication enlarges upon the legacy of "A Guide on Infectious Diseases of Public Health Importance," commonly referred to as the "Blue Book" which ran for seven editions until 2011, clearly demonstrating the strongly felt need by generalists in

our community for a concise guide to the management of communicable diseases. Special gratitude goes to the pioneering foundations provided by Drs Hsu Li Yang, Goh Kee Tai, Adrian Ong and Ling Moi Lin, the World Health Organization, GOARN [Global Outbreak Alert and Response Network], TEPHINET [Training Programs in Epidemiology and Public Health Interventions Network] and the Infection Control Association (Singapore). The totality of the leaders, funders, implementing partners, government agencies, and other stakeholders engaged in the global field epidemiology effort, along with associated workforce competency targets, standards, agreements, technologies that undergird this work constitutes our FETP Enterprise.

Building on years of professional training, closely studying overseas models, and actual practice in applied epidemiology, we share our insights. While due diligence has been made to check for factual accuracy at the time of publication, may I apologise for any shortcomings. I am very grateful to my multidisciplinary associates (Irving, Monica, Nancy), hardworking subeditors (Pei Pei, Cui Lin, Nandar, Yijun, Wan Han, Sarah), artistic colleague (Kelly), and the many professionals who have contributed in multiple ways to this project (please see list of contributors). They have sacrificed much personal time and energy towards a truly collective effort by clinicians, laboratorians and epidemiologists.

It has been a privilege for me to work with so many talented people. My hope is that you find this manual relevant and useful for many years to come.

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The Singapore FETP Enterprise

An aerial photograph of a coastline, likely a bay or inlet, with a blue overlay that has a textured, water-like appearance. The text is overlaid on the lower portion of the image.

**"Experience
makes the
difference!"**

COMMUNITY PREPAREDNESS AND HEALTH PROTECTION

Steven PL Ooi, Yee Sin Leo

INTRODUCTION

On our national day, 9 August 2020, we are still in the early days of the COVID-19 pandemic caused by a new coronavirus although it may feel like ages. As two old-hands who experienced the struggles of the severe acute respiratory syndrome (SARS) outbreak in Singapore, we are gratified to see that preparedness systems are in place here and working well.¹⁻⁴ The measures introduced have even been endorsed by infectious disease experts such as the London School of Hygiene and Tropical Medicine's Professor David Heymann, who noted that despite causing inconveniences, Singapore "is not overdoing it."

Nonetheless, a crisis of public confidence is moving faster than the crisis of public health. Masks, hand sanitisers and disinfectants were the first to fly off the shelves. Even in our traditionally stoic society, a breach in our psychological defence occurred when some took to hoarding of food and household items once Singapore moved to DORSCON [Disease Outbreak Response System Condition] Orange on 7 February 2020. Can we succeed in besting this virus? The answer is most certainly yes, and we are confident of the reasons why.

UNDERSTANDING OUR INSECURITY

Insecurity amidst uncertainty is to be expected. Many reports, some untrue, are making their rounds in chat groups, stoking public anxiety, doubt and fear. We are sad to see SARS revisited in many ways, with the old unfounded fears of infection prompting members of the public to shun healthcare workers and landlords to throw out tenants who had travelled to China.

But COVID-19 is much less deadly than SARS or the Middle East respiratory syndrome (MERS). Case-fatality rate measures the number of deaths among those infected - this is now coming out consistently to be much lower for Covid-19. On the other hand, this disease is far more capable of transmitting between humans than SARS or MERS. Transmissibility is measured by its reproduction number, cases directly generated from each case - this is showing to be more like pandemic influenza.

While social media can be useful, it also means that information can be overstated. Bad news spreads faster than good news. Media which build in algorithms that prioritise sites similar to those often visited, compound biases in line with previous viewpoints and worsen fear. The authorities have been quick to provide timely updates and dispel rumours. But people have different ways to judge the impact for themselves, with some even contemplating the “what-if” future state, such as DORSCON Red.

Hence, expectations and beliefs honed from prior experience and observation of other countries contribute towards behaviours such as panic buying. The verdict on this outbreak is not out yet. Much attention is on the effectiveness of control measures in many countries. Whatever the case may be, we can prepare for the worst while hoping for the best.

WHY WE ARE CONFIDENT OF SUCCESS

Whether the outbreak lasts until the arrival of our first vaccine or longer, halting this outbreak in its tracks ultimately depends not so much on disease duration as on our collective resilience. Sustainability is key to preparing for a long battle. Support for each other is crucial to our psychological defence. When we recall events of 2003, the immediate impact of SARS was fear. But out of this grew one long-lasting positive effect, in the form of a nationwide crash course on the importance of good hygiene practices.

Being a compact city state with a high population density, and dependent on global connectivity for our life blood, we have to accept many hard truths. But we are not helpless. There are many actions we can take together to safeguard public health and minimise the impact of acute events that endanger us. Unwelcome as they are, public health emergencies will occur from time to time and they represent opportunities for us to derive valuable information not just about the disease threat, but also about ourselves.⁵⁻⁸

Courageous volunteers are offering their skills and support in the community. Scientists are readily sharing knowledge to address the dearth of understanding on how COVID-19 originates and spreads. And we have dedicated healthcare and public health professionals, many with experience from SARS. In addition, Singapore’s unique size also works in our favour. Many challenges are much more manageable in scale here than they would be in other countries.

We have ample resources, invested heavily during peacetime. We also have the will to learn from our mistakes and stand together.⁹⁻¹¹ These assets collectively constitute our urban health security. Hence, we are confident of success.

COMMUNITY-BASED RESPONSE IS A VITAL ASSET

As global events unfold, the momentum of this disease is such that we can expect the outbreak to get worse before it gets better. Nonetheless, we remain optimistic. Just as with SARS, here is a chance for us to improve our community-based response with social norms of good hygiene, consideration for others, and cooperation. With concerns over community spread, we must practice safe distancing, wear a mask, and wash our hands regularly. If we feel unwell, see a doctor and avoid contact with others. We must also be judicious in the use of limited resources. Inconvenience is inevitable, but we must be patient. The virus does not discriminate, and neither must we.

While we stay geared to fight, our spirits are uplifted by human stories of selflessness. We sense a groundswell of people motivated to strengthen our urban health security. Indeed, some of the panic buying ostensibly for one's own and relatives could be arising from pent-up emotions seeking ways to respond. Perhaps we can harness this for a greater good. Acts of kindness - people cooperating to cheer on frontline workers with simple tokens of care, and giving others food, masks and hand sanitisers - nourish our hearts with a warm glow of togetherness.

Our National Centre for Infectious Diseases and Saw Swee Hock School of Public Health have linked up with various groups to address requests on how to mount community-based responses, and clarify any misinformation on the outbreak. There is resilience and solidarity. As the national crisis unfolds on two fronts, public health and public confidence, we see an excellent learning moment for all of us. Connection and engagement in one whole-of-society approach should not be ignored because the community is proving vital to Team Singapore.

CONCLUSION

COVID-19 is changing entirely the way our community functions and society will have to chart, in tandem with global developments, a new path for the future. Once Singapore ceases its containment efforts and gets its act together back towards the semblance of normality, we may yet be surprised that it has taken us sooner than we expect.

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URBAN HEALTH SECURITY

Steven PL Ooi, Ming Fai Chew, Charlene J Fernandez, Hon Keong Leong

INTRODUCTION

With global transformations in politics, economics and culture, increasing connectivity and cosmopolitanism, our world is becoming very vulnerable to the threat of outbreaks. Health authorities in cities today face multiple challenges, from emerging and re-emerging infections to the spread of antimicrobial drug-resistance, which all demand improvements to urban health security. This requires epidemic intelligence efforts to minimize the impact of acute public health events that endanger the collective health of our urban populations. Singapore has observed this convergence of circumstances that condition our set of disease control measures, and also notable local features that make our situation unique. In this report, we provide our perspective on five key areas that are core to our city state's public health safeguards against communicable diseases.

CONTACT TRACING AND QUARANTINE

The emerging diseases situation in Singapore is closely monitored through a comprehensive system of public health surveillance. While Singapore's international connectivity always placed it at an increased risk of imported infections, the SARS outbreak has been a defining moment in our nation-building experience.¹⁻³ In February 2003, infection was introduced into the country with the return of three unsuspecting young travellers from Hong Kong, and further imported infections from symptomatic patients to other passengers and crew were documented in at least three flights flying outbound from Hong Kong.⁴ In order to stem its spread, we set up a contact tracing centre which catered for 200 officers who sought to identify all contacts of SARS cases and observation cases in whom SARS could not be ruled out. In total, 238 cases with 33 deaths were reported and the large-scale quarantine operations cost the government approximately US\$5.2 million.^{5,6}

In rolling out quarantine measures, the SARS outbreak had shown that disease control required a whole of government approach and could not be the sole purview of the health authority. Fear and uncertainty over an unknown disease rapidly ignites panic, with adverse repercussions on the economy and social fabric. Hence, in the aftermath of SARS, Singapore invested heavily into contingency planning, pandemic preparedness, and epidemic intelligence.⁷⁻⁹ With these resources, external surveillance,

risk assessments and horizon scanning are routinely undertaken to monitor and analyse changes in overseas disease landscapes. Intelligence acquired from this process is used to track potential threats, trigger public health response, and inform the relevant stakeholders when necessary.

We maintain vigilance over COVID-19, Middle East respiratory syndrome, Ebola virus disease, yellow fever and other global developments. Our national strategy is premised on a well-established surveillance and response system that forewarns, detects, and contains the importation of a novel agent, and on mitigation measure when community spread is sustained, i.e., showing no epidemiological link to imported source cases. As part of our outbreak response, we have introduced a DORSCON colour-coded national risk communications plan with flexible and step-wise advisories to be provided by the public health authority to members of the public according to the nature and transmissibility of the agent, and the evolving situation.

ONE HEALTH FRAMEWORK

Singapore's rapid urbanization has resulted in an increasingly built environment with new dynamic interactions between the natural biosphere and the man-made technosphere.¹⁰⁻¹² Further, our dependency on food imports, growth of high- tech farming, hawker culture, and taste for exotic produce all pose food safety challenges that are compounded by high tropical ambient temperatures and ample opportunities for cross-contamination.^{13,14}

To safeguard public health, the city state has established a One Health framework as the mechanism for expanding cross-sectoral coordination between the human, animal, food and environmental health sectors. This framework is supported by international organisations such as the World Health Organization, World Organization for Animal Health, Food and Agriculture Organization, and Asia-Pacific Economic Cooperation.

In 2007, actions at the human-animal-environment interface were tested by our first locally acquired human *Plasmodium knowlesi* malaria infection, requiring ecological studies into simian malaria transmission from local macaque populations. Following the first case, four additional human cases occurred within the same year, and one in 2008. All cases involved military personnel who had undergone training in restricted-access forested areas in Singapore.¹⁵ The risks of exposure persist and, although Singapore has been certified malaria-free by the WHO since 1982 and the *Anopheles* spp. vector population has been reduced to low levels, urban malaria outbreaks can still be triggered by returning travellers, or foreign workers with relapsing *P. vivax* infection.^{16,17}

Our health protection is made more effective through a larger platform of international cooperation.^{18,19} This is because the country's status as a trade and travel hub together with the presence of vectors renders us both vulnerable and receptive to the introduction of emerging infections from the region. Hence, we maintain professional exchanges with regional neighbours and are strong supporters of WHO's global outbreak alert and response network (GOARN). The benefits are mutual because our officers who deployed overseas have gained useful experience as well as technical, operational, and logistics skills.

CAPACITY BUILDING FOR INTEGRATED RESPONSE

Core capacities to mount an integrated public health response across agencies were put to the test during the 2009 influenza pandemic. The multiple introductions of novel influenza A(H1N1) virus was thought to be related to a high number of flights coming in from major urban centres, and investigations into a cluster of six cases revealed transmission on board a commercial aircraft which confirmed the capability for rapid spread across borders by convenient air travel.²⁰⁻²²

In a public health emergency such as SARS, border closure may not be feasible because we are highly dependent on international trade and food supplies. Nonetheless, while maintaining continuity of services and supplies, morbidity and mortality could be reduced through early isolation and treatment of cases, nation-wide contact tracing, and enhancement of prevention and control measures.²³

Vector-borne epidemics are also occasion for integrated response. The quintessential dengue continued to see cyclical outbreaks and in 2005 and 2013-14, a serotype switch from DEN-2 to DEN-1 unleashed epidemics with record high numbers.^{24,25} The Ministry of Health (MOH) oversaw clinical management while the National Environment Agency (NEA) stepped up vector surveillance and control operations through an inter-agency dengue taskforce. Chikungunya infection also became a serious concern when it surfaced in 2008.²⁶ Genetic analysis showed that the first three local episodes were most likely the result of independent importations of the virus from neighbouring Asian countries while locally acquired cases around July in the same year were largely due to a single strain which was closely related to the strain detected in cases imported from Malaysia.²⁷ In addition, the first local outbreak of Zika occurred in 2016.²⁸ Integrated response ensured clear and timely provision of information, advocacy for social responsibility, and promotion of good housekeeping practices that helped to strengthen social trust and morale.

Capacity building in peacetime leads to better public health coordination in an emergency.²⁹ In 2018, our ongoing collaborative efforts in preparedness and response across four ministries and seven government agencies culminated in a highly favourable joint review of our core capacities by a multi-sectoral team of international experts coordinated by the WHO Western Pacific Region.

UNCERTAINTIES AND PUBLIC HEALTH RESEARCH

We live in an ambiguous and volatile world full of uncertainties - unusual outbreaks, stress-related disorders and other curious aetiologies have occurred from time to time.³⁰⁻³⁴ The role of lifestyle became more evident in an outbreak of *Fusarium* keratitis associated with contact lens wear (ReNu with Moisture Lock, manufactured by Bausch and Lomb) which we investigated in 2006.^{35,36} Of the 66 patients diagnosed, close to 82% reported poor contact lens hygiene practices, highlighting the potential harm posed by novel products if not used properly. In 2016, the Group B *Streptococcus* outbreak associated with consumption of ready-to-eat raw fish in porridge sounded another cautionary note against the increasing sophistication of city life and behavioural determinants finding a greater role in disease aetiology.³⁷

A long-term variable that may amplify disease transmission is climate change, as evident by extreme weather events, particularly the unprecedented flash flooding in the 2010s. Our national environmental agency had encountered difficulties in rainfall prediction, which may augur unfavourably for infrastructural planning. Extreme weather events demonstrate larger forces at work that remain poorly understood and addressed even as the country grapples with new realities. New disease control requires study into the epidemiologic triad as host, environment, and agent rebalances dynamically.³⁸

Singapore, to attain its vision of a distinctive global city with a relatively affluent, well-educated and upwardly mobile population enjoying good access to environments, goods, and services, requires a first world public health service to match.³⁹ Practicing field epidemiologists understand the importance of establishing professional credibility with stakeholders through scholarship in research and publication. This work involves making applied research contributions to the scientific community, designing field studies to test novel hypotheses, and adding to the growth of knowledge via medical journals, news bulletins and surveillance reports.

LEADERSHIP AND SUPPORT IN THE COMMUNITY

In the global village where many potential threats loom ominously over the horizon, we need forward- looking strategies and administrative processes to future-proof public health. Leadership and support for Singaporeans to lead healthier lives is provided by the Ministry of Health in a key shift of focus beyond hospitals to the community. We are currently re-engineering public health systems to improve workstreams and policy decisions using modalities to process large amounts of incoming data, new ways of visualisation, functionalities to splice data by important variables, spatiotemporal analyses, and thresholds to trigger alarms.

Since 2010, our Singapore field epidemiology training programme has been building a cadre of field specialists who are highly competent to lead and support the public health mission.⁴⁰⁻⁴² Modelled after the US Centers for Disease Control and Prevention's epidemic intelligence service, our graduate fellows have moved on to gain peer recognition through involvement in WHO, GOARN and TEPHINET activities worldwide. We are also an active founding member of the regional ASEAN+3 field epidemiology training network.⁴³⁻⁴⁴

Working within our local communities, we are promoting shared values through outreach programmes such the One Health diploma course at Temasek Polytechnic and a mini medical school at Khoo Teck Puat Hospital. Saw Swee Hock School of Public Health was established at the National University of Singapore in 2011 to produce future leaders and innovate new technologies to address complex challenges. And the new National Centre for Infectious Diseases has officially opened in 2019 as a purpose-built state-of-the-art facility for the public health and clinical management of communicable diseases.

CONCLUSION

We have described our experience of upholding urban health security that perhaps offers a case study in communicable diseases control. Singapore's territorial compactness, population heterogeneity, and affluent lifestyles mirror the characteristics of many cities today. To beat the odds of tropical disease outbreaks, policy and control measures must evolve with the dynamics of modern life. The presence of a flexible and responsive field epidemiologic service contributes strongly to our capability for managing outbreaks and guiding positive human behaviour.

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SURVEILLANCE AND OUTBREAK RESPONSE

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INTRODUCTION

In our rapidly evolving modern environment, the public health authority can no longer rely just on classical surveillance mechanisms to recognise emergence of new threats. Such surveillance, often referred as indicator-based surveillance, provides structured data on selected communicable diseases of public health importance. Epidemic intelligence adds event-based surveillance to augment the information on unusual occurrence of diseases and conditions not usually captured by traditional surveillance programmes.^{1,2} This is important because good outbreak response requires the systematic gathering of information on suspect or confirmed communicable diseases to enable early detection of outbreaks and to implement timely control measures.³ Singapore's system is described here and comprises its national surveillance programmes, event-based surveillance, field epidemiologic investigations, and epidemic response capabilities.

NATIONAL SURVEILLANCE PROGRAMMES

National surveillance programmes are essential for the monitoring of communicable diseases and the timely prevention and control of outbreaks through early detection.⁴ Global travel and trade bring new threats of communicable diseases, while data management and diagnostic technologies can transform the way we monitor and respond to such threats.⁵ In addition to the legally required disease notifications, animal surveillance for zoonotic diseases, environmental surveillance for mosquito breeding and rodent infestation, as well as food safety surveillance for foodborne pathogens, all contribute towards our national surveillance programmes. In addition, we are seeing advances in monitoring by syndromes, viruses, serology and molecular methods.

Disease notifications

According to the World Health Organization, a national surveillance programme should be able to identify diseases of public health importance in the local population for prevention and control actions⁶. Indicator-based surveillance to determine the national incidence of selected diseases depends on mandatory notifications by registered medical practitioners and clinical laboratories, as stipulated under the First Schedule

of the Infectious Diseases Act (IDA). There are 45 diseases currently on the Schedule⁷ which is reviewed and adjusted periodically as the risk assessment changes (these specific diseases are listed in the Public Health Resources section at the back of this book). All notifications are verified to fulfil surveillance case definitions before being classified as cases. For vector-borne, food-borne and environment-related diseases, the Ministry of Health (MOH) works closely with public health agencies such as National Environment Agency (NEA) and Singapore Food Agency (SFA) to investigate and implement control measures. For those that are spread through human-to-human transmission, MOH works closely with the healthcare community to effect control measures involving isolation, vaccination and chemoprophylaxis.

Syndromic surveillance

Syndromic surveillance provides data on disease conditions which cannot be obtained through passive reporting systems.⁸ MOH conducts sentinel surveillance through the collection of disease data from a network of carefully selected reporting sites known as sentinel sites. Polyclinics located throughout the country act as sentinels providing us with weekly returns on the number of patients who have been treated for acute respiratory infection, conjunctivitis and diarrhoeal illness. Outpatient attendances for these syndromes are obtained from their computerised system which collates data on the clinical diagnoses of all patients treated at polyclinics.

Virological surveillance

MOH, in collaboration with the National Public Health Laboratory, conducts virological surveillance which is the ongoing and systematic collection and analysis of viruses in order to monitor their characteristics. Examples of virological surveillance include:

- Influenza virus types isolated from respiratory specimens taken from hospitalised patients and those presenting with influenza-like symptoms at polyclinics and sentinel general practitioner (GP) clinics;
- Enteroviruses isolated from throat swabs taken from hand, foot and mouth disease patients seen at emergency departments or hospitalised in paediatric public hospitals and those presenting with symptoms at polyclinics and sentinel GP clinics;
- Dengue virus serotypes isolated from blood specimens taken from cases tested positive for dengue virus infection;
- Chikungunya virus detection from blood specimens tested negative for dengue in sentinel GP clinics; and
- Enteroviruses isolated from stools of cases presenting with acute flaccid paralysis as well as patients diagnosed with associated conditions (e.g. encephalitis, transverse myelitis).

Serological surveys

From time to time, serological surveys are carried out to assess the herd immunity of our population against specific diseases, and to evaluate the effectiveness of the national childhood immunisation programme. For instance, National Seroprevalence Studies in 2005 and 2012 showed that childhood immunisation efforts have been successful in increasing the population immunity against rubella.⁹ The coverage of the national childhood immunisation programme is monitored via a notification system maintained at the National Immunisation Registry.

Molecular epidemiology

With new molecular methods, we are able to study the molecular epidemiology of pathogens.¹⁰ MOH increasingly applies molecular surveillance to complement the existing surveillance systems and to assist in epidemiological investigation. For instance, HIV molecular surveillance enables monitoring of recent infections among newly-diagnosed, treatment-naïve HIV-positive individuals, circulating HIV subtypes, and transmitted antiretroviral resistance.¹¹ Molecular serotyping of *Salmonella* isolates provides the most common *Salmonella* serotypes causing local salmonellosis. Whole genome sequencing conducted as part of outbreak investigations¹² supplements our field observations and facilitates detection of possible transmission pathways.

EVENT-BASED SURVEILLANCE

Event-based surveillance looks at anecdotal and unofficial information on unfolding events that could pose a public health risk. Two types of event-based monitoring are the reporting of significant events by medical practitioners and the use of internet-based external surveillance, both complementing our national surveillance programmes.

Reporting of significant events

Ad-hoc reports of suspect/confirmed disease clusters or outbreaks by astute physicians are valuable because they are the front-line sensors in detecting unusual occurrences in the number of patients with a particular illness. Such information enables MOH to detect outbreaks early, and even pick up conditions which are new and not legally notifiable. Three examples of significant events alerted by astute physicians are an outbreak in 2015 of Group B *Streptococcus* infections with epidemiological links to the consumption of raw fish,¹³ our first Zika virus disease outbreak in 2016,¹⁴ and a large community outbreak in 2016 of rotavirus affecting a neighbourhood.¹⁵

Internet-based surveillance

Internet-based external surveillance is used by MOH to routinely monitor and track communicable disease threats overseas through a systematic framework of horizon scanning and risk assessment.¹⁶ Recognising the potential for outbreaks to be introduced across borders, information available on internet from mainstream media and social media¹⁷ are regularly processed into epidemic intelligence information for assessing the risks to local public health. This ongoing process enables public health preparedness and early detection of imported infection.

FIELD EPIDEMIOLOGIC INVESTIGATIONS

In addition to single and sporadic infections, disease clusters are common in settings such as nurseries, pre-schools, schools, army camps and long-term care institutions. These settings often present ideal conditions for disease to spread because their populations experience close proximity and difficulty in ensuring compliance with good personal hygiene practices and respiratory etiquette.¹⁸ The response to a disease cluster must include field epidemiologic investigations to ascertain an outbreak, actively find cases, identify the source of infection and mode of transmission, and prevent further disease transmission.

Outbreak ascertainment

Upon notification of a disease cluster, we would need to verify the diagnosis to rule out misdiagnosis and laboratory error and ascertain whether an outbreak exists. This requires review of case notes and confirmation of the laboratory results. Laboratory specimens must be obtained from the initial cases reported to test for the pathogen. If the disease is life-threatening but the aetiology is still uncertain, it is necessary to recommend immediate precautionary measures based on knowledge about infections that are clinically similar.

Active case finding and contact tracing

A proper case definition is required in order to identify all persons with the infection by place and time. Case definitions should be sufficiently sensitive, but also differentiate between probable and confirmed cases. For air and droplet-borne diseases, contacts (persons who have had contact with known cases during their infectious period) should be identified, located and, under some conditions, asked to stay at home or be placed under quarantine for the duration of the incubation period.

Descriptive and analytic studies

All cases should be interviewed to provide information on their demographics, symptoms, travel history, movement history, contact history, and exposure to risk factors such as animals or lifestyles. This information will be useful in identifying the source of infection and mode of transmission. Once a possible source has been identified, alternate hypotheses on the chain of infection should be developed and analytic studies conducted to determine the chronology of events leading to spread of infection. Knowing the population-at-risk ensures that proper surveillance and control measures can be undertaken.

Prevention of further transmission

Precautionary measures are applied to break the chain of infection and prevent further transmission. Such measures may include social distancing, closure of institutions, avoidance of specific foods, and culling of animals. Vigilance is necessary until there are no new cases after two incubation periods of the disease.

EPIDEMIC RESPONSE CAPABILITIES

An epidemic is defined as the occurrence in a community of cases of a disease clearly in excess of normal expectancy whereas an outbreak is the aggregation of disease in space and time that can be attributable to a single source. Often, public urgency and political reaction dictate the need for immediate control measures while an investigation is ongoing. Public health response measures include, among many actions, establishing a task force/outbreak response team, managing ill persons, sizing the extent and severity of illness, instituting epidemic control measures, and undertaking risk communications.¹⁹ To effectively coordinate responders, intelligence gathering, and health interventions, we need a dedicated physical space, documentation of meeting decisions, joint plans of action, and tools for communicating to stakeholders.²⁰ In the event of a pandemic where an epidemic occurs worldwide, the response will be maximised into a national level and the whole-of-government approach will be implemented.²¹

The One Health framework protocol

We adopt the One Health framework protocol in epidemic response and outbreak management. This is a collaborative interdisciplinary and multi-sectoral approach working at the local and global levels to achieve optimal health outcomes recognising the interconnection between people, animals, plants and their shared environment.²² Under One Health, multiple public health agencies work together to investigate and control disease outbreaks comprehensively.

For instance, Singaporeans like to eat out and are exposed to multiple risks ranging from contaminated food imports to insanitary practices at food establishments involving poor food and personal hygiene.²³ The principal considerations for epidemic response are for: (i) MOH to protect public health by minimising disease transmission; and (ii) SFA to ensure food safety by prompt recall of implicated food products from the market. The latter has an integrated food safety system which includes accreditation of countries and overseas export plants, import inspection as well as the regulation of farms, food factories, and retail food establishments.

Outbreak communications

MOH employs various communications platforms for information sharing with medical practitioners and other stakeholders. Depending on the urgency and type of information to be disseminated, they involve the following:

- **MedAlert System** - During outbreaks, the MedAlert System enables the rapid dissemination of information to all medical practitioners, via SMS, email and fax. Medical practitioners receive timely updates on the outbreak situation via this system.
- **Weekly Infectious Diseases Bulletin** - MOH's Weekly Infectious Diseases Bulletin publishes detailed information on the weekly incidences of infectious diseases including graphs demonstrating trends and comparisons with the preceding year. The bulletin is available online at <https://www.moh.gov.sg/resources-statistics> under the filter type "Infectious Disease Statistics."

In addition, we are exploring new technologies in health informatics to enhance existing systems for dissemination of important public health information. Effective risk communications empower the population, and uphold their trust which is placed in the public health authority.²⁴ However, advancements in information technology also alter the pace and breath of information people acquire, and can pose serious challenges to the public health authority to stay effective.²⁵ Information provided to the public must be simple, reliable and timely. Various communication media channels such as televisions, newspaper and social media exist. Effective communication is important because it maintains public confidence, avoids undue anxiety, and helps individuals and the community to understand the situation.

CONCLUSION

Singapore's epidemic intelligence system comprises its national surveillance programmes, event-based surveillance, field epidemiologic investigations, and epidemic response capabilities. Early disease detection relies on astute physicians and close collaboration between the public health agencies which work together under the One Health framework. Communications are disseminated in a timely manner so that medical practitioners, stakeholders and the public can make informed decisions and participate in prevention and control.

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HEALTHCARE EPIDEMIOLOGY

Dale Fisher, Angela Chow

INTRODUCTION

Healthcare epidemiology is the core scientific basis for monitoring healthcare-associated infections (HAIs). Identifying and tracking HAIs allows healthcare providers and policy makers the opportunity to introduce and reinforce Infection Prevention and Control (IPC) activities and interventions. Prevention of infections needs to be strategic with insight into the vulnerability of those at risk, the scale of the problem (or potential problem) and the threat posed by likely pathogens. Such agents include the well-known, the vaccine preventable, novel emerging and multi drug resistant organisms (MDROs).

The healthcare sector is vast involving patients, families, visitors and staff of acute hospitals, community hospitals, rehabilitation centres, long term care facilities, and the many forms of ambulatory care including day care centres, day rehabilitation centres, dialysis centres, primary care clinics, and specialist clinics. Furthermore, there is increasing movement of individuals between these settings so in that sense there is a continuum of care where IPC efforts need to be adapted to each setting and undertaken in a sustainable way that addresses HAIs holistically.

Healthcare epidemiology and IPC requires a baseline set of activities agreed to and implemented sustainably and appropriately based on the risk assessment. Surveillance should ensure maintenance and success of these baseline activities whether they be outcome or process orientated. It must also be geared toward early detection of an emerging threat so that the necessary (ideally predetermined) escalation and response can be scaled up rapidly. Whether at baseline activity or an outbreak situation, communications underpin all efforts and omitting any stakeholder or making assumptions regarding situational understanding can lead to failings. The delivery and technical content of communications needs to be tailored to recipients.

The scope of healthcare epidemiology is ever enlarging.¹ Cross-disciplinary collaborations are required to better detect, diagnose, understand, monitor, prevent, and communicate about healthcare-associated infections, harnessing on the capabilities of informatics, health economics, systems engineering, molecular diagnostics, and genomics.

PREVENTION OF HEALTHCARE-ASSOCIATED INFECTIONS

Infections result from the interaction between an infectious agent and a susceptible individual in an environment that brings the agent and individual together (epidemiologic triad).² Transmission of infections occur when the infectious agent leaves the infected individual and is conveyed by a mode of transmission directly or indirectly to infect another susceptible individual.

There can be no IPC in the absence of strong governance and a leadership commitment. There must be a strong top-down influence where safety is a priority, not only to patients but to staff and visitors. In an institutionalised setting, where there is cohabitation of people with varying degrees of immunosuppression exposed to pathogens, the risk to patients is clear. Likewise, visitors and staff can introduce or become recipients of infectious pathogens. Policies and standard operating procedures need to be adapted, clear, sensible, communicated and implemented effectively. This framework of activities represents the core components of an IPC programme.³

To prevent infections, these policies and standard operating procedures require implementation. The success of implementation can be assessed at the highest level via facility credentialing, periodic assessments of “standards” against a checklist or they can be monitored at the facility level via surveillance and audits of processes or even self-assessments of a programme.

The National Infection Prevention and Control Committee (NIPC) in Singapore has guidelines for IPC in acute hospitals expanding on all these issues.⁴ An IPC standards checklist and IPC guidelines for Long Term Care are soon to be published. In healthcare settings, standard and transmission-based precautions are required.⁵ Often some of these items are bundled for specific scenarios e.g. urinary catheter, ventilator and central line care.⁶

TRANSMISSION-BASED PRECAUTIONS AND STANDARDS

Standard precautions are the most basic level of IPC behaviours required in the care of all patients. They include:

1. Hand hygiene
2. Cough etiquette
3. Use of personal protective equipment based on risk assessment
4. Needle stick or sharp injury prevention
5. Blood or body fluid exposure prevention

6. Safe injection practices
7. Environmental hygiene
8. Linen and waste management

Transmission-based precautions are added to standard precautions when caring for patients who are (or are suspected to be) infected by an agent for which additional requirements are needed to prevent spread. Transmission-based precautions come in three forms, namely, contact precautions, droplet precautions, and airborne precautions.

Contact precautions

These are undertaken to prevent the direct transmission of an infectious agent from an infected patient to another patient either from contact with infected blood and body fluids, contaminated environment or objects, or via healthcare workers.

Contact precautions undertaken include the use of gloves and gowns. In acute settings such patients should be isolated or cohorted in keeping with national guidelines.³ Infections that may require contact precautions include MDROs such as methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci (VRE), carbapenemase-producing *Enterobacteriaceae* (CPE), crusted scabies, norovirus and *Clostridium difficile*.

Droplet precautions

Droplets are respiratory secretions >5µm in diameter. They can travel 1-2 metres. Pathogens transmitted via droplets do so via contact with the mucous membranes of the eyes or mouth of a susceptible individual.

IPC measures therefore include the use of masks and eye cover (either visors or goggles). Surgical masks will prevent spread via droplet borne organisms such as influenza, rhinovirus and meningococcus.

Airborne precautions

Airborne precautions are undertaken for infectious agents that can be transmitted via aerosols ≤ 5 microns in size and capable of being suspended in air for long periods of time or dispersed by air currents.

Airborne precautions require the use of N95 masks and the isolation of patients in negative pressure rooms. Infections that require airborne precautions include tuberculosis, chickenpox and measles.

SURVEILLANCE

Surveillance in acute healthcare institutions is a systematic way of collecting, collating, and analysing data on the incidence and prevalence of MDROs and HAIs as well as selected process indicators. Surveillance is necessary to monitor the trends in MDROs, HAIs and IPC activities. When correctly implemented surveillance and national indicator reporting can assess the effectiveness of infection prevention and control efforts.⁷

IPC monitoring involves healthcare-associated MRSA bacteraemia, clinical VRE and CPE, ventilator-associated events, central line-associated blood stream infection, catheter-associated urinary tract infection which are actively carried out in acute hospitals (public and private). Hand hygiene and environmental cleaning compliance rates are also actively being monitored by all hospitals. Consideration of any hospital's case-mix and infrastructures should always be undertaken when comparing institutions. Within one institution, benchmarking across time can gauge improvement and identify "hot spots" for escalated IPC interventions.

Surveillance should be tailored to the risk, the acuity and the capacity of the setting. Needs in the acute care setting paired with the capacity supports much more robust systems that are not required or practical in less acute care settings, for instance in nursing homes. This is reflected in the respective guidelines but must be accepted and implemented by front line staff. Refusing a MRSA colonised patient admission to a nursing home despite being common practice reflects on a poor understanding of IPC practice, nationally and holistically.

Finally, surveillance at points of entry to the healthcare system i.e. hospital level as well as primary care is crucial for the monitoring of international threats⁸. Early suspicion and isolation for novel pathogens is critical for Singapore in today's well-connected world. Recent threats have included Ebola and yellow fever viruses while in 2018 the greatest threat is Middle East respiratory syndrome. Communication with the Ministry of Health over such suspect cases ensures our compliance with World Health Organization's International Health Regulations (IHR) and with strengthening global security. Singapore is an international air hub and especially vulnerable as demonstrated by the importation of the SARS outbreak in 2003 and with that local amplification involving more than 200 people mostly because of healthcare associate exposures.

IMMUNISATION OF HEALTHCARE WORKERS

Staff in all acute hospitals as well as the intermediate and long-term care (ILTC) sectors are entitled to a proper occupational health assessment to ensure safety in their place of work. Patients and residents in these settings need to be assured that any risk from infection via their health care provider is minimised.

To prevent the transmission of infections from healthcare workers to patients and to ensure personal protection of staff, vaccination records of all staff will need to be maintained. Staff will be screened for immunity to varicella, measles and hepatitis B. Immunisation for varicella and boosters for mumps, measles, rubella (MMR), tetanus, diphtheria, pertussis (Tdap), and hepatitis B should be given if required. Furthermore, all staff immunisation programs should include annual influenza vaccination.

Soon there will be expectations for institutions to report on their programmes. Larger institutions will require a formalised occupational health department or system, nursing homes and small hospitals may choose to outsource this significant effort. The expectations irrespective of how they are met are critical to staff and patient safety. Future guidelines will elaborate more on the identification and management of latent tuberculosis.

NOSOCOMIAL OUTBREAK INVESTIGATION AND CONTROL

Ideally, strong surveillance in healthcare settings will enable early identification of an outbreak threat. Outbreaks and certainly events in the form of the threats are inevitable and these require prompt investigation for risks including identification and follow up of contacts. Inadequate IPC processes with inherent breaches increase the risk of outbreaks.

Pathogens causing outbreaks in acute hospitals include MDROs and air-borne transmissible organisms such as tuberculosis, chickenpox and measles. In contrast, common causes of outbreaks in nursing homes include upper respiratory tract infection, influenza, noroviral gastroenteritis, and scabies.

Whenever an infectious cluster is identified, the first step is to confirm the scale and introduce early containment interventions. These are somewhat predictable, and processes can be predetermined. The importance of routine surveillance cannot be overemphasised in enabling these critical early steps.

In LTCFs processes for surveillance, intervention and notification are outlined in the upcoming NIPC LTCF guideline.⁹ The acute care guidelines outline expectations in that setting.¹⁰

CONTROL OF ANTIMICROBIAL RESISTANCE

The overuse and misuse of antibiotics is an important driver of the development of antimicrobial resistance and the emergence of MDROs. It is critical to work with antibiotic users and see these products as biological tools.¹¹ Internationally, there are tremendous efforts being undertaken with researchers, prescribers, patients and those with a stake in veterinary use. In Singapore, we need to emulate this. In November 2017, the National Strategic Action Plan on Antimicrobial Resistance was launched in Singapore, with the aim to reduce the emergence and prevent the spread of MDROs through education, surveillance and risk assessment, research, prevention and control of infection, and optimisation of antimicrobial use.¹²

Antimicrobial stewardship programs are active in all restructured acute public hospitals. They are a growing entity in the private and non-acute sectors. Their mission is to ensure antibiotic guidelines for empiric therapy as well as subsequent targeted antibiotic therapy is optimised.

CONCLUSION

With an ageing population and increasing complexity of care, HAIs will continue to pose a threat in all healthcare settings. Healthcare professionals have a responsibility to understand healthcare epidemiology, the principles and practices of infection prevention and control, and antimicrobial stewardship, to better protect and care for those to whom they are responsible.

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CONTROL OF ANTIMICROBIAL RESISTANCE

Xin Mei Ong, Astrid Khoo, Yueh Nuo Lin, Tau Hong Lee

INTRODUCTION

Antimicrobial resistance (AMR) develops naturally in microorganisms such as bacteria, viruses, fungi and parasites and occurs most commonly upon exposure to antimicrobial substances.¹ Posing a perilous threat to global health, drug-resistant diseases presently contribute to at least 700,000 deaths every year.² It is estimated that by 2050, this will escalate to 10 million deaths annually and cost upwards of tens of trillions of USD to global economic output if no immediate action is taken. AMR threatens effective prevention and treatment of an increasing range of infections, and currently treatable infections may become fatal when numerous antimicrobials become obsolete. It also elevates the risk of various medical procedures such as organ transplantation, chemotherapies and other major surgeries due to the lack of effective prophylactic antimicrobial agents.³

The problem of AMR is not unique to humans. Animals, food products and the environment do carry AMR organisms or AMR genes which can be transmitted to humans.⁴ The interconnection between people, animals, plants, and their shared environment imply that strategies addressing the AMR issue cannot be confined to a single sector. To tackle AMR holistically, a coordinated and cohesive One Health approach needs to be adopted.

BACKGROUND ON AMR

In the bid to address the AMR problem within public hospitals, the National Antimicrobial Taskforce was established in 2009.⁵ Surveillance and monitoring of major drug-resistant pathogens and antimicrobial prescription in hospitals were made compulsory two years later, based on Taskforce recommendations. Public hospitals were also given financial support in order to implement antimicrobial stewardship programmes and develop clinical decision support systems. These served to curb antibiotic misuse and support guideline-based antibiotic prescriptions. With the aim of maintaining AMR surveillance and risk assessments within public hospitals while extending engagement to private hospitals and doctors in the community, Taskforce was reconstituted as the National AMR Control Committee in 2014. This Committee

is supported by two advisory panels, the National AMR Expert Panel and National Antimicrobial Stewardship Expert Panel.

The One Health AMR Workgroup was assembled by the One Health Coordinating Committee in early 2017.⁵ Through the collation of existing responses and coordination of efforts across the animal, human, food, and environment sectors, the National Strategic Action Plan (NSAP) was conceived by the work group in November 2017.^{5,6} The NSAP set in place a framework to unify and formalise existing response across animal, human, food, and environment sectors, address existing gaps and prioritise future interventions, and complement existing strategies against infectious diseases. The Antimicrobial Resistance Coordinating Office was subsequently established as a coordinating body to facilitate the implementation, monitoring of the NSAP and the coordination of AMR efforts across the sectors.

ONE HEALTH AMR WORKGROUP

The Workgroup is currently represented by members from the Ministry of Health, Health Promotion Board, National Environment Agency, Public Utilities Board, Singapore Food Agency, and National Parks Board's Animal and Veterinary Service. It reports directly to the One Health Coordinating Committee which provides the strategic direction in setting priorities on specific issues. The work group established three technical sub-groups to implement cross-sectoral initiatives in the education, surveillance and research domains. The main functions of the Workgroup are to:

- Develop and review the national strategic action plan (NSAP)
- Oversee the implementation, monitoring and evaluation of the NSAP
- Maintain information-sharing among all relevant sectors and stakeholders
- Establish policies relating to AMR issues
- Review proposed NSAP activities and initiatives
- Engage other relevant sectors as necessary

NATIONAL STRATEGIC ACTION PLAN ON AMR

The World Health Assembly endorsed the Global Action Plan on AMR in May 2015 with the aim of maintaining successful treatments and prevention of infectious diseases through the use of effective and safe medicines which are quality-assured, utilized responsibly and available to everyone who require them⁷.

In alignment with this plan and benchmarks set by the Food and Agriculture Organization, and the World Organisation for Animal Health, Singapore's National Strategic Action Plan on antimicrobial resistance aims to curtail the emergence and restrict the transmission of drug-resistant organisms through the following five main strategies.⁵

Education

It is vital for all relevant parties and the community to have accurate knowledge and perception with regard to the effects of AMR on health and society. In order to achieve significant changes in behaviour particularly within practices affecting AMR, different messaging strategies ought to be adopted when targeting professions and the public. Some of the key focus areas in this domain include:

- Raising public awareness and understanding of AMR and the importance of appropriate antibiotics utilisation
- Reinforcing education initiatives for professionals working in human and animal health

Surveillance and risk assessment

To facilitate rapid and efficient responses in tackling AMR, regular surveillance and monitoring of AMR along with risk assessments will need to be conducted. Information on resistance rates in particular organisms, epidemiological data of drug-resistant infections, antimicrobial utilisation levels and health outcomes will reveal resistance patterns over time. Accompanied with risk evaluations, these data can provide insights into the socioeconomic burden attributed to AMR and guide assessments of subsequent programmes. Key priority areas in this core strategy consists of:

- Consolidating surveillance efforts across human, animals, food and environment sectors
- Publishing and reporting relevant surveillance data at the national, regional and international levels
- Expanding surveillance to include private hospitals
- Broadening AMR surveillance to all animal production sectors

Research

Appreciating the underlying mechanisms and risk factors leading to the initial occurrence and subsequent transmission of drug-resistant organisms is necessary to design corresponding interventions. Globally, there are gaps in existing research pertaining to the development of novel vaccines and drugs for bacterial infections and better diagnostic assays that facilitates proper antimicrobial utilization. Several prioritised areas identified are:

- Mapping of AMR research conducted locally and providing more avenues for collaboration
- Incorporating AMR research into existing research programmes
- Identifying and providing funding for more areas related to One Health AMR research

Prevention and control of infection

Vaccination has been recognised as a crucial yet cost-saving method against AMR as it can protect both humans and animals from infectious diseases. Additionally, suitable prevention and control measures can reduce risks for infections and thus lower the need to prescribe antimicrobials. Some of the priority areas for further action include:

- Strengthening infection prevention and control measures in hospitals
- Raising the uptake of vaccination in community and animals
- Enhancing animal health management practices

Optimisation of antimicrobial use

One of the key drivers for AMR has been identified as the improper use of antimicrobials in both humans and animals. With the intention to encourage informed and evidence-based prescribing decisions among physicians, antimicrobial stewardship programmes were initiated in public hospitals. Having rapid and effective diagnostic tests will also be able to reduce antimicrobial utilisation when dealing with infections of an unfamiliar source or nature. Priority areas in this core strategy encompasses:

- Enhancing antimicrobial stewardship and utilisation within hospitals and community
- Strengthening the system to ensure prudent antimicrobials usage in the veterinary sector and reduce improper use of antimicrobials for food-producing animals

IMPLEMENTATION OF STRATEGIC ACTION PLAN

Antimicrobial Resistance Coordinating Office

The Coordinating Office was set up in September 2018 by the Ministry of Health under the auspices of the National Centre for Infectious Diseases. Through collaborations with One Health agencies and various other stakeholders, the Coordinating Office seeks to oversee and coordinate efforts in implementing, monitoring and evaluating the proposed activities and plans under the NSAP.⁸ The key functions consist of:

- Strengthening and coordination of AMR education efforts across different sectors;
- Collation and analysis of surveillance data as well as assessment of control strategies;
- Coordination of research relating to AMR; and
- Secretarial support for national committees such as the AMR Workgroup and Expert Panels

Key achievements

Since the launch of the NSAP in November 2017, significant progress has been made. A national coordinating centre has been established to support the national agenda for AMR, together with a One Health work plan detailing particular activities and programmes to be accomplished over the span of five years. Under the education sector, public education campaigns such as the “Use Antibiotics Right” by HPB propagated messages to the public that “Antibiotics do not work on the flu virus.”⁹ Outreach events organised by the Saw Swee Hock School of Public Health at local regional libraries since 2016 were expanded to include a pet component and engaged children in fun hands-on activities to learn about antibiotic resistance while educating adults on how they can play their part to reduce AMR.¹⁰ Through unification of efforts across different ministries and agencies, the first joint report on AMR surveillance and antimicrobial utilisation was generated.¹¹ This is a significant step in achieving better integration with regards to local surveillance in antimicrobial resistance and utilisation. Healthcare professionals within the different healthcare facilities can now refer to the national infection control guidelines for healthcare facilities formulated by the National Infection Prevention and Control Committee.¹² Following the establishment of programmes in public acute care hospitals, local community hospitals have been engaged to initiate similar programmes.

Regional and international collaboration

The movement of people, animals and goods globally due to trade or travel exacerbates the transmission of drug-resistant organisms and corresponding resistance genes. It is therefore essential for Singapore to collaborate with international partners to tackle AMR in an effective manner. The ASEAN Strategic Plan for AMR using the One Health approach was launched at the 14th ASEAN Health Ministers Meeting in 2019. This framework outlines certain goals and targets relevant to AMR control that ASEAN Member States should achieve in areas of human health, animal health, agriculture and environment. Singapore also voluntarily participated in the WHO Joint External Evaluation in 2018, and was recognised to have notable capacity in preventing, detecting and responding to public health threats, including AMR.¹³

CONCLUSION

With Singapore being a global trade and tourist hub, international movement and trade contributes significantly to dynamic trends and patterns of resistance. Hence, sustained collaboration and engagement at both regional and international platforms are critical. As there is generally low public awareness of AMR, a more directed approach will need to be adopted for education strategies. There is also incomplete data on antimicrobial utilization in specific areas such as among the general practitioners, veterinary clinics and aquaculture. Appropriate approaches to streamline data collection from different systems are currently being explored. To further the commitment towards reducing infections and optimising antimicrobial use, support for resources and efforts must be combined with defined targets to ensure longer-term sustainability.

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VACCINATIONS AND TRAVEL MEDICINE

Poh Lian Lim

INTRODUCTION

Travellers' health is an important aspect of public health and infectious diseases world-wide through the movement of people and products. At the clinician level, travel health is focused on keeping the individual traveller safe and healthy, and providing diagnosis and treatment for returning travellers who are ill or concerned about specific exposures. At the public health level, travel health is concerned with preventing imported infections, particularly from pathogens which can cause outbreaks.

IMPORTANCE OF TRAVEL MEDICINE

The severe acute respiratory syndrome (SARS) outbreak in 2003 started in Singapore with one index patient who acquired the respiratory infection in Hong Kong.¹ The MERS outbreak in South Korea in 2015, which caused 186 cases and 36 deaths, started with one ill returning traveler.² Along with the 2009 H1N1 pandemic³ and 2014 Ebola outbreak in West Africa, these are sobering reminders that we are only a short plane-ride away from an outbreak, and infections occurring even in faraway places may be relevant to us. With increasing globalization and urbanization, the risk of outbreaks spreading through travel will continue to rise over the next few decades.⁴

Singapore remains vulnerable to infections brought in through imported food and inbound travellers, whether returning Singaporeans or tourists from abroad. The total population of Singapore in 2018 is 5.6 million, comprising 3.4 million citizens, 500,000 permanent residents, and 1.7 million non-residents.⁵ Singaporeans and non-residents travel outbound for work, education, family visits, leisure as well as volunteer activities. In addition, 62 million passengers passed through Changi Airport,⁶ and Singapore saw 17 million tourist arrivals in 2017.⁷

At an individual level, patients have acquired life-threatening infections such as malaria and typhoid even from short trips to locales nearby (Indonesia, Cambodia) and faraway (Nigeria, Nepal). Singaporeans have died abroad from non-infectious hazards such as altitude illness⁸ and motor vehicle accidents.⁹ What you do not know can

hurt you, but with internet access, it is easy to book flights at short notice, and travel without appropriate precautions.

SCOPE OF TRAVEL MEDICINE

Travel medicine covers pre-travel consultation and post-travel management. For pre-travel visits, after making an assessment of the traveller's risks and the hazards of the destination, vaccine recommendations and prescriptions for malaria and altitude illness, if appropriate, will be provided. Travel health visits may be conducted by a well-trained nurse or pharmacist, which is common in many developed countries. Doctor visits are often reserved for those with more complex medical issues, higher risk travel itineraries, and those who require prescriptions by a physician.

TRAVELLER RISKS

The risk for a traveller depends on several factors, including age, gender, pregnancy and breast-feeding status, degree of immunosuppression (whether due to malignancy, chemotherapy, medications or medical conditions such as HIV), and active medical conditions such as dialysis, anti-coagulation, asplenia, recent surgery or blood clots. Traveller risk also depends on what vaccines and prior immunity the traveller already has. If the individual is travelling to an area with ongoing measles or chickenpox transmission, the risk is obviously greater for an unvaccinated individual.

Another type of risk pertains to the category of travel engaged in. Travelers who visit friends and relatives, also known as VFR travellers, and expatriates are well-documented categories at higher risk for certain travel-acquired diseases such as vector-borne infections.^{10,11} Duration of travel also introduces another dimension of risk, with long-term travel (over 6 months) putting individuals at higher risk due to more prolonged exposure and inability to maintain precautions for extended periods.¹²

DESTINATION HAZARDS

Travel health risk is directly related to the destination, and what activities the traveller engages in at the destination. Rural destinations generally pose a greater risk for malaria, and Japanese encephalitis. Some infections are present only on certain continents: yellow fever in Africa and South America, Japanese encephalitis in Asia. Geography can result in specific health hazards risks such as high altitude cerebral and pulmonary edema which can occur above 3000 meters, and hypothermia with extreme weather events like blizzards, or high latitude locations such as the Arctic and

Antarctic. Vector-borne infections will vary by location, with falciparum malaria more common in Africa compared to vivax malaria in India, Lyme disease and babesia in North America, Chagas disease and yellow fever in South America, and so on.

The activities a traveller engages in at the destination will also affect travel health risks. Someone volunteering in an orphanage in a developing country may be exposed to vaccine-preventable infections of childhood, such as pertussis. Sex tourists may be exposed to resistant HIV or gonorrhoea. Active individuals on treks or safaris may be at risk for abrasions (tetanus) or tick-borne rickettsial infections. Travelers with freshwater exposures (lakes, waterfalls) may be exposed to leptospirosis or schistosomiasis. Medical tourists getting organ transplants or joint replacements abroad may acquire infections that reflect the antibiotic resistance of their overseas hospital.

PRE-TRAVEL CONSULTATION

A competent pre-travel consultation will review the destination, timeframe for travel and activities planned, as well as the traveller's medical history, medications (including any immunosuppression within the previous 6 months), and vaccine records. The patient should be up-to-date for routine vaccinations. Vaccines for travel, and prescriptions for malaria or altitude illness prophylaxis should be given, if appropriate. Advice about food and water precautions, travellers' diarrhoea prevention and treatment, non-infectious risks such as traffic safety, and management of animal bites should be discussed, if relevant.

TRAVEL AND ROUTINE VACCINES

Routine vaccines are defined as vaccines a patient should have received, based on their age and medical conditions, even if they were not travelling. Individuals who are behind on their routine vaccinations should be advised to get them done prior to travel. Common examples of routine vaccinations include:

- Influenza & pneumococcal vaccines: for adults > 65 years old, diabetics, chronic heart, lung, liver, and kidney disease, asplenic, immunocompromised patients
- Measles, mumps & rubella vaccine (MMR): two doses four weeks apart, for anyone >12 months old, who is non-immune, unless pregnant or severely immunocompromised
- Chickenpox vaccine: two doses six weeks apart, for anyone >12 months old, who is non-immune, unless pregnant or severely immunocompromised
- Hepatitis B vaccine: three doses at zero, one, six months, for anyone who is unvaccinated and non-immune

- Travel vaccines are recommended based on destination or potential exposures, to persons who either have no vaccine records, or are uncertain of their vaccination history. Common examples of travel vaccinations include:
- Hepatitis A: two doses six months apart, to protect against this food and water-borne virus
- Typhoid: one dose injected, valid for 2-3 years, to protect against this food & water-borne *Salmonella*
- Yellow fever: one dose, valid lifelong, to protect against this *Aedes*-transmitted virus
- Japanese encephalitis: Imojev or Ixiaro, to protect against this *Culex*-transmitted virus
- Rabies: 2–3 doses, to protect against this fatal viral infection from mammal bites
- Meningococcus ACWY-135: one dose, to protect against this droplet-borne bacterium

If departure dates do not allow enough time for serology results, or the patient declines testing due to cost or discomfort, vaccination can be given if the patient understands the issues and agrees. If the patient is actually immune but gets vaccinated, the vaccination is unnecessary but should not be harmful to the patient, assuming due diligence has been taken to check for relevant vaccine precautions and contraindications.

POST-TRAVEL CONSULTATIONS

Post-travel consultations are focused on the patient's clinical presentation. Common problems seen post-travel include travellers' diarrhoea, respiratory infections and animal bites for which rabies post-exposure prophylaxis may be required. However, based on public health advisories, the patient may require admission, isolation and diagnostic investigations for infections such as MERS or H7N9 avian influenza.

The most important infection that should not be missed in a returning traveller with fever is malaria.¹³ *Falciparum* malaria typically has an incubation period (duration from exposure to first symptoms) of 1-4 weeks, whereas *vivax* malaria may be somewhat longer. However, there is a long tail with malaria incubation periods, extending up to 6-12 months. Questions about travel exposure will therefore need to take into account the infection being considered, and its incubation period.

CONCLUSION

Travel health is an important aspect of medicine that is relevant to most doctors practicing in Singapore because of its impact on patients as well as public health. Pre-travel consultation requires attention to traveller factors and destination hazards, assessment for vaccinations and preventive advice. Post-travel management requires a detailed travel history, careful consideration of the clinical presentation and an index of suspicion for potential infections with serious clinical or public health impact. Travel-related imported infections such as Zika or yellow fever have the potential to cause outbreak in Singapore because of the presence of *Aedes* vectors locally.¹⁴ Referral to a travel health clinic for preventive vaccines or to infectious disease specialists for diagnosis and treatment may be needed.

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MULTISECTORAL FIELD EPIDEMIOLOGY TRAINING

Steven PL Ooi, Jason Yap, Li Yang Hsu

INTRODUCTION

The Singapore field epidemiology training programme (S-FETP) currently trains a pool of Preventive Medicine residents and non-physicians to meet the Ministry of Health (MOH)'s need for professionals who can carry out field investigations and disease control. Our tropical city state's status as a densely-populated urban tropical trade and travel hub creates the transmission potential for many types of outbreaks. This paper outlines the vital partnership between the National Centre for Infectious Diseases (NCID) and the Saw Swee Hock School of Public Health (SPH) with MOH on creating a new national initiative to allow for stepwise training of more medical and public health officers to meet growing field epidemiology needs.

WORKFORCE DEVELOPMENT APPROACH

Beginning with what works

Field epidemiology training constitutes an important line of public health defence for the world against emerging infectious diseases.¹ Originally designed by the US Centers for Disease Control and Prevention (CDC)'s Epidemic Intelligence Service (EIS) based on a standard curriculum of practical competencies, there are 69 such programmes today across five continents.^{2,3} S-FETP was modelled after the US EIS and is a founding member of the ASEAN+3 field epidemiology training network (FETN).⁴ It joined the international Training Programs in Epidemiology and Public Health Interventions Network [known as TEPHINET] in 2010.

We performed a systematic review to study the characteristics of FETPs and included reference programmes in the US, UK, and Europe, as well as less established front-line ones from the Americas and Africa.⁵⁻⁹ All FETPs devoted over 80% of their training time to fieldwork. Variations in admission and course criteria to tailor to local needs and resources were observed.

Seeking expert advice and reconfiguring

In 2017-18, as chair of the ASEAN+3 training network steering committee, Singapore cross-consulted with other member countries on novel training methods and other

enhancements to engage millennials.^{10,11} We also sought directions at a WHO joint external evaluation of our IHR core capacities. S-FETP's efficacy was affirmed with the maximum score of 5/5.¹² The WHO team noted that our S-FETP experience was indeed valuable and should be shared with the wider global health workforce.

The experts further recommended that our programme be expanded to involve public health agencies outside MOH, with re-design of human resources towards more high-level functioning as innovations in technology are introduced. To address this wider field epidemiology requirement of other agencies such as Singapore Food Agency, National Environment Agency, National Parks Board's Animal and Veterinary Services, and the hospitals, we developed a bespoke training platform for sustainable workforce development.

Meeting the needs of stakeholders

We conducted focus group discussions with public health staff who were interested in field epidemiology training, S-FETP fellows and residents, and management personnel from MOH and other local agencies. We then followed up with key informants and resource persons to refine our provisional framework and curriculum. The following common stakeholder needs were identified:

- Develop a tiered approach to meet training at various levels
- Focus on practical learning on-the-job with buddy/mentorship
- Tailor curriculum to our tropical city state context
- Minimize administrative burden by streamlining processes
- Build capacity for integrated response to health security issues

We noted the need to maintain relevance to the changing challenges of different public health agencies, so that S-FETP can be an essential step for building public health careers and competencies. We will need to work with these agencies to tailor the training (including protected time), refine the reward and recognition system (to incentivise staff) and align with *SkillsFuture* support (for continuing mid-career professional development).

MULTISECTORAL LEARNING CURRICULUM

Taking the above into account, we have introduced a pyramid model comprising three tiers for Singapore's sustainable field epidemiology workforce development for the various agencies. S-FETP is open to all medical and public health officers as a tripartite collaboration between NCID, SPH and MOH from 2020, tapping on each institution's strengths. Apprenticeship with the buddy-and-mentoring system is also emphasised throughout the training.

We aim to customise our core curriculum, which is based on the US CDC's FETP standard curriculum, to agencies' needs in the domains and instructional goals that constitute competencies for each officer's continuing professional development. The proposed curriculum, which will be tailored to the needs of requesting agencies, is as follows:

Domain	Instructional goals	Level of Training		
		Specialist	Intermediate	Foundational
Field Epidemiology and Rapid Response Methods	Identify and address communicable diseases of national priority	Advanced	Proficient	Proficient
	Know how to access and review public health literature	Advanced	Proficient	Proficient
	Conduct descriptive and analytic epidemiological studies	Advanced	Proficient	Developing
	Create tables, graphs, charts and maps for data analysis	Advanced	Advanced	Proficient
	Analyse and interpret data from descriptive and analytic studies	Advanced	Advanced	Proficient
	Follow ethical guidelines for field epidemiology work	Proficient	Developing	Developing
	Present epidemiology findings in a scientific conference	Advanced	Proficient	Developing

Domain	Instructional goals	Level of Training		
		Specialist	Intermediate	Foundational
Field Epidemiology and Rapid Response Methods	Participate in teams and provide situational leadership	Advanced	Proficient	Proficient
Communicable Diseases Control	Understand and prioritize diseases of public health importance	Advanced	Advanced	Proficient
	Apply the principles and practices of disease prevention and control	Proficient	Proficient	Developing
	Lead in an outbreak investigation and develop intervention strategies	Advanced	Proficient	Developing
	Prepare for and respond to public health emergencies	Advanced	Advanced	Proficient
Public Health Surveillance	Describe the roles and responsibilities in surveillance practice	Advanced	Proficient	Proficient
	Plan and implement a surveillance system	Proficient	Developing	Developing
	Analyse and interpret data obtained from surveillance	Advanced	Advanced	Proficient

Domain	Instructional goals	Level of Training		
		Specialist	Intermediate	Foundational
Public Health Surveillance	Operate different types of surveillance in the system	Advanced	Advanced	Proficient
	Identify an appropriate public health response based on surveillance data	Advanced	Advanced	Proficient
	Evaluate a surveillance system	Advanced	Developing	Developing
	Understand the roles and functions of laboratory-based surveillance	Proficient	Proficient	Proficient
Risk Communication	Create systematic reports	Advanced	Advanced	Proficient
	Communicate risks and response to different stakeholders	Advanced	Proficient	Developing
	Write scientifically for an epidemiologic bulletin or journal	Proficient	Developing	Developing
Policy and Administration	Describe epidemiologic roles and functions within the Agency	Advanced	Proficient	Proficient
	Lead in a multisectoral meeting on prevention and control strategies	Proficient	Proficient	Developing

Domain	Instructional goals	Level of Training		
		Specialist	Intermediate	Foundational
Policy and Administration	Formulate recommendations for policy development in the Agency	Proficient	Developing	Developing

THREE-TIER FIELD EPIDEMIOLOGY TRAINING

In our bespoke model, agency-specific emphases on matters such as food hygiene, vector control, environmental sanitation, or veterinary public health epidemiology goals, can be set out clearly so as to provide a checklist for trainees to track progress in an itemized manner. Operating out of the agencies for fieldwork and SPH-NCID for didactics, the new training network is designed for the challenging future of Public Health practitioners at all levels of field epidemiology practice.

Foundational Tier (1) - Provided to frontline staff, including rapid response teams, according to the needs of each specific agency in the form of a primer in field epidemiology practice (workshops of up to a week’s duration). Interaction consists of approximately 40 hours of stackable didactics interspersed with on-the-job training. The officer acquires basic awareness and understanding of core competencies, with skills to perform field epidemiology objectives under supervision. Successful participants can be accorded joint professional certification and entered into the NCID professional registry.

Intermediate Tier (2) - Offered to upcoming medical and public health officers for cross-training on five specific competencies in surveillance, epidemiology and response. Training comprises approximately 120 hours of didactics interspersed with applied on-the-job field epidemiology work. This proficiency level accords the officer essential knowledge and skills so as to be able to operate independently with minimal supervision. Academic components can be pursued as a graduate certificate or as Masters level modules. Successful participants will be accorded S-FETP fellowship status on the national rolls by NCID.

Specialist Tier (3) - Reserved for trainees who continue after the intermediate tier to seek relevant experiences in epidemic intelligence and global health practice, including exposure to ASEAN+3 FETN, GOARN and EIS training. This level of proficiency requires an in-depth knowledge of field epidemiology, and sufficient application of

knowledge and skills to guide and mentor others. Trainees will be tested for situational field leadership roles, and have options to obtain a graduate diploma or higher qualifications in applied epidemiology and public health. Successful participants would be recognisable as subject matter experts and specialists.

LAUNCHING THE NEW TRAINING NETWORK

A fresh cohort of trainees will be inducted under our new initiative in 2020, and a time frame until graduation of 1-2 cohorts is envisaged before NCID and SPH can ensure the new field epidemiology training network is a sustainable platform for national workforce development in public health. Successful outcome will deliver a cadre of highly competent physician and non-physician professionals who, having cross-trained in field epidemiology with other hospitals and agencies, can provide domain expertise in public health with skills and knowledge for outbreak management and pandemic response.

The experience of COVID-19 has shown that Singapore needs to build up this vital pool of expertise for communicable diseases control, including field epidemiology trainers who can provide proper curriculum delivery and mentorship across each training cohort, and improve on our practices in urban field epidemiology, health security and outbreak management. In addition, we intend for basic elements to be a mandatory component for all Preventive Medicine residents in their residency training. Tutorials are also being introduced in the undergraduate medicine curriculum.

At the level of global health engagement, we must maintain our international reputation as a reliable training partner for growth and sharing of practical experiences on public health matters of international concern. S-FETP already has well established ties with WHO, GOARN, TEPHINET and counterparts in the ASEAN+3 network, and we need to continue building on these strong links. Regular exchange with international partners also helps to secure relevant global health experiences for our advanced trainees.

CONCLUSION

We have built on the strong foundations set by the original MOH programme, creating a holistic national approach which caters to all levels of workforce. The new S-FETP adopts a three-tiered framework where not all staff have to complete two years of training. This flexibility allows trainees at the foundational and intermediate levels to perform competently at their jobs while maintaining an advanced level of training for those willing and able to become subject specialists.

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INTERNATIONAL HEALTH REGULATIONS

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INTRODUCTION

Global health security is a major concern to member states of the World Health Organization (WHO). The International Health Regulations (IHR) (2005) is an international legal instrument that binds 196 countries, including 194 state parties of WHO.¹ The objective of IHR (2005) is to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks, and which avoid unnecessary interference with international traffic and trade.^{2,3} Singapore being a Member State of the WHO is obliged to fulfil the IHR requirements.

HISTORICAL DEVELOPMENTS

European cholera epidemics in 1830-47 had brought about international concerns and sparked off the call for communicable disease diplomacy and multilateral cooperation in public health. The first international sanitary conference was held in France in July 1851 with the objective of harmonizing and reducing costly maritime quarantine requirements among European nations. Cholera and plague were the first two diseases to be addressed in international conferences.⁴

After the first world war, two independent international health organizations co-existed in Europe – the Office International d’Hygiene Publique and the Health Organization of the League of Nations. Across the Atlantic, the equivalent health organization was known as the Pan American Sanitary Organization. In April 1945, at a United Nations (UN) conference, China and Brazil proposed that an international health organization should be established. This notion brought about the birth of the WHO.

The constitution of WHO was adopted and signed by 51 members of the UN and ten other nations at the International Health Conference in New York City on 22 Jul 1946. This constitution came into force on 7 April 1948 and WHO was officially commissioned on 1 September 1948. During the world health assembly in 1951, state parties of WHO adopted the International Sanitary Regulations. This was replaced in 1969 by the IHR⁵ which had as its primary objective the control of six diseases, namely plague, cholera, yellow fever, smallpox, typhus and relapsing fever.

The inadequacies of IHR(1969) became apparent in the 1990s with major epidemics such as cholera in South America in 1991, plague in Surat, India in 1994, and Ebola in Kikwit, Democratic Republic of Congo in 1995.⁷ The scope of IHR(1969) was also found to be inflexible in responding to pandemic diseases such as influenza and to non-infectious health threats.⁸ Other limitations of IHR(1969) were notification of diseases being solely dependent on official reports by governments, lack of formal internationally coordinated mechanisms to contain international spread of disease, absence of definite measures to detect and assess risks, lack of strategies to improve surveillance capabilities of States Parties, and inability of WHO to ensure compliance by state parties.

In 1995, a resolution was made to call for a drastic revision to IHR(1969). The momentum for the revision was accelerated by the SARS pandemic in 2003.⁹ Following many deliberations, the revised IHR(2005) was adopted by the world health assembly on 23 May 2005 and came into effect on 15 June 2007.

REGULATORY ENHANCEMENTS

There are seven enhancements to IHR(2005) that transformed the previous passive regulations to a pro-active set of rules, with more defined procedures and responsibilities between WHO and the state parties. The new regulations placed emphasis on the collaborative actions between state parties and WHO in the identification and assessment of events, and the corresponding responses to public health emergencies.¹⁰

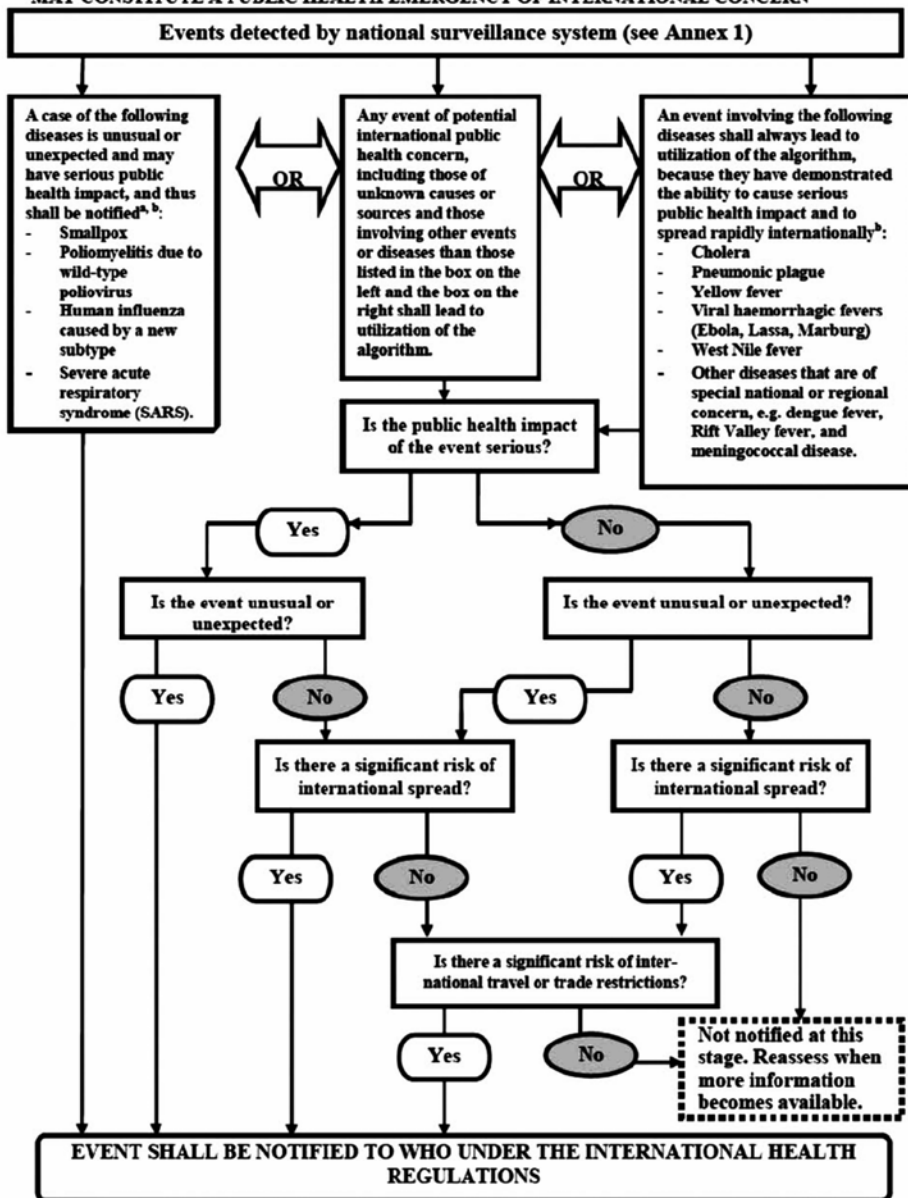
Broader scope of public health threats

IHR(2005) has expanded coverage to a wider range of public health threats including natural disasters, as well as chemical and nuclear events.¹¹ Instead of specifying the types of diseases subjected to the regulations, IHR(2005) defines public health threats as “illness or medical condition, irrespective of origin or source that presents or could present significant harm to humans.”

Obligations on States Parties to notify WHO of events that may constitute Public Health Emergency of International Concerns (PHEIC)

State parties are obligated to notify WHO of events which may constitute a PHEIC within 24 hours of an assessment, based on a decision instrument stipulated under Annex 2 of the IHR(2005) as follows:

**ANNEX 2
DECISION INSTRUMENT FOR THE ASSESSMENT AND NOTIFICATION OF EVENTS THAT
MAY CONSTITUTE A PUBLIC HEALTH EMERGENCY OF INTERNATIONAL CONCERN**



^a As per WHO case definitions.

^b The disease list shall be used only for the purposes of these Regulations.

A PHEIC is defined as “an extraordinary event which is determined to constitute a public health risk to other States through the international spread of diseases and potentially requires a coordinated international response.” State parties are required to furnish additional information of the public health event such as situation update, laboratory results and response measures to WHO when available.

Authorization of WHO to consider unofficial reports of public health events and to obtain verification from States Parties

WHO is authorized to consider reports from unofficial sources related to a public health event other than official notification, and to seek verification of the event with the implicated country where this allegedly occurred. This allows WHO to assess the seriousness of the event, recommend appropriate actions, facilitate or help coordinate technical assistance when needed, and inform other state parties of the public health risk involved.

Establishment of IHR national focal points and WHO IHR contact point

With an expectation of timely notification, state parties are required to establish an IHR national focal point which serves as the point of contact for communications with WHO. Likewise, WHO has appointed IHR contact points in each region to receive information and communicate with the national focal points.

State Party obligations to develop minimum core public health capacities

States parties are required to develop, strengthen and maintain core public health capacities for the purpose of surveillance and respond to public health events.

Powers of Director-General to determine a public health event a PHEIC, and to issue corresponding temporarily recommendation

There is provision of powers to the WHO Director-General (DG) to determine if a public health event constitutes a PHEIC. The DG shall consult the implicated country if the health authority is in agreement with the assessment. Once consensus is reached, DG will seek the views of the Emergency Committee, which will also advise on the temporary recommendations to respond to the event.

Protection of human rights of person and travellers

In the name of preventing spread of diseases across borders through travel, state parties may apply additional health measures to suspect or infected travellers including least intrusive and invasive medical examination. However, no medical examination, treatment or health measures should be carried out on the travellers without their informed consent.

IMPLEMENTATION EFFORTS

States Parties were required to fulfil the core capacities outlined in the Regulations not later than five years after the date of entry into force, as of June 2007, surveillance, reporting, notification, verification, response and collaboration activities, and their activities concerning designated airports, ports and ground crossing in the aspect of preventing the international spread of public health threats. At the end of the first deadline in June 2012, only 42 of 193 State Parties reported that they had met the core capacities requirements,¹² and 121 States Parties had requested and were granted with a two-year extension. At the end of the second deadline at June 2014, a total of 65 state parties reported that they had met the minimum requirement, and 84 had requested for an additional two-year extension.¹²

WHO developed an IHR monitoring framework¹³ to assist state parties to monitor and conduct self-assessment on the development of core capacities. WHO outlined 13 core capacities that were required to detect and respond to human health hazards and events at the Points of Entry (PoE). State parties were required to report 20 selected indicators to WHA annually through the submission of IHR monitoring questionnaire (IHR MQ).¹⁴ When this was first administered in 2010, state parties made their own assessments whether their national capacities have met the requirements under the IHR (2005).¹⁵ In 2018, WHO introduced a new reporting tool known as the IHR State Party Self-Assessment Annual Reporting Tool (IHR SPS ART). This provided for the use of a five-progress-level table to assess indicators, and a scoring system at indicator and capacity level.

Following recommendations from a second IHR review committee, WHO has developed the new IHR monitoring and evaluation framework which combined qualitative and quantitative review processes.¹⁶ State parties are now recommended to conduct the monitoring and evaluation process through a four-year cycle anchored in the national health system review cycle. The new framework comprises four interrelated components:

- Annual reporting of IHR SPS ART
- Joint external evaluation (JEE) – State parties are encouraged to conduct at least one JEE every four years.
- After-action review – State parties should conduct reviews on real public health events to draw lessons and identify gaps for improvement.
- Simulation exercise – In the event where there is no suitable public health event to review, States Parties can consider conducting simulation exercise to test the functions of IHR core capacities.

The importance of IHR (2005) was demonstrated from 2007-16 when WHO declared four events to be PHEICs - the influenza A(H1N1) pandemic in 2009,¹⁷ international spread of wild poliovirus in 2014,¹⁸ Ebola virus disease outbreaks in West Africa in 2014,¹⁹ and clusters of microcephaly and other neurological disorders associated with Zika virus in 2016.²⁰

SINGAPORE'S EXPERIENCE

Since IHR(2005) entered into force in 2007, Singapore has conscientiously ensured that our policies and public health responses are in line with WHO's IHR requirements, and to achieve the stipulated core capacities. The Ministry of Health (MOH), National Environment Agency (NEA), Singapore Food Agency, and National Parks Board's Animal and Veterinary Service work together under the One Health framework to oversee surveillance, verification, response and notification of infectious diseases in human and animal, as well as border health control to prevent international spread of diseases. In addition, MOH and NEA work closely with the Singapore Civil Defence Force on matters related to chemical and nuclear threats.

In addition, MOH and NEA, together with the Civil Aviation Authority of Singapore, Maritime and Port Authority of Singapore, and Immigration and Checkpoint Authority, have put in place a set of border health measures to prevent the incursion of public health threats, and to mitigate its spread under the legal power of the Infectious Diseases Act. For example, in response to the ongoing threat of Middle East respiratory syndrome (MERS), temperature screening is conducted at the international airport on passengers disembarking from flights from the Middle East. Symptomatic travellers suspected for MERS by the healthcare providers at the point of entry would be transferred to a designated hospital for isolation and testing.

Since the IHR MQ was rolled out in 2010, we have responded to the questionnaire annually. In Oct 2011, Singapore officially informed WHO that the country had established the requisite national core capacities set out in the IHR(2005). In Apr 2018, the country was evaluated by a team of WHO external evaluators for our core capacities in detecting and responding to potential public health emergencies. This joint external evaluation exercise gave us a high overall score for public health preparedness, and the WHO evaluation team assessed that Singapore demonstrated good capacity and notable progress in the implementation of the IHR.

CONCLUSION

Global health security is important to Singapore because, with today's ease of travel, emerging infectious diseases can be readily introduced. Serious outbreaks can result in high mortality and morbidity, and enormous economic loss to the country. To date, there are no completely effective screening tools to detect a traveller with imported disease at the points of entry. Having a robust public health system with detailed preparedness plans can help to detect outbreaks earlier and mitigate its spread locally and internationally.

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Engaging stakeholders in a disease cluster goes with the job

EXPERIENCING A PUBLIC HEALTH EMERGENCY

Qing Yuan Pang, Hwi Kwang Han, Minn Thu, Steven PL Ooi

INTRODUCTION

In the digital age and information era that we live in, information is pivotal and a critical component of our lives. It serves to create assurances on what we are uncertain or unsure of, just with a click of a button on our handheld devices. Despite this, our fears of the unknown have not been confounded but rather amplified by the tsunami of information. With conflicting information available on the internet, it creates anxiety and uncertainty as to which article or information should be trusted and from a credible source. What should we do?

As four field epidemiologists with varied experience in communicable diseases and environment-related emergencies, our public health journey has taken us beyond the ten nearby ASEAN countries into diverse cultural settings such as Bangladesh, Sierra Leone, and Peru. In our commentary here, we share observations on the common human response amidst pandemics and other crises.

FEAR OF THE UNKNOWN SNOWBALLS

Avoiding uncertainty is a typical human desire that fuels our unease and fear. Fearing the unknown is not programmed but biologically wired into all cultures. In the absence of information, we tend to gravitate towards negative scenarios instead of relying on logical thought processes. Rational thinking which is often thwarted in high-strung, high impact events such as a public health emergency, giving rise to irrational behaviour that can be driven by fear.¹ Carleton² described that the default response to uncertainty, novelty and threat is the sympatho-excitatory preparation for action commonly known as the fight or flight response. He added that there is a default tendency towards the “negativity bias” which is the tendency to prioritise negative information over positive.

Throughout the COVID-19 experience as events unfolded, disease transmission events showed that reality is cruel and does not pan out the way we want it to be. As Dan Ariely³ described in his book, a simple experiment suggested that even as we consider ourselves rational beings, we are often unable to understand ourselves or

predict our next course of action in a different emotional state. When fear is prevalent, it can override our rational train of thought because we fear that we are losing out on something⁴. Panic buying of toilet paper became a global phenomenon during this emergency and serves as a classic example⁵. Social experiments suggested that even as some who wish to act socially responsible, they are concerned that others will not and in fear of that, they join the frenzy.^{6,7} As characterized in the prisoner's dilemma, both sides are left with the worst possible outcome.

Psychologists have described such behaviours as group polarization, where decisions made by groups often sway towards the extremes⁸. Observations involving COVID-19 included stealing toilet paper from public toilets⁹, hoarding food, supplies and boasting about it on social media, buying alcohol swabs as a replacement for hand sanitizers. During SARS 17 years ago, when social media was still gaining popularity, such behaviour could have been localized and likely went under the radar.¹⁰ However, in this day and age, where information through social media goes viral, such behaviours snowballed into a global phenomenon when everyone started to catch the “uneasiness bug.”

UNACCEPTABLE RISK CAUSES OUTRAGE

What the community seeks is some consensus on what constitutes acceptable risk. There are quantifiable risks that affect multitudes without upsetting many, and there are risks that upset multitudes without affecting many. Gather together all the reasons people get upset and label them, collectively, the outrage factor. What the public perceives as risk is actually impact, which is the real risk plus the outrage factor¹¹. Typically, the outrage factor is high when a new disease is unfamiliar, carries many inconveniences, affects people's pockets, and actions are not within personal control. Accepting risk needs a number of steps.

Firstly, we must expect to be affected by the changing new normal in a susceptible environment. We remain porous because our borders cannot be shut. As a major trade and travel hub with high people traffic, periodic re-introductions of the virus are inevitable. Travel will also be affected.¹²⁻¹⁴ We will continue to see occasions of infection arising from imported or locally acquired cases, usually by asymptomatic persons who may be unaware of their infection.

Secondly, we must understand the difference between public impacts such as panic buying and real risk which guides public health actions. Risk is measured as the probability of getting infected and dying from exposure to the virus. Hence, through

disruptive measures that reduce exposure, the experts have calibrated a risk-based approach to safeguard health. Overcoming COVID-19 requires community support of these measures which can be personally intrusive.⁶

Finally, we must adapt to the long-term impacts by being less emotive (outraged) and by changing daily routines in ways that reduce the stress of future disruptions. Supply chains are already disrupted, so we have to be judicious in our use of limited resources.¹⁵⁻¹⁷ Inconveniences are inevitable, so we must be patient instead of just complaining. This outrage factor is not a distortion in the public's perception; it is an intrinsic part of having to deal with the impact.

STIGMA AND VIOLENCE MUST BE ADDRESSED

For many of us, worries about being discriminated after seeking treatment can be a major consideration against obtaining appropriate care and treatment. The level of stigma associated with COVID-19 stems largely from the fear of the unknown since it is a novel pathogen that appears easily transmissible from others. Stigma greatly undermines social cohesion and can result in the isolation of vulnerable groups.¹⁸⁻²⁰ This might contribute to a situation where the virus is more, not less, likely to spread. With social media, stigmatization can be amplified and reinforced in an instant.²¹⁻²³

In many countries, when symptomatic patients delay presenting themselves at healthcare services, infectious individuals become under-detected.²⁴ Repercussions on clinical management and community spread may be severe, exacerbating the problem and creating a vicious cycle.^{25,26} Even in an outbreak such as chickenpox, caregivers of refugee households delay treatment as they are afraid of being stigmatized for spreading the infection in the community. Individuals or families may wish to carry out the right actions but their communities might view it differently.^{27,28} In order to conform, most succumb to pressure placed on them to do the “right” thing in the eyes of others.²⁹

Amidst infodemics,³⁰ rage and aggression can rise to epidemic proportions. Discriminatory practices against ethnic Chinese were observed in many countries such as the US, UK, Russia, and Australia.¹⁸⁻²⁰ Diplomatic relations have also been strained by reports of attacks on Chinese residents, and unfair treatment by the authorities directed towards Asian and those of Asian descent residing in these countries. Some have capitalised on this fear to forward their political agenda, marginalising minority groups and polarising views further. As sharing of xenophobic posts on social media increases, it reinforces negative sentiments and animosity, creating further rifts, racial

division and social divide, and sparking waves of incidents that undermine public security.³¹⁻³³

As countries adopted variations of the lockdown option, economies suffered and unemployment rose with loss of livelihood. According to WHO, a 10-50% increase in domestic violence helpline calls occurred in some countries.^{34,35} Evidence shows that the violence can increase in the aftermath of an emergency.³⁴

POSITIVITY NEEDS REINFORCEMENT

Field epidemiologists must often learn the social dynamics, culture and thinking of the community before they can incentivise individuals' conditioned behaviour to carry out socially responsible actions. Dealing with disease control in an emergency requires a deeper understanding of fear and what drives our primal "fight or flight response." In this digital age, social media and the ease of misinformation flow can amplify fear and anxiety, undermining public health interventions. We need to reflect hard on the following: (1) why do we carry out the actions; (2) who in the community should own the actions; and (3) how can we better assist the community to deal with the situation.

The frontline battle continues as our community seeks normality, grappling with expenses and employment, in a post-circuit breaker world. We will make mistakes, but we must continue to be adaptive and entrepreneurial in our innovations. We continue to learn even as we are already sailing, and give leeway to discard what does not work without entering into a blame game. Our pluralistic society is a strength here, for we can learn much from each other when we are open. The community is leveraging not just on our government, but also economic, social and people-to-people links to bridge existing gaps.³⁶⁻³⁸ In addition, there have arisen alternative voices from which to seek advice, and credible non-government sources capable of dealing with critical feedback and public confidence.³⁹

Reactions to emergency situations can be positively or negatively reinforced by collective actions. In dire times, the spirit of altruism is very welcome.⁴⁰⁻⁴² For example, the community spirit can be sparked by a distribution of hand sanitizers in public spaces and volunteers who help the less fortunate. Initiatives developed in cooperation between private, public and people sectors have sought to ease the burden on lower socio-economic groups by providing them with basic necessities.^{43,44} Acts of care and concern to boost morale have also been well received by frontline workers.

CONCLUSION

As we recall the movie “Matrix” released 21 years ago, Morpheus provided Neo with 2 choices, to take either the red pill or the blue pill. Being informed individuals, we can either choose the blue pill by sharing positivity, spreading the warmth or the red pill to spread the fear and negativity that fuels rage and animosity. Experiencing a public health emergency, the collective efforts of government, institutions, organizations, businesses, community and individuals are probably the most effective antidote towards fear. The choice is entirely ours.

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A to Z of Communicable Diseases Control

**"Health is
Our First
Wealth!"**

The background is a light blue watercolor wash with darker blue and white accents, creating a soft, artistic texture. A faint, thin black outline of the United States is visible in the lower right quadrant, extending from the bottom edge towards the center.

ANTHRAX

NOTIFIABLE DISEASE: NO

Although anthrax is not on the list of notifiable diseases under the Infectious Diseases Act, it is recommended that all suspected or confirmed cases be reported to MOH as soon as possible.

Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Call MOH Surveillance Duty Officer and submit MD131 Notification Form via CDLENS (http://www.cdlenz.moh.gov.sg) or fax (6221 5528/38/67)	Immediately
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Bacillus anthracis, a gram-positive spore-forming bacterium.

INCUBATION PERIOD

Typically, 1-6 days, up to 60 days.

INFECTIOUS PERIOD

Anthrax in humans is not considered contagious. Person-to-person transmission of cutaneous anthrax has rarely been reported.

TRANSMISSION

A zoonotic disease mainly of herbivorous animals. Transmitted by direct contact with *B. anthracis*-infected animal tissues or products (e.g. animal hide), or with anthrax spores in soil. Humans are generally incidental hosts. Articles and soil contaminated with spores can remain infective for decades.

Three forms of transmission exist:

1. **Cutaneous anthrax** results from introduction of the spore through the skin barrier (e.g. via abrasions or injections) or hair follicles;
2. **Gastrointestinal anthrax** results from ingestion of contaminated undercooked meat; and
3. **Inhalation anthrax** results from inhaling spores aerosolized by industrial processing of contaminated animal products (e.g. hair, bone, hides), among persons working with contaminated animal products or bioterrorism.

EPIDEMIOLOGY

Most common in agricultural regions in Central and South America, sub-Saharan Africa, Central and Southwestern Asia, and Southern and Eastern Europe. Risk factors include handling products such as wool or hide from infected animals and rural travel in endemic regions.

CLINICAL FEATURES

There are 3 main syndromes of anthrax disease:

1. **Cutaneous anthrax** is characterized by localized itching, followed by a painless papule which turns vesicular and enlarges, ulcerates, and develops into a painless, depressed black eschar usually surrounded by oedema. It commonly involves exposed areas (e.g. head, neck, forearms, hands). There may be satellite lesions with regional lymphadenopathy associated with fever and headache. The case fatality rate (CFR) is less than 2% with treatment (up to 20% if untreated).
2. **Gastrointestinal anthrax** causes a rapid onset of abdominal pain with haemorrhagic ascites. Shock and death may occur within 2-4 days of symptom onset. CFR is less than 40% with treatment (more than 50% if untreated). Less frequently presents with an oropharyngeal form of disease characterized by oedematous lesions, necrotic ulcers and swelling in the oropharynx and neck.
3. **Inhalation anthrax** initially presents as non-specific flu-like symptoms lasting 4-5 days. This is followed by a fulminant phase characterized by acute respiratory distress and sepsis. It may also present as acute haemorrhagic mediastinitis. A widened mediastinum without infiltrates on chest X-ray in a previously healthy patient without trauma is pathognomonic for anthrax. Anthrax meningitis may result from hematogenous spread and should be considered in all cases of systemic anthrax. CFR is approximately 45% with aggressive treatment (generally more than 85%).

MICROBIOLOGY INVESTIGATIONS

Notify laboratory when anthrax is suspected. Refer to the table below for types of samples and laboratory tests.

Disease	Specimen Type	Tests
Cutaneous anthrax	Swabs of lesions	Bacterial culture
Gastrointestinal anthrax	Stool	
	Blood	
Inhalation anthrax	Sputum	
	Blood	
Post mortem cases	Affected tissues	

Note for laboratories: *B. anthracis* is a biothreat organism and also a WHO Risk Group 3 organism. Laboratories should take additional precautions and perform all testing in a biosafety cabinet. Please contact the National Public Health Laboratory for further identification and confirmation of the pathogen.

MANAGEMENT OF PATIENTS

Treatment with antibiotics should be initiated as soon as the disease is suspected. Combination antimicrobial therapy is recommended for inhalation anthrax or anthrax meningitis. Adjunctive IV dexamethasone should be started at the time of initial antimicrobial drug treatment for suspected meningitis. An antitoxin should be added to combination antimicrobial treatment if there is a high level of clinical suspicion for systemic anthrax.

MANAGEMENT OF CONTACTS

Post exposure chemoprophylaxis should be offered to all persons who may have been directly exposed to anthrax spores. It is critical to administer prophylactic antibiotics as soon as possible after potential exposure. Oral antibiotic prophylaxis should be continued for at least 60 days.

- **Recommended first line medication:** PO ciprofloxacin 500 mg BD.
- **Alternatives:** PO doxycycline 100 mg 12 hourly, or PO levofloxacin 750 mg once daily, or PO amoxicillin 1 g 8 hourly if the strain is sensitive.
- **For children:** PO ciprofloxacin 20-30 mg/kg/day BD (not to exceed 1 g/day), or doxycycline 2.2 mg/kg/day BD (not to exceed 100 mg BD), or amoxicillin 80 mg/kg/day TDS (not to exceed 500 mg TDS).

If vaccine is available, exposed persons should be vaccinated with three doses of anthrax vaccine (days 0, 14, 28).

Contacts should be placed under surveillance for seven days to monitor for symptoms.

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions apply. After an invasive procedure, the instruments used and the area where the procedure is performed should be thoroughly disinfected with a sporicidal agent (e.g. 5,000 ppm sodium hypochlorite).

Quarantine of persons exposed to anthrax spores may be required if the contact refuses chemoprophylaxis.

No anthrax vaccine is available locally. Vaccine efficacy against cutaneous anthrax has been documented for humans. Evidence for protection against inhalational anthrax exists for animals but data in human is limited. Evidence for protection against gastrointestinal anthrax is limited to animal studies.

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Our biosphere, fauna and flora, can be both friend and foe

BOTULISM

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Within 24 hours
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Clostridium botulinum, a gram-positive spore-forming bacterium that is present in the environment and produces toxins under specific conditions. The disease is caused by neurotoxins produced by the bacterium.

INCUBATION PERIOD

Depends on the mode of transmission. In general, the shorter the incubation period, the more severe the disease and higher the CFR.

1. **Food-borne botulism:** typically 12-72 hours after ingestion of toxin, range is 2 hours to 10 days.
2. **Infant botulism:** spores may take up to 30 days (average 2-4 weeks) to germinate and colonise the infant gut, before the onset of symptoms. Infant guts are believed to be susceptible to colonisation as normal bowel flora has not been fully established.
3. **Wound botulism:** typically 4-14 days.
4. **Inhalational botulism:** Symptoms may appear 12-36 hours or longer after exposure.

INFECTIOUS PERIOD

No person-to-person transmission.

TRANSMISSION

There are various modes of transmission:

1. **Food-borne botulism** occurs via the ingestion of pre-formed toxins in contaminated food. Usually involves home-canned foods (e.g. fruits, vegetables, fish).
2. **Infant botulism** results from ingestion of botulinum spores rather than pre-formed toxin. Sources of spores include environmental dust/soil and contaminated food (e.g. honey).
3. **Wound botulism** occurs via the introduction of botulinum spores into wounds, especially among injection drug users.
4. **Inhalational botulism** can occur if botulinum toxins are inhaled when released in the form of an aerosol (e.g. bioterrorism).
5. **Iatrogenic botulism** can be caused by cosmetic use of botulinum toxin administered as an unlicensed, highly concentrated preparation.

EPIDEMIOLOGY

Botulinum toxins are a group of 8 related neurotoxins (Types A-H), produced by *C. botulinum*. Most cases of human botulism are caused by toxins types A, B, E, and rarely F, G, and H.

Sporadic cases, and outbreaks among family and the community occur worldwide. These cases consist mostly of infant botulism (ingestion of spores in uncooked food), foodborne botulism (home-canned food), and wound botulism (IV drug users). Rarely, botulism may be iatrogenic, arising from cosmetic use of botulinum toxin.

In Singapore, there have been 2 reported cases of botulism (1 each in 2017 and 2018) since the disease was made notifiable in 2016. Both were cases of infant botulism.

CLINICAL FEATURES

Botulism is a rare neuroparalytic disease that can be life-threatening. Beyond infancy (i.e. >1 year of age), it usually manifests as an acute onset of bilateral cranial neuropathies associated with symmetric descending flaccid weakness. Other features include: absence of fever, symmetric neurologic deficits, normal mentation, normal or slow heart rate and normal blood pressure, and no sensory deficits with the exception of blurred vision. In severe cases, respiratory failure can develop. There may also be non-specific gastrointestinal symptoms in foodborne botulism.

In infant botulism, onset can be insidious and constipation is a prominent feature. Constipation may precede weakness by weeks. Infants may develop irritability with a weak cry and loss of head control/truncal tone. In infants, dysphagia, poor feeding, poor gag, and pooling of oral secretions often precede respiratory distress. Serial electromyography (EMG) testing may be required as EMG results may be normal early in the disease. Characteristic findings are seen on EMG (facilitation of the compound muscle action potential on repetitive nerve stimulation).

Other disorders that resemble botulism include Guillain-Barré syndrome, myasthenia gravis, Lambert Eaton myasthenic syndrome, stroke, tick paralysis, poliomyelitis, organophosphate poisoning, heavy metal intoxication, atropine poisoning, tetrodotoxin and shellfish poisoning, and antimicrobial-associated paralysis. For infants, other differential diagnoses include sepsis, meningoen­cephalitis, Reye syndrome, hepatic encephalopathy, organic aciduria, infantile spinal muscular atrophy, congenital myopathy and muscular dystrophy syndromes

MICROBIOLOGY INVESTIGATIONS

Diagnosis is primarily based on a compatible clinical presentation. The index of suspicion should be high in afebrile infants who present with significant hypotonia with cranial nerve signs after a period of normal growth and development.

Specialised laboratory tests are available for public health investigations. Please contact MOH and NPHL to arrange further laboratory tests.

Disease	Specimen Type	Tests
Infant botulism	Blood (plain tube)	PCR for <i>C. botulinum</i> genes enzyme immuno assay (EIA) for botulinum neurotoxin
	Stool	Culture for <i>C. botulinum</i>
Food-borne botulism	Stool	EIA for botulinum toxin
	Implicated food	
Wound botulism	Fluid/exudate/tissue	Culture for <i>C. botulinum</i>

MANAGEMENT OF PATIENTS

Treatment of botulism involves botulinum antitoxin and supportive care, including prompt intubation and ventilation if necessary. Prolonged ventilatory support is often required in severe cases. Antitoxin should be administered early and is less beneficial if given more than 72 hours after symptom onset. In infants, human-derived botulinum immunoglobulin has a lower risk of side effects but may have to be sourced overseas. For wound botulism, antibiotics may be used in addition to appropriate debridement of wounds.

MANAGEMENT OF CONTACTS

No specific management of contacts is required.

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions apply. Decontamination of surfaces contaminated by toxin can be achieved using soap and water, or 5,000 ppm hypochlorite solution. If contamination of food is suspected, boiling the food item for 10 minutes will destroy the toxins.

There is no available vaccine or post-exposure prophylaxis. Infants should not be fed honey to reduce risk of infant botulism.

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BRUCELLOSIS

NOTIFIABLE DISEASE: NO

Although brucellosis is not on the list of notifiable diseases under the Infectious Diseases Act, it is recommended that all suspected or confirmed cases be reported to MOH as soon as possible.

Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Call MOH Surveillance Duty Officer and submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Immediately
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

The following *Brucella* species are usually responsible for disease in humans: *B. melitensis*, *B. abortus*, *B. suis*, *B. canis*, *B. ceti*, and *B. pinnipedialis*.

INCUBATION PERIOD

Typically, 1-2 months; range is 5 days to 5 months.

INFECTIOUS PERIOD

Person-to-person transmission is rare.

TRANSMISSION

Transmission usually occurs from the consumption of undercooked meat or unpasteurised dairy products from infected animals. Transmission can also occur via contact of mucous membranes or breaks in the skin with infected animal tissue or their excretions. Aerosol transmission has also been reported (e.g. laboratory and slaughterhouse workers).

EPIDEMIOLOGY

This is a zoonotic disease that occurs worldwide, particularly in developing countries and the Mediterranean region. Risk exposure is higher in certain occupations or in settings with exposure to *Brucella* bacteria (e.g. slaughterhouse workers, meat-packing employees, veterinarians, laboratory workers). Brucellosis is rare in Singapore.

CLINICAL FEATURES

Brucellosis has a wide clinical spectrum, ranging from subclinical infection to severe disease. It presents with fever and systemic symptoms that include sweating, malaise, anorexia, headache, arthralgia and myalgia. Localized suppurative infections in the liver and spleen have been reported. Complications include osteoarticular (sacroiliitis, spondylitis, arthritis), genitourinary (orchitis, epididymitis), neurological involvement (in 5% of cases) and endocarditis. Case fatality rate is less than or equal to 2% if untreated. Symptoms can persist if not adequately treated, and relapses are known to occur.

MICROBIOLOGY INVESTIGATIONS

Specimen Type	Tests
Blood	Bacterial culture
Bone marrow	PCR
Tissue	
Fluids from other sterile sites	
Serum	Serology

MANAGEMENT OF PATIENTS

Treatment of choice in uncomplicated brucellosis is combination antibiotic therapy for at least 6 weeks. The recommended regimens are:

- PO Doxycycline 100mg BD and PO Rifampicin 600-900mg (15mg/kg) once daily for six weeks.
- PO Doxycycline 100mg BD for 6weeks and IM Streptomycin 1g once daily for first 14-21 days.

Relapse rates are 5-15% in treated patients. Monotherapy is not recommended as relapse rates can be up to 50% in these cases.

MANAGEMENT OF CONTACTS

No specific management of contacts is required.

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions apply in the healthcare setting.

There is no available vaccine. Undercooked meat and unpasteurised dairy products should be avoided. People who handle animal tissues should wear protective clothing (e.g. gloves, goggles, gowns) to reduce their risk of infection.

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CAMPYLOBACTERIOSIS

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Laboratories	Upon laboratory confirmation	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Within 72 hours

CAUSATIVE AGENT

Campylobacter jejuni and less commonly, *Campylobacter coli*. There are 18 other species that can also cause infection.

INCUBATION PERIOD

Typically, 2-5 days; range is 1-10 days.

INFECTIOUS PERIOD

While organisms can be excreted in the faeces for 2-7 weeks, person-to-person transmission is uncommon.

TRANSMISSION

Consumption of undercooked food (notably poultry), unpasteurised milk and contaminated food or water. Transmission can also occur via direct contact with infected animals (e.g. farm animals, domestic pets) or animal products.

EPIDEMIOLOGY

Campylobacter is an important cause of diarrhoeal illness worldwide and a major cause of traveller's diarrhoea. In developed countries, males and children younger than 5 years have the highest incidence of illness, though all age groups can be affected.

CLINICAL FEATURES

Symptoms can be clinically indistinguishable from other foodborne illnesses. Majority of cases present with abdominal pain and diarrhoea (which may be bloody). There may be a prodromal period of fever and malaise a day preceding gastrointestinal symptoms. Symptoms last several days to 2 weeks (average 7 days). Rare late onset complications include reactive arthritis and Guillain-Barré syndrome.

MICROBIOLOGY INVESTIGATIONS

Specimen Type	Tests
Stool	Stool culture for <i>Salmonella</i> , <i>Shigella</i> and <i>Campylobacter</i>

MANAGEMENT OF PATIENTS

Campylobacteriosis is usually mild and self-limiting. Treatment is generally supportive. Antibiotics (e.g. azithromycin) are not indicated except for patients with severe symptoms or at risk of invasive disease. Features of severe disease include bloody stools, high fever, extra-intestinal infection or symptoms lasting more than a week.

MANAGEMENT OF CONTACTS

No specific management of contacts is required.

PRECAUTIONS, PREVENTION AND CONTROL

Standard and contact precautions (if active diarrhoea) apply in the healthcare setting. There is no available vaccine.

Infected individuals should not prepare or handle food until symptoms have resolved. Poultry should be cooked thoroughly. Unpasteurised dairy products should be avoided. Utensils and cutting boards used to handle raw poultry should be washed thoroughly. The same cutting board should not be used for both raw and cooked food to avoid cross-contamination.

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CHICKENPOX

NOTIFIABLE DISEASE: NO

CAUSATIVE AGENT

Varicella-zoster virus (VZV)

INCUBATION PERIOD

10-21 days. Administration of varicella-zoster immunoglobulin (VZIG) following exposure can prolong the incubation period up to 28 days.

INFECTIOUS PERIOD

From 48 hours prior to onset of rash until skin lesions have fully crusted (which is typically 5-7 days after the onset of rash).

TRANSMISSION

Transmission is mainly via the airborne route (respiratory secretions) and less often by direct contact with vesicle fluid of skin lesions. Chickenpox is highly contagious, with secondary attack rates of greater than 90% among susceptible household contacts.

EPIDEMIOLOGY

Chickenpox is a common childhood disease in Singapore with cases occurring throughout the year. Outbreaks have been reported in childcare centres, kindergartens, schools and other educational institutions.

CLINICAL FEATURES

Chickenpox is a benign, self-limiting illness in immunocompetent children, but can be severe in adolescents, adults, and immunocompromised individuals.

Typically, a prodrome of fever, malaise, pharyngitis or loss of appetite starts 1-2 days before the rash appears. Groups of new lesions appear in crops over 4-7 days. The patient usually has rashes at various stages of maturity – macules, papules, vesicles, pustules, and scabs. The scalp, face, limb and trunk are all involved, with relatively sparing of palms and soles. Conjunctival and oral mucosal lesions may be present. Complications of chickenpox include secondary bacterial skin infections, encephalitis, pneumonia and hepatitis.

Chickenpox in early pregnancy (5-24 weeks) carries a 2% risk of congenital malformation (congenital varicella syndrome), with mortality up to 30%. There is no indication for therapeutic abortion in such a situation. Infection in the later stages of pregnancy predisposes the infant to herpes zoster. Onset of chickenpox in the mother within 5 days prior to delivery, and within 48 hours after delivery, predisposes the neonate to severe infection.

Clinical diagnosis is usually adequate for uncomplicated varicella or zoster syndromes.

MICROBIOLOGY INVESTIGATIONS

The following laboratory tests may be considered for confirmation of diagnosis or in atypical cases.

Specimen Type	Tests
Vesicular fluid	PCR Immunofluorescence for viral antigen
Cerebrospinal fluid	PCR

MANAGEMENT OF PATIENTS

In uncomplicated disease, treatment is symptomatic (e.g. antipyretics). Antivirals (e.g. acyclovir, famciclovir, and valacyclovir) are usually recommended in those with complications or are at higher risk of complications. Intravenous acyclovir is recommended for severe, complicated disease or immunocompromised hosts.

MANAGEMENT OF CONTACTS

Contacts are not routinely quarantined except under special circumstances (e.g. settings with immunocompromised children). The contacts should be assessed to determine the need for post-exposure prophylaxis, which in general should be administered as soon as possible. See Public Health Resources section of this book.

Susceptible contacts should be offered varicella vaccination if eligible. Vaccination is effective in preventing illness or modifying severity if administered within 3 days (possibly up to 5 days) following exposure.

Passive immunisation with varicella-zoster immune globulin (VZIG) is recommended in susceptible contacts who are at high risk for severe varicella and complications but ineligible for vaccination: immunocompromised persons (including people on long-term treatment with corticosteroids more than 2 mg/kg of body weight, or a total of 20 mg/day of prednisone or equivalent); pregnant women; neonates whose mothers had onset of varicella within five days before and two days after delivery; preterm infants after 28 weeks of gestation whose mothers are susceptible to varicella; preterm infants before 28 weeks gestation or less than 1000g birth weight (regardless of maternal history or serological status).

In general, post-exposure prophylaxis with VZIG should be administered as soon as possible to provide maximum benefit, generally within 72-96 hours after exposure to an index case. However, VZIG may be effective even if administered up to 10 days after exposure.

PRECAUTIONS, PREVENTION AND CONTROL

Infected individuals in the community should be isolated from school or other public places until all skin lesions have crusted. In hospitals, patients should be isolated, and standard, contact and airborne precautions applied.

Vaccination against chickenpox is recommended for all children and adults who are not immune to chickenpox, especially those at increased risk of contracting the disease (e.g. healthcare workers). Chickenpox vaccination is contraindicated in pregnant and immunocompromised individuals as they are live attenuated vaccines. Two doses of the vaccine are effective (>90%) in preventing the disease. See Public Health Resources section of this book.

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CHIKUNGUNYA FEVER

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Within 24 hours
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Chikungunya virus

INCUBATION PERIOD

Typically, 3-7 days; range is 1-12 days.

INFECTIOUS PERIOD

Usually infectious to mosquitoes during days 2-6 of illness, when the patient is viraemic.

TRANSMISSION

Transmitted by the bite of infected *Aedes* mosquitoes, predominantly *A. aegypti* and *A. albopictus*.

EPIDEMIOLOGY

Outbreaks of chikungunya have occurred in Africa, Asia, Southern Europe, and more recently, the Americas. Singapore's population remained immunologically naive to the virus as evidenced by the low seroprevalence of 0.4% among healthy adults tested in 2002 to 2003. The first local outbreak in Singapore occurred in 2008 and a resurgence was seen in 2013.

CLINICAL FEATURES

Chikungunya fever is typically characterised by high fever, joint pain and rash. There is an acute onset of fever that lasts 3-5 days (range 1-10 days). Joint pain is a prominent feature that begins 2-5 days after onset of fever. It commonly involves multiple joints, is bilateral and symmetric, and involves distal more than proximal joints.

A rash usually appears in or after 3 days from onset of illness and lasts 3-7 days. A maculopapular rash typically involves the trunk and limbs, and can involve the face. Vesiculobullous eruptions have been described in children.

Other reported symptoms include headache, conjunctival injection, nausea, vomiting and fatigue. Haemorrhagic manifestations are uncommon. Severe complications are more common in those aged >65 years and with underlying chronic conditions (e.g. diabetes, cardiovascular disease). Complications include respiratory failure, bleeding, meningoencephalitis, acute hepatitis, myocarditis and ocular manifestations (e.g. iridocyclitis, retinitis). Rarely, death can occur.

Following acute illness, some patients may have persistent or relapsed symptoms. This may manifest as fatigue and a peripheral arthropathy (arthritis/arthralgia, tenosynovitis). The duration of symptoms is variable, with some patients experiencing symptoms up to 3 years after the acute illness.

A wide spectrum of viral, bacterial and parasitic infections may mimic chikungunya fever in the febrile phase, including malaria, dengue (less persistent joint pains), Zika, and other viral illnesses (e.g. Ross River virus, acute HIV infection, rubella, measles, Epstein-Barr virus). Non-infective aetiologies, such as autoimmune diseases, should also be considered.

MICROBIOLOGY INVESTIGATIONS

Disease	Specimen Type	Tests
Within 5 days from onset of symptoms	Plasma or serum	PCR
More than 5 days from onset of symptoms	Serum	IgM, IgG

MANAGEMENT OF PATIENTS

Management is supportive and symptomatic. Non-steroidal anti-inflammatory drugs may be considered for joint pain (though these should be withheld in the event of thrombocytopenia or haemorrhagic features).

MANAGEMENT OF CONTACTS

No specific management of contacts is required.

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions apply in the healthcare setting.

Vector control remains the mainstay in reducing the spread of mosquito-borne diseases. Individuals can avoid exposure to mosquito bites by using insect repellents containing $\geq 20\%$ DEET, wearing long-sleeved clothes and long pants, and sleeping in air-conditioned or insect-screened rooms.

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CHOLERA

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Laboratories	Upon laboratory confirmation	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Within 24 hours

CAUSATIVE AGENT

Vibrio cholerae toxin-producing strains, most commonly serogroups O1 and O139.

INCUBATION PERIOD

Typically, 2-3 days; range is few hours to 5 days.

INFECTIOUS PERIOD

Throughout the duration of illness and for a few days after clinical recovery. There is no chronic carrier state, however shedding occasionally may persist for several months.

TRANSMISSION

Transmission occurs via ingestion of contaminated water or food. Person-to-person transmission can occur via the faecal-oral route, especially within households.

EPIDEMIOLOGY

Cholera primarily affects resource-limited countries where there is inadequate access to clean water sources. It is endemic in about 50 countries, mainly in Africa and South and Southeast Asia. Recent epidemics have occurred throughout Africa, Asia, the Middle East, South and Central America, and the Caribbean.

Serogroup O1 El Tor organisms, of both Inaba and Ogawa serotypes, now account for virtually all cholera cases worldwide, and the O139 strain is rarely isolated. Cholera occurs sporadically in Singapore.

CLINICAL FEATURES

Majority of infections are asymptomatic or cause mild diarrhoea. In severe cases, illness is characterised by an acute onset of copious watery painless diarrhoea, classically described as “rice-water stool”. Vomiting occurs in most cases, and fever is uncommon. If untreated, severe disease can result in rapid dehydration, electrolyte disturbances, acute renal failure, shock and death.

Risk factors include a lack of access to safe drinking water and adequate sanitation, and individuals with gastric achlorhydria. Persons with blood group O are more vulnerable to severe cholera if infected.

MICROBIOLOGY INVESTIGATIONS

Specimen Type	Tests
Stool	Stool culture for <i>Vibrio</i> species

Note for laboratories: Isolates should be sent as pure culture to NPHL for PCR detection of cholera toxin gene.

MANAGEMENT OF PATIENTS

Aggressive rehydration remains the mainstay of treatment. In mild cases, oral rehydration salt solution can be used. In moderate to severe cases, intravenous fluids are required, and electrolyte abnormalities should be corrected.

Administering antibiotics can shorten the duration of diarrhoea, reduce the volume of stool losses, and reduce the duration of shedding of *V. cholerae* to 1-2 days. Recommended regimens include:

- Azithromycin 1 g (single dose)
- Doxycycline 300 mg (single dose)
- Ciprofloxacin 1 g (single dose).

Single dose azithromycin is the preferred therapy. Tetracyclines and fluoroquinolones are not recommended for pregnant women and children less than 8 years old.

MANAGEMENT OF CONTACTS

See 'Precautions, Prevention and Control' below.

PRECAUTIONS, PREVENTION AND CONTROL

Standard and contact precautions apply in the healthcare setting.

3 components of public health have largely prevented outbreaks of cholera in Singapore: hygienic disposal of human waste, adequate supply of safe drinking water, and good food hygiene.

In the event of an outbreak, contacts and implicated food handlers with or without diarrhoea will be screened for cholera. Epidemiological investigations will be carried out by MOH to trace the source of infection. Closure of implicated food outlets will be initiated if necessary. Also, any outbreak will be notified to the public as well as to the WHO.

Follow up stool examinations are recommended for all cases and mandatory for food handlers.

Oral cholera vaccines are available. Most travellers to resource-limited settings are at low risk for cholera. Select travellers who are at higher risk (e.g. aid workers planning to work in refugee camps in endemic or epidemic settings) may benefit from pre-travel cholera vaccination.

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CONJUNCTIVITIS, VIRAL AND BACTERIAL

NOTIFIABLE DISEASE: NO

CAUSATIVE AGENTS

Infective conjunctivitis is caused by viral (80%) and bacterial agents.

Viral conjunctivitis is typically caused by adenovirus (usually serotypes 8, 19 and 37, though other serotypes have been observed). Other viral causes include enterovirus 70, coxsackievirus A24v and herpes simplex virus.

Bacterial causes include *Staphylococcus aureus* (common in adults), *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Moraxella catarrhalis*. Causes of neonatal conjunctivitis include *Neisseria gonorrhoeae* and *Chlamydia trachomatis*.

INCUBATION PERIOD

1-12 days, depending on pathogen.

INFECTIOUS PERIOD

Throughout the duration of illness. For adenovirus, from late in the incubation period up to 14 days after onset.

TRANSMISSION

Conjunctivitis is highly contagious and transmitted via direct contact with discharge from the eye or upper respiratory tract of an infected person, and indirectly through contaminated surfaces or articles. Public swimming pools have not been implicated in the transmission of conjunctivitis in Singapore due to good chlorination.

EPIDEMIOLOGY

Occurs worldwide.

CLINICAL FEATURES

In both viral and bacterial conjunctivitis, general features include an acute onset of lacrimation, eye irritation or itchiness, and conjunctival injection. A mild decrease in vision, chemosis, eyelid swelling and crusting may also occur.

There are also features specific to the aetiological agent:

1. **Viral:** A history of a recent upper respiratory tract infection or contact with an infected person is common. Viral conjunctivitis usually begins in one eye, and involves the contralateral eye a few days later. Discharge is watery or mucoserous, but not purulent. There may also be pre-auricular lymphadenopathy. Specific viral conjunctival syndromes include:
 - a. **Acute haemorrhagic conjunctivitis:** subconjunctival haemorrhages are a feature. They are typically due to adenovirus and picornaviruses (enterovirus 70, coxsackievirus A24v).
 - b. **Herpes simplex conjunctivitis:** there may be history of ocular herpes simplex, and herpetic vesicles along the eyelid margins or peri-ocular skin. Dendritic corneal ulcers may be seen if the cornea is also involved.
2. **Bacterial:** There is continuous mucopurulent discharge at the lid margins, and around the corners of the eye. Crusting of the eyelids is present.
 - a. **Hyperacute bacterial conjunctivitis:** caused by *Neisseria* spp. Typically features copious purulent discharge. This is a severe and sight-threatening infection that requires urgent ophthalmological consultation.

There are multiple differentials for infective conjunctivitis. These include allergic conjunctivitis, drug or chemical induced conjunctivitis, acute glaucoma, and systemic diseases associated with eye involvement (e.g. Sjogren's syndrome, Kawasaki disease, Stevens-Johnson syndrome).

MICROBIOLOGY INVESTIGATION

Disease	Specimen Type	Tests
Viral conjunctivitis	Conjunctival swab	Laboratory tests may be considered for outbreak investigations.

Disease	Specimen Type	Tests
Bacterial conjunctivitis	Conjunctival swab	Bacterial culture Special tests for <i>Neisseria gonorrhoeae</i> and <i>Chlamydia trachomatis</i>
Keratitis/ Keratoconjunctivitis	Refer to ophthalmologist to investigate cases suspected of Herpes simplex and <i>Microsporidia</i> .	

MANAGEMENT OF PATIENTS

Treatment depends on the underlying cause:

1. **Viral conjunctivitis (non-herpetic):** The condition is usually self-resolving even without specific treatment. Management is supportive and includes the use of artificial tears and topical antihistamines. The use of topical antibiotics is discouraged. Patients should be referred to an ophthalmologist if symptoms do not resolve after 7-10 days because of the risk of complications.
2. **Herpes simplex conjunctivitis:** Ocular acyclovir for 7-10 days should be instituted. Steroids should be avoided because of the risk of enhancing herpetic infection. Patients with suspected eyelid or eye involvement should be referred to an ophthalmologist for a thorough evaluation.
3. **Bacterial conjunctivitis (general):** Appropriate antibiotic eyedrops should be prescribed for 5-7 days. Choices include erythromycin ophthalmic ointment, trimethoprim-polymyxin B drops, bacitracin ointment, sulfacetamide ointment, bacitracin-polymyxin B ointment, fluoroquinolone drops, or azithromycin drops. The dose will be 0.5inch (1.25cm) of ointment deposited inside the lower lid, or 1-2 drops instilled four times a day for 5-7 days. Patients who do not respond to treatment should be referred to an ophthalmologist.
4. **Neonatal conjunctivitis:** If gonococcal or chlamydia conjunctivitis is diagnosed in neonates, parents should be screened for sexually transmitted infections.

Contact lens wear should be discontinued during an episode of conjunctivitis. Contact lens wear can be resumed after conjunctival injection has resolved, there is no discharge for 24 hours, and treatment has been completed. The lens case should be discarded, and the lenses subjected to overnight disinfection or replaced if disposable.

MANAGEMENT OF CONTACTS

No specific management of contacts required. Reinforce good hygiene practices.

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions in the healthcare setting apply.

Education of patients and close contacts is vital to prevent spread. Advise to avoid sharing of face or bath towels, pillows or bedding, and to ensure careful hand-washing. Patients should use hygienic measures to dispose of articles soiled by conjunctival discharges.

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CORONAVIRUS DISEASE 2019 (COVID-19)

NOTIFIABLE DISEASE: YES

Cases of COVID-19 should be reported to MOH as soon as possible.

Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67).	Immediately
Laboratories	Upon laboratory confirmation	Call MOH Surveillance Duty Officer for unstable cases.	

CAUSATIVE AGENT

A novel coronavirus, named SARS-CoV-2, was first identified on 7 January 2020 after a series of reported severe acute respiratory infections related to a seafood market in Wuhan, China in late 2019. The genome sequences of 2019-nCoV were found to be closely related to two other bat-derived coronaviruses (bat-SL-CoVZC45 and bat-SL-CoVZXC21), but sufficiently distinct from SARS-CoV and MERS-CoV to be considered a new human-infecting beta-coronavirus.

INCUBATION PERIOD

Based on exposure history and symptom onset of cases, the mean incubation period of COVID-19 is 5-6 days, with a range from 2 to 14 days. In a small minority of cases, symptoms may develop beyond 14 days. During the 2020 outbreak, 14 days from last exposure was used as the period for quarantine and medical observation.

INFECTIOUS PERIOD

Pre-symptomatic transmission may occur in a minority of persons from 1 to 3 days before they develop symptoms. The highest risk of transmission from pre-symptomatic and symptomatic persons occurs around the day of symptom onset up to the first seven days of illness and declines gradually over time. Patients are unlikely to be infectious after day 14 of illness.

TRANSMISSION

Based on genomic similarities, it is believed that the virus originates from bats, with exotic animals found in Huanan seafood market acting as intermediate host(s).

Although early cases were linked to the seafood market in Wuhan, subsequent data indicated that person-to-person transmission of SARS-CoV-2 was occurring, with reports of infection in family clusters and transmission to healthcare workers. Person-to-person transmission occurs through droplet spread, direct contact or indirect contact via fomites. Airborne transmission is possible although not a major route.

EPIDEMIOLOGY

In late December 2019, China reported a series of cases of viral pneumonia of unknown etiology which rapidly progressed to severe acute respiratory syndrome in Wuhan, Hubei Province. Most of the initial patients worked or lived around the local Huanan seafood wholesale market, where live exotic animals were also on sale. In early January 2020, a novel coronavirus was identified from a throat swab sample of an ICU patient. The virus was subsequently named SARS-CoV-2, and the disease it causes COVID-19. On 30 January 2020, with infections spreading in 18 other countries outside China, the WHO declared COVID-19 a public health emergency of international concern.

The first wave of COVID-19 in Singapore occurred in January 2020 with 13 confirmed cases, all visitors from China. This was followed in February-March by clusters of cases due to autochthonous transmission and imported cases among returning Singaporeans. From April onwards, the bulk of cases were among foreign workers as multiple clusters occurred in their dormitories. By 11 August, there were over 55,292 cases in Singapore, with the majority, 55,339, among foreign workers in dormitories, 2,193 among Singaporeans, and 760 imported cases. Worldwide, there were nearly 20 million people infected and over 732,000 deaths. The aggregate case fatality rate (CFR) globally is about 3.7% to date. Singapore has experienced 27 deaths to date, representing a CFR of about 0.05%.

CLINICAL FEATURES

Spectrum of symptoms may range from asymptomatic, mild upper respiratory tract infection to life-threatening illness. Common symptoms are fever, cough or shortness of breath. Other symptoms include anosmia, muscle ache, headache, chest pain and diarrhea. In patients with severe illness, pneumonia may rapidly progress to acute

respiratory distress syndrome (ARDS), septic shock and end organ damage including acute renal injury. Older age and chronic underlying conditions are significant predisposing factors for disease progression.

Laboratory investigations may show leukopenia with lymphopenia although a normal full blood count at presentation is possible. Lactate dehydrogenase, C-reactive protein, ferritin, D-dimer may be elevated, particularly in severe disease.

Chest radiographs may be normal in early or mild disease. Common CXR abnormal findings include unilateral or bilateral, peripheral, lower lung zone opacities with ground glass opacifications demonstrated on computed tomography scan.

MICROBIOLOGY INVESTIGATIONS

Collect 2 samples over 2 consecutive days, preferably 24 hours apart. Notify the laboratory of suspect SARS-CoV-2 before submitting specimens. Early sampling from the first three to four days of illness onset may result in false negative result. Lower respiratory specimens showed higher sensitivity and are preferred in patients with more than one week of illness or if there is pneumonia on imaging.

Specimen Type	Tests
Respiratory samples include sputum, nasopharyngeal or nasal and throat swabs from the upper tract, and endotracheal aspirate, bronchoalveolar lavage from the lower tract.	PCR

MANAGEMENT OF PATIENTS

Management is supportive in the vast majority of patients. For more severe COVID-19 disease (e.g. receipt of supplemental oxygen or mechanical ventilation), dexamethasone (or equivalent) can be considered. Remdesivir, if available, may be considered for patients who require supplemental oxygen or have a SpO₂ of <94% on room air or who have severe illness. Further data is awaited for interferon beta-based treatments, IL-6 inhibitors and other immunomodulatory therapies, and convalescent plasma.

MANAGEMENT OF CONTACTS

Contacts should be placed under active surveillance for 14 days to monitor for symptoms.

PRECAUTIONS, PREVENTION AND CONTROL

If hospitalization is required, suspected and confirmed SARS-CoV-2 cases should be isolated and treated in negative pressure isolation rooms. Aside from standard precautions, contact, droplet and airborne precautions should be applied (full personal protective equipment: eye protection, N95 mask, gown and gloves). Aerosol-generating procedures (e.g. nebuliser therapy) should be avoided if possible. Early elective intubation is considered for severe cases with the use of full PPE or gowns, gloves OR a Powered Air-Purifying Respirator (if there is sufficient time for donning, and personnel adequately trained) for the healthcare workers involved. Movement of patients (e.g. for scans or other procedures) within the hospital should be kept to a minimum.

Public health measures to limit transmission include effective contact tracing, early case detection, quarantine of exposed persons, surveillance of fever clusters and atypical pneumonia cases. There is currently no available vaccine.

Persons at high risk of severe disease should avoid travel to countries with significant community transmission of SARS-CoV-2. As a precaution to reduce the risks of infection, avoid crowds and gatherings, maintain social distancing and diligent hand hygiene.



Pandemic emergencies are challenging for a cosmopolitan city

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DENGUE

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67).	Within 24 hours
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Dengue virus, a member of the *Flaviviridae* family. There are 4 serotypes.

INCUBATION PERIOD

Typically, 4-7 days; range is 3 to 14 days.

INFECTIOUS PERIOD

Infectious to mosquitoes from 2 days before to 5 days after illness onset (when the patient is viraemic).

TRANSMISSION

Transmitted by the bite of infected *Aedes aegypti* and *Aedes albopictus* mosquitoes.

EPIDEMIOLOGY

Dengue is widely distributed in tropical and sub-tropical areas of the world, and is endemic in over 100 countries. Notification of dengue cases has increased over the past decade, with more than 200,000 annual cases being consistently reported in the Western Pacific region since 2007.

Dengue is endemic in Singapore, with year-round transmission observed. Despite sustained vector control efforts, dengue outbreaks occur periodically, with the largest epidemics in the past decade occurring in 2013 and 2014. Cases typically increase

during the hotter months of the year likely due to a reduction in the time needed for the mosquito and virus to replicate. All four dengue virus serotypes co-circulate in Singapore.

CLINICAL FEATURES

Dengue fever (DF) consists of three phases:

1. **Febrile phase:** acute onset of fever. Other symptoms include headache, backache, myalgia, maculopapular rash, retro-orbital pain. There may be minor haemorrhagic manifestations, including petechiae and bruising.
2. **Critical phase:** occurs around the time of defervescence (around Days 3-7 of infection) and lasts for 24-48 hours. Thrombocytopenia usually worsens around this time. Patients should be monitored for warning signs of severe dengue (see below). A small proportion of patients develop a systemic vascular leak syndrome that is characterised by plasma leakage (e.g. pleural effusions, ascites), bleeding, shock and organ dysfunction.
3. **Recovery phase:** resolution of plasma leak and resorption of extravasated fluids. This phase usually lasts 2-4 days. There is a gradual recovery of platelet count during this phase. Some patients may develop a generalised erythematous rash with small islands of sparing.

In 2009, the WHO revised the dengue classification scheme in response to studies demonstrating that the previous 1997 classification system may have underestimated severe disease in adults. Briefly, the revised classification system is as follows:

1. **Dengue fever:** Laboratory-confirmed or probable dengue, which is based on clinical criteria and history of possible exposure:
 - a. Live in/travel to endemic area
 - b. Fever and 2 of the following criteria: nausea/vomiting, rash, aches and pains, positive tourniquet test, leukopenia, any warning signs.
2. **Dengue with warning signs:** Criteria as above for dengue fever and any of the warning signs: abdominal pain or tenderness, persistent vomiting, clinical fluid accumulation, mucosal bleed, lethargy or restlessness, hepatomegaly more than 2cm, increase in concurrent with rapid decrease in platelet count.
3. **Severe dengue:** Presence of any one of the following: severe plasma leakage (leading to shock, fluid accumulation with respiratory distress), severe bleeding, severe organ impairment such as elevated liver transaminases (AST or ALT >1000 U/L).

A wide spectrum of infections mimic dengue in the febrile phase. Chikungunya fever is very similar to dengue. Zika infection may present with mild fever and rash with conjunctivitis, the latter of which is not typical of dengue. Co-infection with zika, dengue, and chikungunya viruses has been described. Marked thrombocytopenia with concurrent haemoconcentration differentiates severe dengue from diseases such as endotoxin shock from bacterial infection or meningococcaemia.

MICROBIOLOGY INVESTIGATIONS

Disease	Specimen Type	Tests
Within seven days from onset of symptoms	Plasma or serum	Dengue NS1 antigen (rapid test) PCR Dengue IgM, IgG
More than seven days from onset of symptoms	Serum	Dengue IgM, IgG

There are combination tests including dengue NS1, IgM and IgG available for laboratory diagnosis of dengue.

Note for laboratories: Send NS1 or PCR positive specimens to NPHL for dengue serotyping by PCR.

MANAGEMENT OF PATIENTS

Management is supportive. Avoid non-steroidal anti-inflammatory drugs and intramuscular injections. Intravenous fluids should be given for hypotension (including postural hypotension), narrowed pulse pressure (<20mmHg) and dehydration (avoid over-hydration that may precipitate pulmonary oedema during the critical phase). Full blood count, in particular, platelet and haematocrit should be monitored closely. There is no role for prophylactic platelet transfusion in the absence of bleeding.

MANAGEMENT OF CONTACTS

No specific management of contacts is required.

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions apply in the healthcare setting. In addition, during the febrile period, prevent patients from access by day biting mosquitoes.

Dengvaxia® (also referred to as CYD-TDV), a live recombinant tetravalent dengue vaccine, is available for the prevention of dengue fever caused by all four serotypes, in individuals aged 12 to 45 years. There is a higher risk of severe dengue following vaccination in individuals who have not had a previous dengue infection, and vaccination is not recommended in these individuals. Those with an unknown history of dengue infection should have serology testing prior to vaccination. Individuals interested in getting the vaccine should consult their doctors on the benefits and risks of vaccination.

Vector control remains the mainstay in reducing the spread of mosquito-borne diseases. Individuals can avoid exposure to mosquito bites by using insect repellents containing $\geq 20\%$ DEET, wearing long-sleeved clothes and long pants, and sleeping in air-conditioned or insect-screened rooms.

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DIPHTHERIA

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67).	Within 24 hours
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Toxin-producing strains of *Corynebacterium diphtheriae*. Four biotypes: gravis, intermedius, mitis and belfanti.

INCUBATION PERIOD

Typically, 2-5 days; range is 1 to 10 days.

INFECTIOUS PERIOD

The infectious period is variable, and depends on how long organisms remain present in discharges and skin lesions. Usually this is 2-4 weeks after onset of illness. Seldom, for respiratory diphtheria, the infectious period may be more than four weeks. Rarely, chronic carriers may shed organisms for six months or more.

TRANSMISSION

Transmission is person-to-person via droplet spread and direct contact with discharging skin lesions. Rarely, indirect transmission occurs via fomites.

EPIDEMIOLOGY

The disease is endemic in many countries in Asia, the South Pacific, the Middle East, Europe, Africa and America. In countries where diphtheria is endemic, between 3-5% of healthy individuals may carry the organism asymptotically and can serve as important reservoirs.

In Singapore, diphtheria vaccination is part of the National Childhood Immunization Programme and has been mandatory since 1977. An isolated case in 2017 involving a 23-year-old Bangladeshi construction worker was believed to have been acquired in Singapore. Screening of his immediate contacts was negative. Prior this, the last local case of diphtheria was reported in 1992.

CLINICAL FEATURES

The presentation of diphtheria depends on the site of involvement. It usually involves the mucous membranes of the upper respiratory tract, skin, and rarely, other mucous membranes (any mucosal site can be involved).

The main clinical forms of diphtheria are:

1. **Respiratory diphtheria:** Commonly presents with sore throat, fever and malaise. In moderate to severe cases, cervical lymphadenopathy and marked oedema can result in a “bull neck” appearance. The classic lesion is a thick greyish pseudomembrane on the tonsils that extends to the soft palate. Extensive pseudomembrane formation can lead to airway obstruction, respiratory failure and death.
2. **Cutaneous diphtheria:** Chronic, non-healing ulcer with dirty grey membrane, covered with eschar – a hard brownish-grey membrane. Commonly occurs on exposed limbs (legs). Systematic toxicity is rare.

Other sites of involvement include the mucous membranes of the conjunctiva and vulvovaginal area, as well as the external auditory canal.

Complications of diphtheria infection are due to absorption and dissemination of toxin, and include myocarditis, arrhythmia, heart failure, polyneuropathies, respiratory failure, and death. CFR for respiratory diphtheria is 5-10% even with treatment, with higher death rates (up to 20%) among persons younger than 5 and older than 40 years of age. Before treatment was available, the disease was fatal in up to half of cases.

MICROBIOLOGY INVESTIGATIONS

Disease	Specimen Type	Tests
Respiratory diphtheria	Throat, nasal swabs	Bacterial culture on selective media
Cutaneous diphtheria	Wound swab, exudate, tissue	

Note for laboratories: *C. diphtheriae* isolates should be sent as pure culture to the NPHL for toxin detection by PCR.

MANAGEMENT OF PATIENTS

Treatment should be started immediately after a clinical diagnosis is made and cultures are obtained. Diphtheria antitoxin is the specific treatment for respiratory diphtheria. Antibiotics are administered for both respiratory and cutaneous diphtheria, and help eliminate the organism and prevent spread. Patients should be given diphtheria toxoid immunisation since infection does not confer immunity.

Recommended antibiotic treatment regimens are:

- Erythromycin orally or by injection (40mg/kg/day, maximum 2g/day) 500mg every six hours for total 14 days.
- Other macrolides: clarithromycin 500mg every 12 hours for 14 days, or azithromycin 500mg daily for 14 days.
- Penicillin is a good alternative antibiotic choice:
 - IM Procaine Penicillin G 300,000 units every 12 hours for those weighing ≤ 10 kg, and 600,000 units every 12 hours for those weighing > 10 kg for 14 days.
 - Oral Penicillin V 125-250mg four times a day can be given instead of injections for persons who can swallow.

A repeat culture should be done two weeks after antibiotic therapy is completed to ensure eradication of organism. Persons who continue to harbour the organism after treatment should receive an additional 10-day course of antibiotic, and should submit samples for follow-up cultures

MANAGEMENT OF CONTACTS

Cultures from the nose and throat should be obtained from close contacts.

Immunisation history of close contacts should be determined.

- If fewer than three doses of diphtheria toxoid have been given, or vaccination history is unknown, an immediate dose of diphtheria toxoid should be given and the primary series completed according to the current schedule.
- If more than 5 years have elapsed since administration of diphtheria toxoid-containing vaccine, a booster dose should be given.
- If the most recent dose was within five years, no booster is required.
- Unimmunised contacts should start a course of DTaP/DT/Td vaccine and be monitored closely for symptoms of diphtheria for seven days.

Close contacts should receive prophylactic antibiotics. Regimens include:

- Oral erythromycin (40mg/kg/day for children and 1g/day for adults) for 7-10 days, or
- IM benzathine penicillin (600,000 units for persons younger than six years old and 1,200,000 units for those six years of age and older) as a single dose.

Contacts should be monitored closely and give antitoxin at the first sign of illness.

PRECAUTIONS, PREVENTION AND CONTROL

Standard, droplet and contact (for cutaneous diphtheria) precautions apply during management of the patient. Droplet precautions should be instituted until 2 negative cultures from both throat and nose (at least 24 hours apart), and at least 24 hours after cessation of antimicrobial therapy. Asymptomatic carriers should receive prophylactic antibiotics, as above.

Vaccination against diphtheria is compulsory under Singapore law (see Public Health Resources section). The National Childhood Immunisation Schedule recommends:

- DTaP (diphtheria and tetanus toxoids and acellular pertussis vaccine) at 2 months, 4 months and 6 months of age (separated by minimum of 4 weeks);
- DTaP at 18 months (minimum six months after the third dose, and not before 12 months of age); and
- Tdap (Tetanus- diphtheria- acellular pertussis) at 10-11 years of age.

The National Adult Immunization Schedule recommends:

- Booster Tdap vaccination every 10 years;
- Tdap vaccination for pregnant women, one dose per pregnancy, regardless of previous Tdap history, to be administered at 16-32 weeks of gestation.

Adults travelling to endemic areas should receive booster Tdap vaccine if their vaccination has lapsed for more than 10 years.

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EBOLA VIRUS DISEASE

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Call MOH Surveillance Duty Officer and submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Immediately
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

The genus *Ebolavirus* is divided into five species of which four are known to cause Ebola virus disease (EVD) in humans (*Zaire ebolavirus*, *Sudan ebolavirus*, *Bundibugyo ebolavirus*, and *Tai Forest ebolavirus*).

INCUBATION PERIOD

Typically, 5-15 days; range is 2 to 21 days.

INFECTIOUS PERIOD

Patients are infectious when symptomatic.

TRANSMISSION

Fruit bats of the *Pteropodidae* family are the most likely natural reservoir of Ebola virus, and humans can become infected by close contact or by manipulating the blood, secretions, organs or other bodily fluids of infected wildlife.

Person-to-person transmission of EVD occurs via direct contact with the blood, secretions, organs or other bodily fluids of infected individuals or those who have died from the infection. Indirect transmission can occur from direct contact with surfaces and materials (e.g. bedding, clothing) contaminated with these fluids.

EPIDEMIOLOGY

Since the virus was first discovered in 1976, Ebola outbreaks have been described in Central and West Africa. In 2014-2016, a major outbreak started in Guinea and spread to Liberia, Sierra Leone, Nigeria, Senegal and Mali. In 2018, another major outbreak surfaced in the Democratic Republic of Congo.

CLINICAL FEATURES

Initial symptoms are the sudden onset of fever, chills, fatigue, muscle pain, headache and sore throat. This is followed by the development of rash (non-pruritic, maculopapular and can desquamate) at Day 5-7 of illness. Gastrointestinal symptoms such as watery diarrhoea, nausea, vomiting and abdominal pain are common. Severe diarrhoea and vomiting can lead to massive fluid losses and consequent dehydration and shock. Signs of respiratory failure or hypoxia such as shortness of breath may be evident, and may occur in the setting of aggressive fluid resuscitation.

Many patients develop internal or external haemorrhage during their illness, most commonly manifested as blood in the stool, ecchymoses and or mucosal bleeding. Occasionally, patients develop neurologic manifestations such as meningoencephalitis with altered level of consciousness and seizures.

Patients who survive EVD typically begin to improve during the second week of illness. Fatal disease has been characterised by more severe clinical signs and symptoms during earlier phase of infection, with progression to multiorgan failure with death typically occurring in the second week. Overall CFR in the 2014-2016 outbreak was 40%, but has approached nearly 90% in other outbreaks.

The differential diagnoses are varied and include malaria, Lassa fever, meningococcal disease, measles, influenza, traveller's diarrhea, typhoid and other viral haemorrhagic fevers.

MOH's suspect case definition for EVD is as follows:

- Fever (>38°C) or current history of fever, AND
- Exposure to a confirmed or suspected case of EVD, or the body fluids (i.e. blood, urine, faeces, tissues, laboratory cultures) of a confirmed or suspect case of EVD within the past 21 days.

MICROBIOLOGY INVESTIGATIONS

Notify the laboratory when Ebola virus disease or other viral hemorrhagic fever (VHF) is suspected. Please inform MOH and NPHL to arrange laboratory tests for Ebola virus and/or other agents of viral haemorrhagic fever at NPHL.

Specimen Type	Tests
Blood	PCR

Note for laboratories: Refer to the institution's guidelines for handling and testing of patient's samples. Blood specimens should be packed appropriately as described in MOH circular 24/2014 (Laboratory protocol for testing for Ebola virus disease). Please engage an approved courier for the transport of specimens to the NPHL.

MANAGEMENT OF PATIENTS

Transfer of suspected cases to the National Centre for Infectious Diseases (NCID) to be arranged by MOH on a case by case basis. All confirmed EVD cases will be managed at the High Level Isolation Unit in NCID. Treatment is supportive and directed at the management of the complications of EVD. As yet there is no proven treatment available for EVD, though a range of potential treatments are being evaluated.

MANAGEMENT OF CONTACTS

See 'Precautions, Prevention and Control' below.

PRECAUTIONS, PREVENTION AND CONTROL

Standard, droplet and contact precautions all apply. When in close contact (within 1 meter) with EVD patients, healthcare workers should wear face protection (a face shield or a medical mask and goggles), a clean, non-sterile long-sleeved gown, and gloves (sterile gloves for some procedures). If possible, aerosol-generating procedures should be avoided. Laboratory specimens should be handled by trained staff and processed in suitably equipped laboratories. Waste should be handled appropriately.

MOH will conduct contact tracing of the confirmed EVD case and close contacts may be quarantined for at least 21 days following last exposure.

An experimental vaccine, the recombinant vesicular stomatitis virus-vectored vaccine expressing the Ebola virus surface glycoprotein has been found to be highly protective in a ring vaccination cluster-randomised trial. Although not commercially licensed, it has been recommended for use in the ongoing EVD outbreak in Congo (outbreak in North Kivu province declared on 1 August 2018) on compassionate grounds.

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ERYTHEMA INFECTIOSUM (FIFTH DISEASE)

NOTIFIABLE DISEASE: NO

CAUSATIVE AGENT

Parvovirus B19

INCUBATION PERIOD

Typically, 4–14 days

INFECTIOUS PERIOD

Later part of the incubation period and the prodromal phase. Immunocompetent hosts are non-infectious by the time the characteristic rash appears.

TRANSMISSION

Transmission occurs primarily by respiratory droplets. Occasionally, transmission can be vertical (i.e. mother to fetus) and rarely, via contaminated blood products or during bone marrow transplantation.

EPIDEMIOLOGY

Worldwide, parvovirus B19 infection is common in childhood, and up to 60% of adults are seropositive for parvovirus B19 by 20 years of age. In temperate countries, epidemics of erythema infectiosum tend to occur in late winter or early spring, with cyclical peaks of incidence every 4 to 7 years.

Parvovirus B19 infection is less common in Singapore. A sero-epidemiological study in 1993 showed that only 16.2% of 600 healthy individuals between 6 months and over 50 years of age tested positive for parvovirus B19 IgG antibody.

CLINICAL FEATURES

Non-specific prodromal illness during early viremia which is often mild and unrecognised. Main symptoms include fever, coryza, headache, nausea and, occasionally, diarrhoea and arthralgia. The classic slapped-cheek rash appears 2–5 days after the prodromal phase. This is a fiery red eruption accompanied by relative circumoral pallor.

A second-stage erythematous maculopapular exanthem may erupt on the trunk and limbs within a few days – as it fades, a typical lacy pattern is seen, especially on the proximal extremities. The rash may be evanescent and can recur upon exposure to sunlight, heat, emotion, exercise, and may be confused with rubella. There is great variation in the dermatologic manifestations in terms of severity and duration. In contrast to children, non-erosive arthropathy affecting symmetrical small joints, especially in females, are the most common presentation in adults.

Complications are unusual, but can cause a transient aplastic crisis in susceptible hosts (e.g. patients with haemoglobinopathies), a chronic parvovirus B12 infection with pure red-cell aplasia in immunocompromised hosts, and hydrops fetalis and intrauterine death (if intrauterine infection in the first half of pregnancy).

INVESTIGATIONS

Diagnosis is made based on clinical presentation alone and further investigations are often unnecessary. However, confirmation may be useful in certain clinical settings, such as immunocompromised patients or outbreaks.

Specimen Type	Tests
Serum	IgM, IgG
Blood Amniotic fluid Others	PCR

MANAGEMENT OF PATIENTS

Erythema infectiosum is a benign and self-limiting infection which results in lifelong immunity. No treatment is required in most cases other than symptomatic relief. In immunocompromised hosts, management strategies include reduction in immunosuppression, institution of antiretroviral therapy in HIV patients, intravenous immunoglobulin, and packed cell and/or platelet transfusions.

MANAGEMENT OF CONTACTS

No specific management of contacts is generally required. Reinforce good hygiene practices. Exposed, susceptible pregnant women should be advised on the risk of complications to the foetus.

PRECAUTIONS, PREVENTION AND CONTROL

In the hospital setting, patients with transient aplastic crisis or a chronic infection in immunocompromised hosts should be maintained on standard and droplet precautions.

There is no available vaccine. Prevention is difficult because patients are infectious prior to onset of the distinguishing rash. Nevertheless, children with fever should be excluded from preschool centres and a high standard of personal hygiene (e.g. hand washing) should be observed.

Those at risk of complications (e.g. pregnant women) should avoid exposure to potentially infectious persons in the hospital or outbreak settings. Non-immune pregnant women who continue to have close contact to those with parvovirus B19 infection should be advised on the risk of complications to the fetus.

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Shophouses and eating establishments inspection, Joo Chiat Road

FOOD-BORNE ILLNESS AND FOOD POISONING

NOTIFIABLE DISEASE: – YES in the following circumstances:

- A) The legally notifiable diseases are: botulism, campylobacteriosis, cholera, non-typhoidal salmonellosis, typhoid and paratyphoid fever (see specific chapters for details).
- B) An outbreak is suspected.

Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67).	Within 24-72 hours (depending on pathogen)
Laboratories	Upon laboratory confirmation		

DEFINITION

Food-borne illness comprises specific diseases (e.g. cholera, hepatitis A) and food poisoning. The latter results from the ingestion of food contaminated with chemicals (insecticides, methyl alcohol), microorganisms (bacteria, fungi, viruses, parasites, algae) or their toxins (e.g. ciguatera poisoning), and natural toxins (e.g. puffer fish and poisonous mushrooms) but does not include food allergies.

CAUSATIVE AGENTS

The most commonly identified pathogens causing food poisoning include norovirus, *Campylobacter jejuni*, *Salmonella* spp. (non-typhoidal), *Staphylococcus aureus*, *Vibrio parahaemolyticus*, *Bacillus cereus* and *Escherichia coli*.

INCUBATION PERIOD

Depending on the pathogen and ingested dose, it can vary from hours to days (see Table).

INFECTIOUS PERIOD

If the infectious dose of the causative agent is low, disease is generally not contagious but person-person transmission can occur with poor personal hygiene and food handling practices via faecal-oral transmission.

TRANSMISSION

See Table.

EPIDEMIOLOGY

Food-borne illness is increasingly recognised as an important public health issue in both developed and developing countries. In recent years, there have been significant changes in global food production, processing, distribution and preparation, which in turn contribute to the changes observed in the epidemiology of foodborne pathogens and the nature of outbreaks (from locally limited outbreaks to widespread trans-regional or international outbreaks). Factors including the globalisation of food source, population demographics, consumer behaviour, food hygiene practices, as well as enhanced surveillance systems, influence the local epidemiology of food borne illness.

CLINICAL FEATURES

The majority of food-borne illnesses present with acute gastrointestinal symptoms: vomiting (e.g. *S. aureus*, *B. cereus*, norovirus) and diarrhoea (e.g. *Salmonella* spp., *Campylobacter* spp., enterotoxigenic *E. coli*). Fever is usually absent if caused by an organism that expresses a toxin (e.g. *S. aureus*); its presence suggests infection with invasive bacteria (e.g. *Salmonella*, *Shigella* or *Campylobacter*), enteric viruses, or a cytotoxic organism such as *Entamoeba histolytica*. Some infections present with fever, abdominal pain and diarrhoea with leucocytes or blood (e.g. *Salmonella* spp., *Shigella* spp., *C. jejuni*).

Post-infectious syndromes rarely occur, e.g. Reiter's syndrome after salmonellosis, Guillain-Barré syndrome after campylobacteriosis, and haemolytic uremic syndrome (HUS) after infections with *E. coli* O157:H7 or other Shiga-toxin producing *E. coli* (STEC).

MICROBIOLOGY INVESTIGATION

Appropriate specimens for laboratory confirmation vary depending on the clinical and epidemiological features (e.g. food implicated), and the likely aetiological agent. Specimens to be obtained include:

- Patient's stools, vomitus and blood.
- Food handlers' hand, stool or nose cultures.

Multiplex PCR for gastrointestinal pathogens is available. However, interpretation of the results should be done with caution as the positive findings may be incidental, rather than causative.

Agents of public health importance may require further culture for confirmation. Isolation of the organism from food is preferred when diagnosing *S. aureus* or *Clostridium perfringens*, as these bacteria are also part of the normal flora. If *E. coli* O157:H7 or other STEC is suspected, the microbiology laboratory needs to be informed.

MANAGEMENT OF PATIENTS

Rehydration (either oral or intravenous) remains the mainstay of therapy. Most cases of food poisoning can be treated outpatient with oral rehydration salts (ORS) and symptomatic treatment.

Patients with bloody diarrhoea, high fever and dehydration and failure to retain fluids should be considered for admission. Anti-motility agents should be avoided as they may cause dangerous paralytic ileus and abdominal distension, especially in children and infants.

Antimicrobial agents are of no value in the management of viral gastroenteritis, Staphylococcal, *C. perfringens* or *B. cereus* food poisoning. Food poisoning caused by *V. parahaemolyticus*, Shiga toxin-producing or invasive *E. coli* or *Yersinia enterocolitica* are usually self-limiting.

Antimicrobial therapy for people with infections attributed to *E. coli* O157 and other STEC that produce Shiga toxin 2 should be avoided as this has been associated with an increased risk of developing HUS. These patients should also be evaluated expectantly for the development of HUS.

Antimicrobial agents may be used in the treatment of shigellosis, cholera, invasive salmonellosis and typhoid fever, but should be avoided in uncomplicated gastrointestinal infection caused by non-typhoidal *Salmonella*.

Listeria monocytogenes gastroenteritis may not require antibiotic therapy but treatment can be considered in elderly, pregnant women and those with compromised cell-mediated immunity. *C. jejuni* infection is mostly self-limiting, though treatment may be considered if there are high fevers, prolonged or severe symptoms, bloody diarrhoea, and in pregnant or immunocompromised hosts. Antimicrobial therapy should be given for *Giardia lamblia* and *Cyclospora* infection.

MANAGEMENT OF CONTACTS

No specific management of contacts required in sporadic or isolated cases.

PRECAUTIONS, PREVENTION AND CONTROL

Patients infected with pathogens of high public health impact may be isolated and staff should adhere to contact precautions.

When an outbreak of food-borne illness is suspected, the aim of investigations is to identify the source and contain/control the outbreak. Epidemiological investigations will be conducted to obtain information on food history, onset of illness and symptoms. Microbiological (e.g. stool samples from cases, food samples) and environmental investigations (e.g. food preparation practices, environmental sanitation) are also conducted. Implicated food handlers will be referred to the designated referral laboratory for stool cultures.

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**EPIDEMIOLOGICAL AND CLINICAL FEATURES
OF IMPORTANT AETIOLOGICAL AGENTS OF FOOD-BORNE ILLNESS**

Causative Agent	Incubation Period	Mode of Action	Clinical Features	Food Vehicle	Prevention & Control
<i>Staphylococcus aureus</i>	1-6 hours	Preformed toxin	Abd cramps, N, V	Unrefrigerated or improperly refrigerated meat, dairy products, cream pastries.	Proper food handling and storage with proper temperature control. Exclude food handlers with septic wounds.
<i>Bacillus cereus</i>	1-6 hours or 10- 16 hours	Preformed toxin or diarrhoeal toxin	N, V Abd cramps, D	Improperly refrigerated cooked or fried rice, meat, vegetables.	Thorough and rapid reheating of cooked food
Non-typhoidal <i>Salmonella</i>	12-36 hours	Infection	D, abd cramps, N, V, F	Meat, poultry, eggs and dairy products.	Proper meat processing; adequate cooking; avoid cross-contamination; proper temperature control and storage.
<i>Campylobacter jejuni</i>	2-5 days	Infection	D, abd cramps, N, V, F	Under-cooked meat (particularly poultry) and unpasteurized milk.	Wash hands after contact with animal/animal products; thorough cooking and proper storage of food of animal origin; pasteurisation of milk.
<i>Clostridium perfringens</i>	6-24 hours	Enterotoxin	D, abd cramps	Beef, poultry, gravies, dried foods	Adequate cooking; proper temperature control; thorough reheating of cooked food

Causative Agent	Incubation Period	Mode of Action	Clinical Features	Food Vehicle	Prevention & Control
Enterohaemorrhagic <i>E. coli</i> (EHEC) including <i>E. coli</i> O157:H7 or other STEC	3-8 days	Infection	Severe abdominal cramps, watery to bloody D, haemorrhagic uremic syndrome (HUS)	Ground beef, unpasteurised milk and hamburgers.	Proper processing and handling of meat; adequate cooking and storage.
<i>Listeria monocytogenes</i>	9-48 hours for gastrointestinal symptoms, 2-6 weeks for invasive disease	Infection	Mild flu-like illness to meningitis, meningococcal encephalitis	Cold processed meat, fresh soft cheeses, unpasteurised milk, dairy products, fruits and vegetables.	Proper processing and handling; prevent cross-contamination; adequate cooking; pasteurisation of dairy foods.
<i>Clostridium botulinum</i>	12-72 hours	Preformed toxin	V, constipation, dryness of mouth, change of voice, dysphagia, ptosis, diplopia	Home canned food, improperly canned commercial foods.	Proper supervision of home canning; adequate heating to 100°C for 10 minutes OR 80° C for 30 minutes.
Norovirus	12-48 hours	Infection	N, V, D, abdominal cramps, transient F, myalgia	Contaminated food such as oysters and contaminated water supply and environment (person-to-person transmission can occur)	Provision of safe food and water, proper handling of cold foods, hand-washing
Rotavirus	1-3 days	Infection	V, D, F	Contaminated food (person-to-person transmission can occur)	Proper handling of food, personal hygiene

Causative Agent	Incubation Period	Mode of Action	Clinical Features	Food Vehicle	Prevention & Control
Hepatitis A	28-30 days	Infection	N, V, F, jaundice, dark urine, abd cramps, LOA	Contaminated food and water	Proper handling of food, personal hygiene, adequate cooking
Hepatitis E	26-42 days	Infection	N, V, F, jaundice, dark urine, abd cramps, LOA	Contaminated food and water	Proper handling of food, personal hygiene, adequate cooking
Cyclospora	1-14 days	Infection	D, N, V, abd cramps, LOA, LOW	Contaminated food and water	Avoiding food and water that may be contaminated with human stool
<i>Cryptosporidium parvum</i>	2-10 days	Infection	D, abd cramps, F, LOW, V	Water, including recreational water, contaminated by faeces of livestock (person-person transmission can occur)	Provision of safe water supply, boiling water advised for immunocompromised persons
<i>Giardia lamblia</i>	1-2 weeks	Infection	N, V, D, abd cramps, bloatedness, LOW, malabsorption	Contaminated food and water (person-person transmission can occur)	Proper water treatment, good personal hygiene
<i>Entamoeba histolytica</i>	2 days-4 weeks	Infection	Bloody D, lower abd cramps	Food contaminated by ill food handler	Good personal hygiene

Causative Agent	Incubation Period	Mode of Action	Clinical Features	Food Vehicle	Prevention & Control
<i>Vibrio cholerae</i>	2-3 days	Infection	Often mild or without symptoms. Can be severe characterised by profuse watery D, V, and leg cramps.	Contaminated food (e.g. seafood) and water	Provision of safe food and water, proper processing and handling; adequate cooking; good personal hygiene
<i>Vibrio parahaemolyticus</i>	12-24 hours	Infection	D, abd cramps, N, V, F, headache, bloody stools	Contaminated food (e.g. seafood) and water	Provision of safe food and water, proper processing and handling; adequate cooking; good personal hygiene

Abbreviations: N, nausea; V, vomiting; D, diarrhoea; abd, abdominal; LOW, loss of weight; LOA, loss of appetite; F, fever.

Reference: American Medical Association, American Nurses Association-American Nurses Foundation, Centers for Disease Control and Prevention et al. Diagnosis and management of foodborne illnesses: a primer for physicians and other health care professionals. MMWR Recomm Rep. 2004;53:1-33.

GROUP A STREPTOCOCCAL INFECTION

NOTIFIABLE DISEASE: NO

CAUSATIVE AGENT

Group A *Streptococcus* (GAS) or *Streptococcus pyogenes*

INCUBATION PERIOD

Typically, 1-3 days for pharyngitis, and 7-10 days for impetigo.

INFECTIOUS PERIOD

Infected persons who have received appropriate antibiotic treatment for 24 hours or longer are generally no longer considered contagious or able to spread the bacteria.

TRANSMISSION

Transmission occurs through droplet spread or direct contact with bodily secretions of infected person, such as nasal or oral secretions, open wounds or skin sores. The risk of transmission is highest when the infected person is actively ill. Asymptomatic carriers of GAS may also spread the bacteria, although they are considered much less contagious.

EPIDEMIOLOGY

Invasive GAS infections and sequelae from non-suppurative complications cause a significant burden of disease worldwide, especially in poorer or developing countries. Streptococcal pharyngitis also remains one of the most common bacterial infections in childhood. Scarlet fever, one of the diseases caused by GAS, was reported to be re-emerging in China, Hong Kong and South Korea in 2011, and in England in 2014. Since then, Hong Kong and England have reported an upsurge in cases and accentuation of the usual winter-spring pattern.

CLINICAL FEATURES

There are 2 distinct entities of GAS infections – non-invasive and invasive disease.

Non-invasive disease is usually milder, and common forms are:

1. **Pharyngitis:** commonly presents with acute onset exudative pharyngitis, enlarged tender anterior cervical lymphadenopathy and may be associated with other non-localising features such as fever, malaise, headache and occasionally abdominal pain. Suppurative complications may occur shortly after the initial infection: peritonsillar or retropharyngeal abscesses, acute otitis media and acute bacterial sinusitis. Children between 5-15 years old are typically at highest risk for developing GAS pharyngitis and scarlet fever. GAS pharyngitis is rare in children below 3 years of age. Close contact with infected persons with GAS pharyngitis is a common risk factor for infection.
2. **Scarlet fever:** Children, most commonly between 5-15 years of age, may develop scarlet fever after GAS infections. Symptoms include a characteristic scarlatiniform rash with sandpaper like quality, typically beginning on trunk spreading outwards with sparing of palms, soles and face, high fever, and a “strawberry” tongue. Accentuation of the red rash can occur in flexor creases (i.e. under the arm, in the groin), termed “Pastia’s lines”.
3. **Skin infections:**
 - a. Impetigo and ecthyma: superficial skin infections.
 - b. Cellulitis and erysipelas: erysipelas is an acute infection involving the upper dermis and superficial lymphatics, while cellulitis involves the lower dermis and subcutaneous tissue.

Invasive disease is less common and refers to infection where GAS is isolated from a normally sterile site (e.g. blood) or the patient has severe clinical presentation. The elderly and certain comorbidities (e.g. diabetes mellitus) have been associated with an increased risk of invasive GAS infection. However, a significant proportion of invasive GAS infections occur in individuals with no identifiable risk factors (up to 30% in adults and 80% in children).

1. **Streptococcal toxic shock syndrome:** may occur with systemic or focal GAS infections. It is characterised by shock and multiorgan failure. Mortality rates can be as high as 40%.
2. **Necrotising fasciitis:** a rapidly progressive disease that involves skin, fat, muscle and fascia. Pain is classically described as out of proportion to physical examination findings.
3. **Rarer forms of invasive disease:** Primary bacteraemia, osteomyelitis, septic arthritis, and pneumonia.

GAS infections may result in immune-mediated non-suppurative complications that may present after a latency period of weeks to years after the initial GAS infection – these are post-streptococcal acute glomerulonephritis and acute rheumatic fever.

MICROBIOLOGY INVESTIGATIONS

Specimen Type	Tests
Throat swab Blood Cerebrospinal fluid Tissue Other fluid	Bacterial culture

Rapid antigen detection tests from a throat swab sample may also be performed; they are specific but have varying sensitivities compared to bacterial culture. Anti-streptococcal antibody titre is not useful for the diagnosis of acute infections.

MANAGEMENT OF PATIENTS

Choice of antibiotic therapy would depend on clinical syndrome. Initial intravenous or oral route of administration depends on site and severity of disease. Penicillin remains the antibiotic of choice for GAS pharyngitis and mild skin infections, while amoxicillin and oral cephalosporins are also highly effective. Clindamycin and macrolides (clarithromycin, azithromycin) may be considered in patients with penicillin allergy.

In invasive disease, initial resuscitation measures and stabilisation of the patient should be instituted without delay. In addition to antibiotic therapy, early surgical debridement of the site of infection, if indicated, is also crucial.

MANAGEMENT OF CONTACTS

Close household contacts of patients with GAS infections should maintain good hand hygiene practices at all times. Screening or chemoprophylaxis for household contacts of patients with invasive GAS disease is not routinely recommended. At the individual clinician's discretion, antibiotic prophylaxis may be offered to contacts considered at high risk of developing invasive disease. Choice of antibiotic prophylaxis varies according to different guidelines – oral penicillin V is usually first line, followed by azithromycin or clindamycin.

PRECAUTIONS, PREVENTION AND CONTROL

Standard, droplet and contact precautions (depending on form of clinical disease) should be instituted until 24 hours after initiation of effective antibiotic therapy. There is no available vaccine.

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GROUP B STREPTOCOCCAL INFECTION

NOTIFIABLE DISEASE: NO

Although not a notifiable disease, public hospitals are required to report the monthly number of patients with invasive infection to MOH.

CAUSATIVE AGENT

Group B *Streptococcus* (GBS) or *Streptococcus agalactiae*

INCUBATION PERIOD

There is no defined incubation period for GBS acquisition to infection in adults, however onset of disease is usually acute, within days. For cases of mother-to-child transmission in neonatal infection, incubation period is from 1-6 days (early onset disease), and between 7-90 days (late onset disease).

INFECTIOUS PERIOD

There is no clearly known infectious period for adults with active GBS infections, however this is an important issue in mother-to-child transmission (see below).

TRANSMISSION

Asymptomatic carriage in gastrointestinal and genital tracts is common. Pregnant women with vaginal colonisation of GBS (especially those who test positive in later pregnancy, at 35-37 weeks gestation) risk transmission to the foetus in utero or to the neonate during labour at time of delivery. The rates of vertical transmission can be as high as 50% if intrapartum antibiotic prophylaxis is not given before delivery. Nosocomial transmission can occur but this is uncommon.

EPIDEMIOLOGY

GBS is distributed worldwide. Approximately 10-40% of the general population can be asymptotically colonised with GBS. Sites of colonisation are skin and mucosal surfaces (including the oropharynx and lower gastrointestinal tract), or genital tract. Colonisation rates vary by site, geographical location and population demographics.

In Singapore, an outbreak of invasive GBS infections (Type III disease, sequence type 283 strain) in mid-2015 was associated with consumption of a particular Chinese-style freshwater raw-fish dish. Compared to non-ST283 GBS, patients with ST283 infection were younger and had fewer comorbidities but were more likely to develop meningococcal meningitis, septic arthritis, and spinal infection. Culture of 43 fish samples yielded 13 ST283-positive samples.

CLINICAL FEATURES

GBS can cause invasive disease (i.e. isolation of GBS from a normally sterile site). In adults, primary bacteraemia accounts for up to 20-50% of cases of first episode of infection – initial presentation may be varied and symptoms may be non-focal, including fever, chills, general malaise, drowsiness or altered mental status. The most common focal site of infection is the skin and soft tissues. Patients can present with cellulitis, abscesses, and less commonly necrotising fasciitis. Other sites of GBS infection include urinary tract infection, septic arthritis, osteomyelitis, endocarditis and meningitis.

Common manifestations of neonatal infection are sepsis without a focal source, pneumonia, and meningitis.

Risk factors for invasive GBS infection include: infants born to mothers colonised with GBS, age >65 years and underlying medical conditions (e.g. diabetes mellitus, chronic liver, renal or pulmonary disease, malignancy, chronic alcoholism, immunosuppression, cardiovascular disease, cerebrovascular disease).

MICROBIOLOGY INVESTIGATIONS

Specimen Type	Tests
Blood Cerebrospinal fluid Other fluid	Bacterial culture

MANAGEMENT OF PATIENTS

Most isolates of GBS remain susceptible to penicillins and cephalosporins. Penicillin is the usual drug of choice for treatment. However initial empirical antibiotic choice should also be guided by local or hospital antibiotic guidelines and susceptibility data. Duration of antibiotic treatment varies depending on site and severity of infection.

It is also of utmost importance to obtain adequate source control when needed (e.g. surgical debridement or washout, or drainage of collections or abscesses).

MANAGEMENT OF CONTACTS

No specific management of contacts is required.

PRECAUTIONS, PREVENTION AND CONTROL

Intrapartum GBS prophylaxis (usually penicillin) should be administered to women colonised with GBS to reduce transmission and likelihood of neonatal infection.

There are otherwise no known effective measures to prevent infection in adults, unless in cases of a specific established epidemiological link during an outbreak investigation.

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Parliament house, seat of infectious diseases legislation

HAEMOPHILUS INFLUENZAE TYPE B DISEASE

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Laboratories	Upon laboratory confirmation	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67).	Within 24 hours

CAUSATIVE AGENT

Haemophilus influenzae type b (Hib), a gram-negative coccobacillus.

INCUBATION PERIOD

Unknown, probably 2-4 days.

INFECTIOUS PERIOD

Hib is communicable as long as the organism remains within the nasopharynx (which can be for weeks to months). Cases are no longer infectious once they have received at least 24 hours of appropriate antibiotics.

TRANSMISSION

Inhalation of respiratory droplets or direct contact with respiratory tract secretions. Intrapartum acquisition of infection in neonates may occur by aspiration of amniotic fluid or by contact with maternal genital tract secretions.

EPIDEMIOLOGY

Colonisation by Hib occurred in 3-5% of children in the pre-vaccine era, reducing after widespread immunisation to <1%. In developing countries, where routine vaccination with Hib vaccine is not widely available, Hib remains a major cause of invasive disease, e.g. meningitis, lower respiratory tract infections and sepsis in infants and children. In Singapore, Hib vaccination was included in the National Childhood Immunisation Programme in May 2013.

CLINICAL FEATURES

Hib disease can result in various clinical syndromes, including pneumonia, occult bacteraemia, meningitis, epiglottitis, septic arthritis, cellulitis, otitis media, purulent pericarditis and less commonly, endocarditis, endophthalmitis, osteomyelitis and peritonitis.

1. **Meningitis:** symptoms include fever, lethargy, irritability and vomiting (there may be prior symptoms of a respiratory tract infection). There may occasionally be rapid neurological deterioration with respiratory arrest. Shock is present in 20% of cases and may be associated with coagulopathy and purpura. Complications include subdural effusions or empyema, cortical infarction, intracerebral abscess and hydrocephalus. Up to 20% of patients who survive Hib meningitis have permanent hearing loss or other long-term neurological sequelae.
2. **Epiglottitis:** Symptoms include high fever, sore throat, stridor and dyspnea with rapid progression to dysphagia, pooling of secretions and drooling. The patient is usually restless and anxious and adopts a sitting position with neck extended and chin protruding to reduce airway obstruction. Rapid deterioration can occur and cause death unless an artificial airway is established.
3. **Pneumonia:** There is typically a consolidative pulmonary infiltrate and evidence of pleural involvement in 50% of cases on chest radiograph. Concomitant meningitis or epiglottitis is present in 25% of patients. Purulent pericarditis is a complication resulting from contiguous spread of infection and these patients usually have severe dyspnoea, tachycardia and cardiac failure.
4. **Septic arthritis and osteomyelitis:** Prior to conjugate vaccine introduction, Hib was the commonest cause of pyogenic arthritis in children under 2 years of age. Contiguous osteomyelitis is present in 10-20% of cases.
5. **Cellulitis:** This is usually seen in young children and is the result of a metastatic focus of bacteraemia. Symptoms and signs include fever and an area of warmth, tenderness and erythema (or violaceous discolouration) over the cheek or periorbital area. Bloodstream infection is usually present concomitantly and another focus of infection (e.g. meningitis) develops in about 10% of cases.

Between 3% and 6% of Hib cases in children are fatal. Unimmunised children under 4 years of age are at increased risk of invasive infection, especially if they are in prolonged close contact with an index case. Patients with immunodeficiency disorders, asplenia and sickle cell disease are also at increased risk of invasive disease. Patients ≥ 65 years of age with invasive *H. influenzae* disease have higher CFRs than children and young adults.

MICROBIOLOGY INVESTIGATIONS

Specimen Type	Tests
Blood Sterile fluids	Bacterial culture
Cerebrospinal fluid	Bacterial culture PCR

Note for laboratories: Strains isolated from sterile sites should be tested for capsular type b antigen. Please send isolates from invasive samples only to NPHL.

MANAGEMENT OF PATIENTS

Antibiotics are indicated in the treatment of Hib disease, with beta-lactam agents being the preferred antimicrobial agents for susceptible organisms. The duration of treatment for uncomplicated meningitis should be at least seven days of intravenous antibiotics. Complicated cases may require longer therapy.

Dexamethasone may be of benefit in children with Hib meningitis in reducing the risk of hearing loss and other neurological sequelae, but not mortality, if administered before or concurrently with the first dose of antibiotics.

Epiglottitis is a medical emergency that requires immediate endotracheal intubation or a tracheostomy. Pleural, pericardial or synovial fluid that is infected should be drained.

MANAGEMENT OF CONTACTS

Chemoprophylaxis with rifampicin should be initiated as soon as possible for the whole household where there is at least 1 household contact with a person who has invasive Hib disease, and where there are children under 2 years old who are not immunised or incompletely immunised against Hib, or where there are children under 12 months who have not received their primary series of vaccines, or where there is an immunocompromised child (regardless of immunisation status).

Chemoprophylaxis is recommended in childcare settings when two or more cases of invasive Hib disease have occurred within 60 days, and unimmunised or under immunised children attend the facility. When prophylaxis is indicated, it should be prescribed for all attendees, regardless of age or vaccine status, and for childcare providers.

The chemoprophylactic dosage of rifampicin in children is 20mg/kg (maximum dose 600mg) once daily for 4 days. The adult dose is 600mg.

PRECAUTIONS, PREVENTION AND CONTROL

Patients with invasive Hib disease should be isolated with droplet precautions till 24 hours after starting effective antibiotic therapy. Healthcare workers without adequate personal protective equipment (e.g. surgical mask) exposed to the index case respiratory secretions (e.g. aerosolization, suctioning) prior to completion of 24 hours effective treatment should be offered chemoprophylaxis as well (see Public Health Resources section).

Drugs other than ceftriaxone and cefotaxime used to treat Hib infections do not reliably eradicate Hib from the nasopharynx. Hence, if the index patient is under 2 years old and was treated with a regime other than cefotaxime or ceftriaxone, chemoprophylaxis should be given to the index case just before hospital discharge to eradicate nasopharyngeal colonisation with Hib.

Vaccination is the most important strategy for prevention of Hib infection (see Public Health Resources section). The recommended series of Hib conjugate vaccines consists of 3 primary doses given within the first 6 months of life with a booster dose given at 12-18 months of age. It can be given in combination with diphtheria, tetanus, acellular pertussis, inactivated poliovirus and hepatitis B either as a pentavalent or hexavalent vaccine.

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HAND, FOOT AND MOUTH DISEASE

NOTIFIABLE DISEASE: NO

CAUSATIVE AGENT

Numerous members of the Enteroviruses group of the family Picornaviridae, e.g. coxsackievirus, echovirus, enterovirus (EV)-A71.

INCUBATION PERIOD

Typically, 3-5 days; range is 2 days to 2 weeks.

INFECTIOUS PERIOD

Few days before onset of prodromal symptoms to about 1 week from the onset of illness. The maximum duration of excretion is 3-4 weeks from the nasopharynx, and 6-12 weeks from faeces.

TRANSMISSION

Transmitted via the faecal-oral route, direct contact with respiratory droplets, saliva, vesicular fluid or indirectly via fomites contaminated by secretions.

EPIDEMIOLOGY

Hand, foot and mouth disease (HFMD) is a common childhood viral illness that is mild and self-limiting. Majority of infections occur at the pre-school age, although infection can also occur in adults. Infection leads to specific immunity against a particular virus but reinfection can occur through a different virus from the enterovirus group.

Singapore experienced an epidemic of HFMD in September–October 2000 during which 3,790 cases were reported, with EV-A71 the predominant virus. There were 4 EV-A71-related deaths in 2000 and 3 in 2001. Reporting of HFMD was made legally mandatory on 1 October 2000. HFMD is no longer legally notifiable in Singapore as of 31 January 2019.

CLINICAL FEATURES

About 50-80% of HFMD infections are asymptomatic. HFMD commonly presents with fever that lasts 2-3 days (up to 5 days) followed by a rash over the palms, soles, dorsum of the feet, shins and buttocks. The rash start as papules before becoming vesicular. The rash resolves in 7-10 days. Patients also develop mouth ulcers over the soft/ hard palate, uvula, buccal mucosa and tongue. Some cases may have no rash but only ulcers, in which case the patient is labelled as having herpangina, which is caused by the same group of enteroviruses. There may be symptoms of cough or rhinitis.

Complications are rare, but include myocarditis, pulmonary oedema, acute respiratory distress syndrome, viral pneumonitis, aseptic meningitis, brainstem encephalitis, acute flaccid paralysis, and secondary bacterial infection. An important differential diagnosis is herpes simplex stomatitis, which has ulcers more in the anterior mouth and visible externally.

MICROBIOLOGY INVESTIGATIONS

Diagnosis is based on clinical presentation. Laboratory tests may be considered in cases with atypical presentation or for public health investigations.

Specimen Type	Tests
Throat swab	PCR
Swab from vesicles	Virus isolation

MANAGEMENT OF PATIENTS

Most patients can be managed at home with symptomatic measures (e.g. antipyretics). Patients with signs and symptoms of severe disease or complications should be referred to hospital for further management, e.g. prolonged fever, poor feeding, and lethargy.

Antibiotics are used when there is evidence of secondary bacterial infection (especially *Staphylococcus*). There is anecdotal evidence for use of intravenous immunoglobulin (IVIG) in severe cases. However, it is not recommended as a standard therapeutic option.

MANAGEMENT OF CONTACTS

No specific management of contacts is required. Reinforce good hygiene practices.

PRECAUTIONS, PREVENTION AND CONTROL

HFMD cases should be given medical leave until 10 days (2 incubation periods) from the onset of illness in order to break the transmission in child-care centres and schools. Parents should be advised that children with HFMD are to avoid contact with other children at home, and to refrain from visiting crowded public places during the acute infection, and not swim until 6 weeks later.

Articles contaminated by the droplets, saliva, vesicular fluid and excreta of infected cases should be disinfected. Good personal hygiene, such as hand washing and isolation of infected cases are key to controlling an outbreak. Food and contaminated items should not be shared.

No vaccines against enteroviruses are available.

MOH monitors the regional EV-A71-associated HFMD situation and tracks the types of enteroviruses circulating in the community through a sentinel surveillance system. MOH, together with ECDA and MOE, closely monitors the local disease incidence and trends. Cases suspected to be nosocomially acquired must be notified to the Infection Control Unit of the hospital for investigation and containment measures.

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HANTAVIRUS INFECTION

NOTIFIABLE DISEASE: NO

Although hantavirus infection is not on the list of notifiable diseases under the Infectious Diseases Act, it is recommended that all suspected or confirmed cases be reported to MOH as soon as possible.

Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Call MOH Surveillance Duty Officer and submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Immediately
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Hantaviruses, a member of family *Bunyaviridae*. There are at least 25 distinct viral species; those endemic in Asia and Europe are known as the “Old World” hantaviruses (e.g. Hantaan virus, Puumala virus, Dobrava virus), while those found in the Americas are known as the “New World” hantaviruses (e.g. Sin Nombre virus, New York virus, Andes virus).

INCUBATION PERIOD

Typically, 1-4 weeks; range is a few days to 2 months.

INFECTIOUS PERIOD

Person-to-person transmission is rare.

TRANSMISSION

Likely through aerosol transmission from rodent contact as many hantaviruses are shed in the urine, faeces or saliva of acutely infected rodents (which are the reservoir). The risk appears to be highest in indoor exposure with poor ventilation.

EPIDEMIOLOGY

Hantavirus infection is a zoonotic disease that has been reported worldwide, including Asia (China, Korea), North and South America, Europe and Russia.

The incidence in Singapore is likely to be underestimated as serological diagnosis is not readily available. In 2013, 2 cases of haemorrhagic fever with renal syndrome (HFRS) were reported, but both patients did not report any close contact with rodents. Prior to that, the last case of HFRS was reported in 1996. The seroprevalence of hantavirus in the wild rodent population was previously estimated to range from 26-34%.

CLINICAL FEATURES

Hantavirus infection has 2 clinical syndromes:

1. **Haemorrhagic fever with renal syndrome:** This is caused by hantaviruses of the Old World (Asia, Europe, Russia). The clinical course is variable and severity of illness depends on the infecting virus strain. Asian strains such as the Hantaan virus tend to have more severe clinical manifestations. Classical features include fever, bleeding, hypotension and renal failure. Case fatality rate ranges from 5-15%.
2. **Hantavirus pulmonary syndrome:** This is caused by hantaviruses of the New World (North and South America). Patients develop a prodromal febrile phase characterised by myalgias and gastrointestinal complaints, which then rapidly progresses to respiratory failure and shock. CFR can be as high as 35-50%.

MICROBIOLOGY INVESTIGATIONS

Viremia is short and often difficult to detect. The majority of infections are diagnosed by serology.

Specimen Type	Tests
Serum	Hantavirus IgM, IgG, total antibody

MANAGEMENT OF PATIENTS

Treatment is mainly supportive. Ribavirin was reported to improve mortality in patients with Hantaan virus in a clinical trial in China, although this mortality benefit has not been demonstrated in other hantavirus infections.

MANAGEMENT OF CONTACTS

No specific management of contacts required.

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions apply in the healthcare setting.

Preventive and control measures should aim to limit exposure to rodents and prevent infestations. Trapped rodents should be disposed of using suitable precautions (live trapping not recommended). Rodent-contaminated areas should be disinfected by spraying a disinfected solution (e.g. diluted bleach) before cleaning.

Vaccines have been developed for Hantaan and Seoul viruses but the cost limits widespread use.

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HUMAN IMMUNODEFICIENCY VIRUS INFECTION

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Laboratories	Upon laboratory confirmation	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Within 72 hours

CAUSATIVE AGENT

Human immunodeficiency virus (HIV). There are 2 distinct species, HIV-1 and HIV-2. HIV-1 causes the majority of infections worldwide.

INCUBATION PERIOD

The incubation period is variable. Median incubation period is shorter in infants than in adults. The time from infection to development of detectable antibodies (i.e. window period) is generally 3-12 weeks.

From 1-6 weeks (median 3 weeks) after exposure to HIV, half to two-thirds of infected individuals develop a mononucleosis-like illness referred to as acute seroconversion syndrome. Without treatment, about half of infected adults will develop acquired immune deficiency syndrome (AIDS) within 10 years after infection.

TRANSMISSION

Transmission occurs via unprotected sexual intercourse (most common), transfusion of infected blood (or blood products), sharing contaminated needles, mother-to-child transmission (during pregnancy, delivery and breastfeeding).

Transmission from contact with saliva, tears, sweat, urine, vomitus, stool and bronchial secretions from persons with HIV has not been reported.

INFECTIOUS PERIOD

Infectious for whole duration of infection if not virally-suppressed with antiretroviral therapy (ART). The most infectious period is during seroconversion and untreated late-stage disease, when the viral load is very high.

EPIDEMIOLOGY

HIV infections continued to be reported among Singapore residents. Local mother-to-child transmission remained rare.

CLINICAL FEATURES

The natural history of HIV infection has 4 stages:

1. **Acute seroconversion syndrome:** This is a mononucleosis-like illness. Patients commonly have constitutional symptoms (e.g. fever, myalgia), adenopathy, rash, sore throat, diarrhoea, headache, and/or weight loss. Some have oral and genital ulcerations and neurological illnesses (e.g. aseptic meningitis). Median duration of illness is 20 days (range: < 1 week to 3 months). This phase resolves spontaneously in most patients. Majority of infected cases experience this illness, but the condition is under-diagnosed.
2. **Asymptomatic ("latent") disease:** There are no specific symptoms or signs of infection, but active viral replication and immune destruction (declining CD4 counts) occur throughout this period. Lymphadenopathy is usually present (though often not noticed by the patient).
3. **Symptomatic disease:** Prior to the development of severe immunosuppression (i.e. AIDS), patients can have fever, weight loss, persistent generalised lymphadenopathy, skin and oral conditions (e.g. oral thrush, hairy leucoplakia, herpes zoster, recurrent herpes simplex) and immunological conditions (e.g. idiopathic thrombocytopenic purpura, multiple drug allergies).
4. **Acquired immune deficiency syndrome (AIDS):** This is defined as a CD4 cell count <200 per mm³ and/or the presence of an AIDS-defining condition. This group of conditions include persistent herpes simplex virus ulceration (>1 month), cytomegalovirus (CMV) retinitis, tuberculosis (TB), recurrent non-typhoidal *Salmonella* septicaemia, *Pneumocystis jirovecii* pneumonia, oesophageal candidiasis, cryptococcal meningitis, histoplasmosis (extrapulmonary), cerebral toxoplasmosis, lymphoma (e.g. non-Hodgkin's lymphoma), Kaposi's sarcoma, and progressive multi-focal leukoencephalopathy.

Individuals at risk of HIV infections include those having unprotected sexual intercourse, concurrent or multiple recent sexual partners, new sexual partner, sexual partner with a current or previous history of sexually transmitted infections, and those with injecting drug use, tattooing or skin piercing procedures with improperly sterilised needles.

MICROBIOLOGY INVESTIGATION

Fourth generation antibody-P24 antigen combination tests are recommended for screening as they can detect infection as early as 14 days after exposure.

All cases screened reactive by rapid HIV tests should be followed by an approved confirmatory test at a clinical laboratory. Please indicate on the laboratory request form that the rapid HIV test was reactive. Patients should be counselled on the importance of further confirmatory tests following a reactive rapid HIV test.

HIV RNA viral load tests are used for monitoring disease progression and should not be used for the initial diagnosis of the disease.

Consent, counselling, re-testing: A signed consent is not needed for HIV testing. When HIV testing is medically indicated and carried out as part of the overall medical management of the patient, extensive pre-HIV test counselling is not required. However, just like in any diagnostic investigation, it is prudent to inform patients regarding the planned test, document that the patient is agreeable for HIV testing, reasons for refusal if present, and offer to answer any queries.

If a patient voluntarily requests HIV testing, e.g. because he has engaged in high-risk sexual behaviours, pre-HIV test counselling should be carried out for the patient. The implications of positive and negative test results and the patient's potential risk factors should be discussed, and the patient educated on HIV infection and safer sex practices.

Post-test counselling should be offered for both negative and positive HIV tests. Results should be explained and confidentiality reassured in all cases.

Individuals with a negative test should be advised to re-test 3 months later if the risk exposure was within last 6 months in view of the window period (when antibodies may not be detectable). Advice on risk reduction should also be reinforced.

If an individual has a positive test, information about HIV/AIDS and transmission should be provided. An assessment of risk factors, as well as the patient's support system and coping should be undertaken. Explain the need for further medical assessment and follow up at a specialist referral centre, as well as the availability of effective treatment. Advise that treatment cost has declined and that financial assistance is available if required. Advise on the need for contact tracing, partner notification and partner screening. Explain the risk of infecting others through sexual activities, blood/organ donation, sharing injection needles etc. and the need to take preventive measures at all times to prevent the transmission of HIV.

Inform the patient that it is an offence under the Infectious Disease Act (IDA) for a person with HIV to carry out activities that could transmit HIV. A person with HIV is required under the IDA inform a potential partner prior to sex of the risk of contracting HIV. The potential partner must voluntarily agree to take that risk before engaging in sex.

Under the IDA, a medical practitioner may disclose information relating to any person whom he/she reasonably believes to be infected with HIV/AIDS to the spouse, former spouse or other contact of the infected person, if:

- He/she reasonably believes that it is medically appropriate and that there is a significant risk of infection to the partner;
- He/she has counselled the infected person regarding the need to notify the partner and the medical practitioner reasonably believes that the infected person will not inform the partner; and
- He/she has informed the infected person of his intent to make such disclosure to the partner.

MANAGEMENT OF PATIENTS

Patient should be referred to an infectious disease physician for specialist care. ART should be initiated as early as possible regardless of CD4 count or viral load. ART can significantly prolong survival and reduce morbidity and infectivity. Opportunistic infections, if present, should be treated and prophylaxis started dependent on CD4 count.

Pregnant women who are newly diagnosed with HIV should be initiated on ART as soon as possible. A combination of ART use, infant prophylaxis and avoidance of breastfeeding can markedly reduce HIV transmission to the baby. Risk of transmission is minimal (<2%) with ART and undetectable maternal viral load.

MANAGEMENT OF CONTACTS

Sexual and needle-sharing partners should be notified about their exposure and advised on HIV testing.

Post-exposure prophylaxis (PEP) for needle-stick injuries in healthcare workers is advised. PEP significantly reduces risk of transmission of HIV (up to 80% risk reduction if started early). Combination therapy with 3 drugs is recommended for all significant exposures (see Public Health Resources section for details on PEP).

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions apply. There is presently no available vaccine.

The following preventive measures are advised to reduce HIV transmission: being faithful to one partner, practising safer sex (correct and consistent condom use), avoiding casual and commercial sex, avoiding needle sharing, and use of pre-exposure prophylaxis (PrEP) for those who are at high risk (in conjunction with other safe sex practices). People at-risk should not donate blood.

PrEP may be in the form of on-demand PrEP or daily PrEP, and involves taking oral antiretroviral medications at specific intervals. Persons who are at high risk of acquiring HIV infection and are interested in using rPEP should be referred to a specialist familiar with the administration of PrEP. They will require specialised counselling, monitoring of blood tests, and regular follow up.

HIV screening should be offered to patients with sexually-transmitted infections, TB and on dialysis. To enhance screening uptake, all pregnant women and hospitalised patients are routinely offered HIV screening.

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INFLUENZA, AVIAN

NOTIFIABLE DISEASE: YES

While influenza A(H5N1) and influenza A(H7N9) are notifiable diseases under the Infectious Diseases Act, it is recommended that all cases who test positive for atypical influenza A viruses be reported to MOH as soon as possible.

Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Call MOH Surveillance Duty Officer and submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Immediately
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Type A influenza viruses that usually circulate in birds. Classification into two categories based on level of virulence in poultry: low pathogenic avian influenza (LPAI) and highly pathogenic avian influenza (HPAI). All HPAI are of the H5 and H7 subtypes, which have been responsible for large avian epidemics to date.

INCUBATION PERIOD

1-10 days. The incubation period for both influenza A(H5N1) and A(H7N9) is about 5 days, i.e. longer than the typical 2 days for seasonal influenza, and up to 17 days for A(H5N1).

INFECTIOUS PERIOD

Person-to-person transmission is thought to be rare and is not sustained, occurring only when there is prolonged and close contact.

TRANSMISSION

Avian influenza viruses spread among susceptible birds through contact with contaminated excretions of other infected birds. They do not normally infect other species with the exception of pigs and horses.

Human infection results from close contact with infected poultry (live or dead), poultry secretions and excrement, or contaminated environments (such as poultry markets).

EPIDEMIOLOGY

The virus circulates among birds worldwide. The first documented human infection with an avian influenza virus (H5N1 strain) occurred in Hong Kong in 1997. The infection in humans coincided with an epidemic of HPAI caused by the same strain in Hong Kong's poultry population. In 2003, a re-emergence of A(H5N1) in poultry that occurred initially in Southeast Asia spread worldwide. Since then, there have been sporadic human cases with almost all having had antecedent avian exposure. Human cases of influenza A(H7N9) were also detected in China since February 2013. Over 90% of infected persons had exposure to poultry, mostly at live poultry markets. There has not been sustained human-to-human transmission, although several small clusters of infections have been reported.

CLINICAL FEATURES

Avian influenza in humans commonly presents with fever, cough and shortness of breath. The disease progresses rapidly, leading to respiratory failure with acute respiratory distress syndrome (ARDS) and multiorgan failure. Gastrointestinal symptoms (e.g. diarrhoea, vomiting and abdominal pain) have also been reported. CFRs are high – about 60% for A(H5N1) and 40% for A(H7N9).

Clinical suspicion of an avian influenza infection should be raised in individuals with relevant travel history to areas where the virus is endemic in birds, having had contact with sick poultry, confirmed or suspect cases of avian influenza during the travel.

MICROBIOLOGY INVESTIGATIONS

Notify laboratory when avian influenza is suspected.

Specimen Type	Tests
Respiratory samples, including throat and nasopharyngeal swabs, endotracheal aspirate, bronchoalveolar lavage	PCR for avian influenza (H5 or H7)

Note to laboratory: Untyped and untypeable influenza A samples (including influenza A subtype indeterminate or no subtype detected) should be forwarded to NPHL for further analysis.

MANAGEMENT OF PATIENTS

Oseltamivir remains the primary recommended antiviral therapy, although resistance can emerge during therapy and may be associated with clinical deterioration. Treatment for ARDS and sepsis should follow existing guidelines. Corticosteroids should be avoided unless indicated (e.g. vasopressor-refractory shock) as it can cause serious adverse events.

MANAGEMENT OF CONTACTS

The World Health Organization recommends that household and high-risk contacts should receive postexposure prophylaxis (oseltamivir 75mg once daily for 7 to 10 days) and be monitored closely for the development of symptoms (see Public Health Resources section).

PRECAUTIONS, PREVENTION AND CONTROL

All suspected and confirmed cases should be isolated and treated in negative pressure isolation rooms. Aside from standard precautions, contact, droplet and airborne precautions should be applied. Eye protection should also be used. Aerosol-generating procedures (e.g. nebuliser therapy) should be avoided if possible.

A(H5N1) vaccine is not widely available, but some countries have stockpiled the vaccine for pandemic preparedness although effectiveness is unknown. Current seasonal influenza vaccine does not protect against avian influenza, but is recommended for selected populations at-risk to reduce illness caused by seasonal influenza viruses.

Individuals travelling to areas affected by avian influenza are advised to adopt the following precautions to reduce their risk of exposure: regular hand washing (e.g. before and after meals), avoiding contact with poultry or their droppings, visiting wet markets or live poultry markets.

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INFLUENZA, HUMAN

NOTIFIABLE DISEASE: NO

CAUSATIVE AGENT

Three types of influenza viruses: type A (subtypes H1N1, H3N2), B and C.

INCUBATION PERIOD

Average of 2 days, range is 1 to 4 days.

INFECTIOUS PERIOD

One day before symptoms develop and up to 5-7 days after symptoms onset.

TRANSMISSION

Transmission occurs via respiratory droplet spread and direct or indirect contact (via fomites) with nasal or throat secretions.

EPIDEMIOLOGY

Influenza A and B viruses can cause outbreaks. Type C influenza causes a mild illness and does not usually cause outbreaks.

Influenza A and B virus infections occur all year round in Singapore with peaks in May-July and November-January, coinciding with the Southern and the Northern Hemisphere influenza seasons.

CLINICAL FEATURES

Classic influenza includes symptoms of fever, chills, headache, malaise, myalgia, and anorexia. Respiratory symptoms include sore throat, dry cough and nasal discharge. Elderly patients may present with confusion. Well recognised pulmonary complications include primary viral pneumonia and secondary bacterial pneumonia (most often *Staphylococcus aureus*, *Streptococcus pneumoniae* and *Haemophilus influenzae*). Other

complications include croup, exacerbation of chronic pulmonary disease, myocarditis, and Guillain-Barré syndrome.

MICROBIOLOGY INVESTIGATIONS

Specimen Type	Tests
Respiratory samples, including throat and nasopharyngeal swabs, endotracheal aspirate, bronchoalveolar lavage	PCR for seasonal influenza Immunofluorescence

Note to laboratories: Untyped and untypeable influenza A positive samples (including influenza A subtype indeterminate or no subtype detected) and samples from suspected antiviral resistance and severe cases should be forwarded to NPHL for further analysis.

MANAGEMENT OF PATIENTS

Symptomatic treatment (e.g. antipyretics, antihistamines) is usually sufficient in the management of acute symptoms of influenza. Salicylates should be avoided in children because of the risk of Reye's syndrome.

Administration of neuraminidase inhibitors (zanamivir and oseltamivir) within 48 hours of illness onset can reduce duration of symptoms for influenza A and B infections by one day. Recommended regimens are:

- Oseltamivir 75 mg oral BD for 5 days (age ≥ 1 year). Weight-based dosing for those < 40 kg.
- Zanamivir 2 puffs (10mg) BD for 5 days (age ≥ 5 years).

Antibiotics are used for bacterial superinfections.

MANAGEMENT OF CONTACTS

Antiviral prophylaxis may be considered for persons at increased risk of influenza-related complications following an exposure or in certain settings (e.g. outbreak in a nursing home). Antiviral dosage for post-exposure prophylaxis is as follows:

- Oseltamivir 75 mg once daily for adults. Weight-based dosing for those < 40 kg.
- Zanamivir 1 puff (5mg) BD for those ≥ 5 years.

Duration of chemoprophylaxis depends on the period of influenza activity in the community (see Public Health Resources section).

PRECAUTIONS, PREVENTION AND CONTROL

In the hospital setting, patients should be isolated with standard and droplet precautions implemented.

Good hand hygiene practices and cough etiquette should be encouraged for both healthcare workers and the general public.

Vaccination is the most important tool in preventing influenza infections (see Public Health Resources section). Under the National Adult Immunisation Schedule, annual influenza vaccination is recommended for the following groups: persons aged ≥ 65 years, adults with chronic medical conditions (e.g. diabetes mellitus, asthma, heart disease), immunocompromised, persons receiving intermediate and long term care (ILTC) services, and women at all stages of pregnancy. Influenza vaccination is also recommended for young children (6 months to under 5 years), children with chronic medical conditions and those aged 6 months to 18 years on long-term aspirin therapy. To reduce the risk of transmission to patients, healthcare workers are recommended to have influenza vaccination annually.

MOH disseminates circulars on influenza vaccinations to key vaccination providers in the healthcare sector, including medical practitioners, healthcare institutions and ILTC facilities, before the beginning of southern and northern hemisphere influenza seasons. Vaccination may be recommended when there are changes to the vaccine composition to protect against circulating influenza viruses.

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Experience makes the difference - do you see what I see?

JAPANESE ENCEPHALITIS

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Within 24 hours
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Japanese encephalitis (JE) virus, a member of *Flaviviridae* family.

INCUBATION PERIOD

5–15 days

INFECTIOUS PERIOD

No direct human-to-human transmission.

TRANSMISSION

Transmitted by *Culex* spp. mosquitoes especially *C. tritaeniorhynchus* from animals (principally pigs and wild birds) to humans. Due to low viremia in humans, mosquitoes do not transmit virus directly from one person to another.

EPIDEMIOLOGY

Japanese encephalitis virus is endemic to most of Asia and parts of the Western Pacific (see maps under Public Health Resources section). Disease occurs principally in the warm season in temperate countries and year round in tropical countries. It is primarily a disease of rural areas where pig farming and rice cultivation co-exist. People of all ages living in or travelling to rural agriculture areas are at risk of JE.

The disease has been virtually eliminated from Singapore with the phasing out of pig farming, although seroprevalence surveys of wild boars, migratory and resident birds in peripheral Singapore indicate continued enzootic transmission. Sporadic human cases are rare, with the last local case reported in 2008.

CLINICAL FEATURES

Most human infections are asymptomatic. Relatively mild forms of the disease occur as aseptic meningitis or a non-specific febrile illness. Less than 1% will develop encephalitis. In those who develop encephalitis, illness begins with a non-specific febrile prodrome of headache, abdominal pain, nausea and vomiting for several days. This is followed by altered mental state, drowsiness and coma. Convulsions are common in the paediatric population. Some develop a Parkinsonian syndrome. Case fatality rate is about 20-30%. Sequelae include parkinsonism, paralysis, seizures, mental retardation, and psychiatric complaints in up to 70% of survivors. CT/MRI may show abnormal areas in the thalamus and midbrain. Cerebrospinal fluid (CSF) may demonstrate lymphocytic pleocytosis with mildly elevated protein and normal glucose.

MICROBIOLOGY INVESTIGATIONS

Short period of viremia limits the usefulness of PCR. Please contact MOH and NPHL to arrange further laboratory tests.

Specimen Type	Tests
Blood CSF Urine	PCR
Serum CSF	IgM, IgG

MANAGEMENT OF PATIENTS

There is no specific antiviral treatment available. Treatment is supportive and anticonvulsants are used to control seizures.

MANAGEMENT OF CONTACTS

No specific management of contacts is required.

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions apply in the healthcare setting.

Vaccination is available. The vaccine is recommended for persons travelling to endemic regions for ≥ 1 month and are staying or working in rural areas. Travellers who are at risk should take mosquito precautions in addition to vaccination.

Vector control is important. Adult *Culex* mosquitoes are destroyed by insecticide spraying and its larvae eliminated by oiling potential breeding habitats.

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LEGIONELLOSIS

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Laboratories	Upon laboratory confirmation	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Within 72 hours

CAUSATIVE AGENT

There are at least 60 species of *Legionella* bacteria, most of which are pathogenic. *Legionella pneumophila* serogroup 1 accounts for most human infections.

INCUBATION PERIOD

Legionnaires' disease: typically, 5-6 days; range is 2 to 16 days.

Pontiac fever: typically, 24-48 hours; range is 5 to 72 hours.

INFECTIOUS PERIOD

No direct human-to-human transmission.

TRANSMISSION

Transmission via the inhalation of aerosols, and occasionally the aspiration of water that contains *Legionella* spp.

EPIDEMIOLOGY

Legionella spp. are environmental organisms found in water e.g. man-made aquatic reservoirs including cooling towers, water storage tanks, hot water system, spas, evaporative condensers, decorative fountains and other water-containing devices. Legionnaires' disease outbreaks have occurred worldwide, with single and sporadic infections being reported in Singapore. Seroprevalence studies suggest that asymptomatic or subclinical infection also occurs.

CLINICAL FEATURES

There are 2 distinct clinical manifestations of legionellosis:

1. **Legionnaires' disease:** characterised by pneumonia and a dry cough. Clinical presentation is similar to other types of pneumonia. Severity of the disease is variable and ranges from mild to severe.
2. **Pontiac fever:** a self-limiting flu-like illness that does not progress to pneumonia. Predominant symptoms are malaise, myalgia, fever, chills and headache. Chest X-ray remains clear. Only symptomatic treatment is required. Recovery occurs within one week.

Risk factors include increasing age (most cases >50 years of age), cigarette smoking, diabetes mellitus, chronic lung disease, renal disease, malignancy, and compromised immunity, particularly organ transplant recipients and patients receiving corticosteroids.

MICROBIOLOGY INVESTIGATIONS

Special culture media is required for bacterial culture and yield from culture is low. For Legionella serology, acute and convalescent sera will be required. Please note that urine antigen test detects only Legionella pneumophila serogroup 1.

Specimen Type	Tests
Respiratory samples including sputum, endotracheal aspirate, bronchoalveolar lavage	Culture PCR
Serum	<i>Legionella</i> serology (Total antibody)
Urine	<i>Legionella</i> antigen

MANAGEMENT OF PATIENTS

Antibiotics are recommended for treatment of Legionnaires' disease. The duration of treatment should be 10-21 days. Treatment should be started in a timely manner as delay is associated with increased mortality. Severe cases will require hospitalisation.

Pontiac fever is mild and self-limiting, and does not require antibiotic therapy.

MANAGEMENT OF CONTACTS

No specific management of contacts is required.

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions apply in the healthcare setting.

Epidemiological investigations should be conducted to identify the source of infection and the mode of transmission. This includes sampling of water and sludge from cooling towers of air-conditioned premises for the isolation of *Legionella*.

There should be regular mechanical cleaning of the cooling towers and routine treatment with biocides to inhibit organic growth within the air-conditioning system. A corrosion inhibitor as well as a scale inhibitor should be used. Routine environmental monitoring for *Legionella* should be performed in hospitals, given the risk for Legionnaires' disease.

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LEPROSY

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Laboratories	Upon laboratory confirmation	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Within 72 hours

CAUSATIVE AGENT

Mycobacterium leprae

INCUBATION PERIOD

A few weeks to 30 years (average 3-10 years).

INFECTIOUS PERIOD

Untreated patients are the main source of infection, although the disease is not highly contagious. Patients can be considered non-infectious shortly after therapy is started.

TRANSMISSION

The exact mode of transmission not clearly established; household and prolonged close contact appears to be important. Transmission is believed to be from respiratory secretions, and less effectively, direct skin-to-skin contact.

EPIDEMIOLOGY

Worldwide incidence of leprosy appears to be declining. This is due to improvements in socioeconomic conditions and access to effective treatment. Humans and armadillos are the only known reservoirs. Susceptibility is genetically determined with more than 90% of the population naturally immune. Leprosy incidence rates in Singapore have declined significantly

CLINICAL FEATURES

The disease mainly affects the skin and the peripheral nerves. Most patients present with asymptomatic skin lesions while some (<5%) present with nerve deficits without skin signs. The affected skin may be pale or red, and it may be a plaque, nodule or tumour. Loss of pin prick sensation within skin lesions is pathognomonic of leprosy. Peripheral nerve involvement may cause muscle weakness and paralysis of limbs. Examination may reveal enlarged nerves with or without functional deficit.

For the purposes of treatment, leprosy is classified into 2 groups according to clinical manifestations and skin smear results. More commonly however, patients exhibit features of both types (i.e. borderline leprosy).

1. **Paucibacillary (tuberculoid) leprosy:** characterised by 1-5 hypopigmented or hyperpigmented anaesthetic macules or patches in an asymmetric distribution.
2. **Multibacillary (lepromatous) leprosy:** multiple symmetrically distributed skin lesions (papules, nodules or plaques) that may not exhibit sensory loss.

MICROBIOLOGY INVESTIGATIONS

Disease	Specimen Type	Tests
Multibacillary leprosy	Slit skin	Slit skin smear
Both multibacillary and paucibacillary leprosy	Skin biopsy	Histology

The lepromin test is not useful for diagnosis as it only reflects the immune status of the subject.

MANAGEMENT OF PATIENTS

Multidrug therapy is recommended for the treatment of leprosy. The type and duration of treatment depends on the number of skin lesions (which is an indication of bacillary load) – 6 months for paucibacillary and 12 months for multibacillary.

Leprosy is an important treatable cause of permanent physical disability. Early treatment prevents or even reverses nerve damage. Measures to avoid injury to anaesthetic limbs, and rehabilitation of disabled limbs are part of the management of all leprosy patients.

MANAGEMENT OF CONTACTS

Examination and follow up of close contacts are recommended. No quarantine of contacts is required.

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions apply in healthcare settings.

There is no available vaccine for leprosy (although the BCG vaccine is partially protective).

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LEPTOSPIROSIS

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Laboratories	Upon laboratory confirmation	Submit MD131 Notification Form via CDLENS (http://www.cdlenz.moh.gov.sg) or fax (6221 5528/38/67)	Within 24 hours

CAUSATIVE AGENT

Spirochaete bacterium of *Leptospira* genus

INCUBATION PERIOD

Typically, 5-14 days; range is 2 to 30 days.

EPIDEMIOLOGY

Leptospirosis occurs worldwide, but is most prevalent in tropical and subtropical regions. Outbreaks can occur during the rainy season or following flooding. Various animals (rodents are most implicated) are the natural reservoirs. People who work outdoors or with animals may be at higher risk of exposure. The disease has been linked with recreational activities (e.g. swimming, water sports) in contaminated lakes and rivers.

TRANSMISSION

Leptospirosis is a zoonotic disease. Transmission occurs through direct contact with urine, fluids or tissues of infected animals or with a urine-contaminated environment (e.g. through swimming, wading in flood-waters, accidental immersion, occupation immersion, contaminated moist soil or vegetation). The bacteria enters the body through cuts or abrasions on the skin, or through the mucous membranes of the mouth, nose and eyes. Person-to-person transmission is rare.

CLINICAL FEATURES

The clinical manifestations of leptospirosis are variable. In majority of cases, infection is asymptomatic or presents as a mild flu-like illness. In some, the disease can be severe and even fatal.

The clinical course usually has 2 phases. In the initial phase, patients experiences an acute onset of high fever, myalgias and headache (retro-orbital and frontal). About a third of cases have conjunctival suffusion (presents as conjunctival redness), which is a frequently overlooked sign. Some patients recover, but others progress on to a second phase that is more severe with prolonged fever and systematic complications – jaundice and renal failure (Weil's disease), pulmonary haemorrhage with respiratory failure, and aseptic meningitis or meningoencephalitis.

MICROBIOLOGY INVESTIGATIONS

Serological tests are most frequently used in the laboratory diagnosis of leptospirosis. *Leptospira* culture is not available locally.

Please contact MOH and NPHL to arrange further laboratory tests.

Specimen Type	Tests
Serum	<i>Leptospira</i> IgM
Blood, urine	PCR

MANAGEMENT OF PATIENTS

In mild cases, oral antibiotics (doxycycline 100mg BD for 7 days) can be given. Severe cases will require hospitalisation for intravenous antibiotics (penicillin or ceftriaxone) and management of complications. Jarisch-Herxheimer reaction may occur following antimicrobial therapy.

MANAGEMENT OF CONTACTS

No specific management of contacts is required.

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions apply in healthcare settings.

Epidemiological investigations should be carried out to identify the source of infection and to implement control measures (e.g. rodent control).

The most important control measures for preventing human leptospirosis include avoiding potential sources of infection such as stagnant water and animal farm water runoff, rodent control, and protection of food from animal contamination. Vaccines to specific serovars have been developed and used in specific circumstances (occupational exposures), but is not widely available.

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LISTERIOSIS

NOTIFIABLE DISEASE: NO

CAUSATIVE AGENT

Listeria monocytogenes

INCUBATION PERIOD

Non-invasive disease: typically, a few days; range is 6 hours to 10 days.

Invasive disease: typically, 1-2 weeks; range is 3 to 70 days.

INFECTIOUS PERIOD

Not generally considered infectious (except for vertical transmission that occurs in neonatal infections).

TRANSMISSION

Usually foodborne transmission. Commonly implicated food products include dairy products (especially soft cheeses made from raw/ unpasteurised milk), processed and delicatessen meats (e.g. hot dogs, deli meats, cold processed meat), raw mushrooms, fresh produce including fruits and vegetables and seafood. In neonatal infections, transmission is almost always from mother to foetus.

EPIDEMIOLOGY

Listeria is found primarily in the environment (soil, water, decaying vegetation). It can also be found in the faeces of animals and asymptomatic humans. *Listeria* can multiply in refrigerated food unlike most other foodborne pathogens.

Asymptomatic faecal carriage is common, even without a known exposure. Carriage rate estimates can be much higher among slaughterhouse workers, laboratory workers who work with *L. monocytogenes* cultures, and in asymptomatic household contacts of persons with invasive listeriosis. Infected individuals can shed the organisms in their stools for several months.

Listeriosis occurs worldwide. Most cases are sporadic. Recent outbreaks occurred in South Africa in 2017-2018 (originating from a meat-production plant), and in Australia in 2018 (originating from a rock melon grower).

CLINICAL FEATURES

In healthy individuals, listeriosis presents as a self-limiting febrile gastroenteritis and is rarely invasive. Invasive listeriosis is more common in individuals who are immunocompromised, elderly, pregnant, and in neonates. It usually presents as septicaemia or meningoencephalitis. Rarely, focal infections (e.g. septic arthritis, osteomyelitis) can occur.

Listeriosis in pregnant women can be asymptomatic or experienced as a mild flu-like illness. However, it can lead to foetal infection and result in foetal death, preterm delivery and neonatal infection. Neonatal listeriosis usually presents as sepsis (granulomatosis infantiseptica) or meningitis. CFR for neonatal infection is 20-30%.

MICROBIOLOGY INVESTIGATIONS

In gastroenteritis cases, the pathogen is isolated from implicated food via culture, not from clinical specimens.

Disease	Specimen Type	Tests
Invasive disease	Blood CSF Sterile fluids Amniotic fluid/swab	Culture

MANAGEMENT OF PATIENTS

Immunocompetent patients with non-invasive listeriosis do not generally require antibiotics as the gastroenteritis is self-limiting. Patients at high risk and those with invasive listeriosis are treated with antibiotics (penicillins are the drug of choice). Delays in initiating antibiotics should be avoided as it has been associated with poorer outcomes. Severe cases will require hospitalisation.

MANAGEMENT OF CONTACTS

No specific management of contacts is required.

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions apply in healthcare settings. There is no available vaccine.

In addition to proper food handling practices (which is also applicable to prevention of other foodborne illness), individuals at high risk for invasive listeriosis (e.g. pregnant, immunocompromised) should avoid uncooked meats, soft cheeses, deli meats, meat spreads and smoked seafood.

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MALARIA

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Within 24 hours
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Four different *Plasmodium* species: *P. falciparum*, *P. vivax*, *P. ovale* and *P. malariae*. Another species, *P. knowlesi* usually infects non-human primates, but has occasionally infected humans and is capable of causing life-threatening complications and death.

INCUBATION PERIOD

Ranges from 7-30 days in most cases. Incubation period also varies according to species:

- *P. falciparum*: 9-14 days
- *P. vivax* and *P. ovale*: 12-18 days (up to 6-12 months for some *P. vivax* strains)
- *P. malariae*: 18-40 days
- *P. knowlesi*: 9-12 days

INFECTIOUS PERIOD

Humans are infectious to mosquitoes as long as parasites (infective gametocytes) are present in the blood.

TRANSMISSION

Transmitted via bite of infective *Anopheles* mosquito. Transmission can also occur vertically (mother-to-child), via contaminated blood transfusion or organ transplant.

EPIDEMIOLOGY

Malaria remains a significant problem in developing countries in tropical and subtropical areas of the world. Affected regions include Africa, South America, South Asia and Southeast Asia. *P. falciparum* and *P. vivax* are the most common species worldwide. The development of resistance to antimalarial drugs has been a challenge to global efforts in malaria control. Nearly all *P. falciparum* is resistant to chloroquine. Most *P. vivax* malaria is still sensitive to chloroquine though there have been pockets of resistance identified in Asia, Africa and the Americas. Resistance to artemisinin has also been reported from countries in the greater Mekong region. *P. knowlesi* has been increasingly reported in Southeast Asia, particularly in eastern Malaysia; microscopy misdiagnosis of *P. knowlesi* is common.

Singapore was certified malaria-free by the WHO in Nov 1982. Majority of cases reported in Singapore are imported and have occurred in non-residents. Most Singapore residents who contracted malaria had travelled to endemic areas without taking/completing chemoprophylaxis.

CLINICAL FEATURES

The clinical course of malaria can vary depending on *Plasmodium* species, age and immunity. Severe malaria is usually due to *P. falciparum*, although *P. vivax* and *P. knowlesi* have been reported to cause severe disease as well. Asymptomatic malaria is defined by the presence of malaria parasites in the blood without any symptoms or signs.

Malaria is categorised as uncomplicated or severe:

1. **Uncomplicated malaria** is defined as symptomatic malaria parasitaemia without evidence of severe features or organ dysfunction. It commonly presents as an acute febrile illness. Symptoms include fever, chills, headache, myalgia, cough, vomiting, diarrhoea and abdominal pain. The initial phase can be non-specific and indistinguishable from other febrile illnesses.
2. **Severe malaria** is life-threatening and there are signs of organ dysfunction, which include altered consciousness, convulsions, respiratory distress, circulatory collapse, metabolic acidosis, renal failure, jaundice, severe anaemia, coagulopathy, significant bleeding and hypoglycaemia.

Hyperparasitaemia <10% by itself is not an indicator of severe malaria but denotes a risk for treatment failure and need for close monitoring. In low transmission areas (i.e. Singapore), parasitaemia $\geq 2\%$ (or 100,000/ μl) is associated with an increased risk of mortality.

Full blood count, electrolytes including bicarbonate, glucose, liver function tests, clotting screen and a chest X-ray should be performed in all patients with acute malaria to assess severity.

MICROBIOLOGY INVESTIGATIONS

Specimen Type	Tests
Blood in ethylenediaminetetra acetic acid (EDTA) or acid citrate dextrose (ACD)	Blood film (If suspicion is high, repeat 12hrly for 48hrs if initial film is negative) PCR

MANAGEMENT OF PATIENTS

Cases should be treated in hospital until parasitaemia has cleared. Choice of antimalarial drug would depend on *Plasmodium* species and resistance patterns. Artemisinin-based combination therapies are preferred for falciparum malaria; fixed dose drug combinations are becoming increasingly prevalent. Quinine-based combination therapies are an alternative to artemisinin-based therapies, and is recommended for women (together with clindamycin) during the first trimester of pregnancy.

P. vivax and *P. knowlesi* infections can be managed as for falciparum malaria, particularly for severe malaria and in areas with chloroquine-resistant *P. vivax*. A 14-day course of 30mg oral primaquine should be prescribed to prevent relapse in *P. vivax* and *P. ovale* infections. It is important to ascertain the G6PD status of the patient prior to prescribing primaquine.

Severe malaria is a medical emergency and requires prompt treatment. Apart from administration of artemisinin-based combination therapy, meticulous fluid management, regular monitoring of blood sugar and supportive therapy for organ dysfunction are necessary.

MANAGEMENT OF CONTACTS

No specific management of contacts is required.

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions apply in the healthcare setting.

Epidemiological investigations should be carried out to determine if case was acquired locally or imported. If there is evidence of local transmission, vector control measures will be implemented.

For travellers to endemic areas, appropriate chemoprophylaxis should be started before travel. They should be advised on measures to avoid mosquito bites (e.g. using repellents containing $\geq 20\%$ DEET, wearing long-sleeved clothing and long pants, sleeping under permethrin-impregnated mosquito netting, and treating clothes with permethrin-based products).

Recommended chemoprophylaxis regimens are as follows (see map under Useful Resources section):

- Mefloquine: 250mg (salt) per week, beginning 1 week before departure and continued for 4 weeks after leaving the endemic area. Advantage: weekly dosing, reasonable pricing. Disadvantage: neuropsychiatric side effects.
- Doxycycline: 100mg daily beginning 1 to 2 days before entering the affected area and for 4 weeks after leaving the area. Advantage: cheap. Disadvantage: daily dosing. Side effects: photosensitivity, vaginal thrush and oesophagitis.
- Atovaquone/proguanil (Malarone): 1 adult tablet once daily beginning 1 to 2 days before entering affected area and for 7 days after leaving the area. Advantage: few side effects, short duration of intake before and after travel. Disadvantage: expensive, daily intake.

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MEASLES

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Within 24 hours
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Measles virus

INCUBATION PERIOD

Typically, 14 days; range is 1-3 weeks.

INFECTIOUS PERIOD

From 4 days before onset of rash (from the onset of prodromal symptoms) up to 4 days after onset of the rash. Measles is highly contagious.

TRANSMISSION

Airborne transmission by respiratory droplet nuclei and by direct contact with nasal or throat secretions. Less commonly by articles freshly soiled with nose and throat secretions. Humans are the only reservoirs of measles infection.

EPIDEMIOLOGY

Measles occurs worldwide, and despite the availability of a safe and effective vaccine, it remains a significant cause of mortality in young children. In countries that have implemented effective childhood vaccination programmes, the incidence of measles has dropped by up to 99%. However, there has been a recent global resurgence in measles cases due in part to vaccine hesitancy and falling coverage. Population immunity needs to be maintained at >95% to prevent outbreaks of measles

In Singapore, measles vaccination was made compulsory in 1985. Trivalent measles, mumps, rubella (MMR) vaccine was introduced in 1990. In 1992-97, a spike in cases (due to a build-up of susceptible individuals who were not vaccinated) resulted in “catch-up” immunisations from July-November 1997. A two-dose MMR regime was introduced in 1998.

CLINICAL FEATURES

Measles is seldom seen in infants less than 5 months of age (due to passively transferred maternal antibodies). The illness usually starts with fever and the 3 C's (cough, coryza and conjunctivitis). Koplik's spots appear during the febrile phase. These are 1-2 mm diameter whitish-grey spots surrounded by erythematous rings at the buccal mucosa opposite the molar teeth. Typically between the third to fifth day of illness, a maculopapular rash appears – first behind the ears, or over the eyelids, then spreading to the rest of the face and upper neck and then the rest of the body (centrifugal, top down). Fever usually peaks with the appearance of the rash and lasts for another 3-4 days. The rash darkens and fades after about five days, sometimes with desquamation.

Complications of measles include diarrhoea, otitis media, pneumonia and encephalitis, and can result in permanent impairment (e.g. deafness, intellectual disability) and mortality. CFR of measles is <1% in developed countries and 3-5% in developing countries.

Differentials for measles rash include roseola infantum, rubella other viral exanthem (e.g. ECHO, coxsackievirus, parvovirus B19), Kawasaki disease, and drug rash.

MICROBIOLOGY INVESTIGATIONS

Laboratory confirmation of measles must be attempted for all clinically suspect cases.

Specimen Types	Tests
Throat/ nasopharyngeal swabs	PCR
Urine	Immunofluorescence
Serum	Measles IgG, IgM

Note for laboratories: All clinical samples collected for PCR and IgM testing and samples from notified clinical cases should be sent to the NPHL for further testing.

MANAGEMENT OF PATIENTS

There is no specific antiviral therapy for measles and treatment is supportive. Symptomatic measures (e.g. antipyretics) are used. Those with complications require hospitalisation. Vitamin A supplementation should be given to reduce the risk of serious complications in certain circumstances (e.g. malnourished children).

MANAGEMENT OF CONTACTS

Susceptible contacts should be offered post-exposure prophylaxis to reduce the risk of infection and complications. The MMR vaccine can be administered within 72 hours of exposure. For those in whom the MMR vaccine is contraindicated (e.g. pregnant, immunocompromised, <1 year old), immunoglobulin can be given within 6 days of exposure. At a later date, measles vaccine should be offered to those in whom the vaccine is not contraindicated for future protection.

PRECAUTIONS, PREVENTION AND CONTROL

In hospitals, patients should be isolated, and managed under airborne precautions. Only healthcare workers with positive measles immunity should take care of patients.

Infected children should stay away from school for 1 week after onset of rash. All unimmunised children at the nursery or kindergarten where the infection occurred should receive vaccine as soon as possible. See Public Health Resources section for details on post-exposure prophylaxis and vaccination.

Vaccination remains the primary preventive measure against measles, and is compulsory by Singapore law. As measles is a highly contagious disease, at least 90-95% of the population need to be vaccinated to maintain herd immunity. Proof of vaccination is required for admissions to preschools and primary schools. Catch-up vaccination is carried out for primary one students (6-7 years of age) who did not receive the second dose in their pre-school years.

All childhood vaccinations should be notified to the National Immunisation Registry, Health Promotion Board, and post-vaccination adverse reactions to the Pharmacovigilance Branch, Health Sciences Authority.

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Environment is an integral component of the epidemiologic triad

MELIOIDOSIS

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Laboratories	Upon laboratory confirmation	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Within 72 hours

CAUSATIVE AGENT

Burkholderia pseudomallei

INCUBATION PERIOD

Typically, 9 days; range is 1-21 days. May remain latent for months to years before symptoms develop.

INFECTIOUS PERIOD

Not considered contagious; person-to-person spread is extremely rare.

TRANSMISSION

Transmission occurs through direct inoculation of contaminated soil or water through small cuts or abrasions, inhalation of contaminated soil dust, or through ingestion or aspiration of contaminated water.

EPIDEMIOLOGY

The disease is endemic to Southeast Asia and Northern Australia where *B. pseudomallei* is found in soil and surface water. Cases have been reported in Singapore and elsewhere in Asia, the Pacific, the Americas, the Caribbean and the Middle East. Occupational (e.g. military, farming, construction work), recreational (e.g. adventure travellers) or other contact with soil or surface water is a risk factor. Those with underlying medical conditions, such as diabetes mellitus, chronic renal disease and chronic lung disease, are recognised to be at increased risk of the disease.

CLINICAL FEATURES

The presentation of melioidosis is variable and can mimic many other conditions (e.g. tuberculosis). Melioidosis infections can be subclinical. Common presentations include pneumonia and localised skin ulcers or abscesses. It should also be considered as a differential in a patient presenting with visceral abscesses (e.g. liver, spleen, kidney, prostate). Other presentations include osteomyelitis and meningoencephalitis. Patients are often bacteraemic and can develop a fulminant infection with septic shock. The mortality rate is high in these cases. Some patients may present with a relapse even after appropriate antibiotic therapy for the initial episode of infection.

MICROBIOLOGY INVESTIGATIONS

Serology (e.g. indirect haemagglutination test) is not a reliable method of diagnosis.

Specimen Types	Tests
Blood Respiratory specimens including throat swabs Wound specimens, abscess fluid Throat swabs	Culture PCR

MANAGEMENT OF PATIENTS

Patients require long courses of antibiotics. In the initial intensive phase of therapy, intravenous antibiotics (ceftazidime or meropenem) are given for at least 2 weeks. This is followed by oral eradication therapy, trimethoprim/sulfamethoxazole, for 3-6 months. In the presence of intolerance or contraindication, amoxicillin-clavulanate is a less effective oral alternative (ensure dosing is adequate). Abscesses should be drained when possible.

MANAGEMENT OF CONTACTS

No specific management of contacts is required.

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions apply in the healthcare setting. There is no available vaccine.

Patients with known risk factors should cover all cuts and minimise contact with soil and surface water. Protective clothing (gloves and boots) is recommended for those with occupational exposure to soil and water. In endemic areas, skin wounds that have become contaminated with soil or surface water should be immediately and thoroughly cleaned.

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MENINGOCOCCAL DISEASE

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Laboratories	Upon laboratory confirmation	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Within 24 hours

CAUSATIVE AGENT

Neisseria meningitidis (serogroups A, B, C, W135, Y)

INCUBATION PERIOD

Typically, 3-4 days; range is 2 to 10 days.

INFECTIOUS PERIOD

Patients are infectious while there are live meningococci in secretions from nose and mouth. The bacteria are usually cleared within 24 hours of institution of effective antibiotic treatment.

TRANSMISSION

Transmission occurs through droplet spread or direct contact with respiratory secretions or secretions from the nose and throat of an infected person. Up to 5-10% of the population may be asymptomatic carriers with nasopharyngeal colonisation. Human are the only reservoir for meningococcal infection.

EPIDEMIOLOGY

Meningococcal disease occurs worldwide. Those most at risk are infants, young children, adolescents and young adults. The greatest burden is in the "meningitis belt" of sub-Saharan Africa where large-scale epidemics were previously caused by serogroup A. Introduction of a monovalent conjugate meningococcal A vaccine in 2010 reduced its incidence, with subsequent outbreaks caused by serogroups C, W and X.

Following introduction of serogroup C vaccines, serogroup B has become an increasingly important cause of meningitis globally. Singapore has a low incidence of meningococcal disease, with most cases in children <5 years of age. The main serogroup causing disease locally is B. Singaporean travellers to high-risk countries, or to Mecca for the Hajj or Umrah, are at increased risk which may be mitigated by vaccination.

CLINICAL FEATURES

Most commonly presents as meningitis with an acute onset of fever, headache, nausea and vomiting, stiff neck and photophobia. It may initially be mistaken for a flu-like illness. Meningococcaemia (i.e. bacteraemia) is a severe infection characterised by petechial rash, shock, disseminated intravascular coagulation and multiorgan failure. Patients can have both meningitis and meningococcaemia. The onset of symptoms for these presentations is sudden and death can follow within hours.

Individuals with underlying immune dysfunctions such as asplenia, properdin deficiency, and a deficiency of terminal complement components are at increased risk. CFR can be as high as 15% even with antibiotics. 10-15% of survivors have persistent neurological defects, including hearing loss, speech disorders, mental retardation and paralysis. Less common forms of meningococcal disease include pneumonia, septic arthritis and pericarditis.

MICROBIOLOGY INVESTIGATIONS

Specimen Type	Tests
Blood CSF Sterile site samples	Culture PCR for culture negative specimens

Note for laboratories: Serogroups should be determined for public health purposes. Isolates should be sent as pure culture to both NPHL and Singapore General Hospital (SGH) for serotyping.

MANAGEMENT OF PATIENTS

Meningococcaemia and meningococcal meningitis are medical emergencies and admission to hospital is necessary. Early institution of appropriate intravenous antibiotics (IV ceftriaxone 2g, 12 hourly) is critical to improve outcomes. Dexamethasone has not shown to be of any significant benefit in meningococcal meningitis.

MANAGEMENT OF CONTACTS

Post-exposure chemoprophylaxis of all close contacts is recommended. Healthcare workers generally do not require chemoprophylaxis unless they had direct exposure to patient's secretions e.g. intubation without respiratory protection (see post-exposure prophylaxis under Public Health Resources section).

The recommended chemoprophylaxis regimens are:

- Rifampicin 600mg 12 hourly for two days (adults); in children (>1 month) 10mg/kg for 2 days; or
- Ciprofloxacin 500mg oral single dose; or
- IM ceftriaxone 250 mg single dose (adults); children <15years, 125mg single IM dose.

PRECAUTIONS, PREVENTION AND CONTROL

In addition to standard precautions, droplet precautions should be applied until 24 hours after initiation of effective antibiotic therapy.

There are different formulations of meningococcal vaccines available such as quadrivalent vaccines against serotype A, C, Y and W135, bivalent (A and C), or monovalent vaccines (A, B or C). WHO recommends that in low incidence countries (which includes Singapore), meningococcal vaccination be administered to defined risk groups (e.g. laboratory workers, travellers to countries where disease is endemic, military groups), patients with anatomic or functional asplenia, immunocompromised patients, personnel handling *N. meningitidis* isolates, close contacts of meningococcal disease patients, and people at risk due to an outbreak in the community. Vaccination should also be considered for those living in dormitories. Meningococcal vaccination is a mandatory requirement for travellers to Saudi Arabia for the Hajj or Umrah pilgrimage.

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MIDDLE EAST RESPIRATORY SYNDROME (MERS)

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Call MOH Surveillance Duty Officer and submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Immediately
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Middle East respiratory syndrome coronavirus (MERS-CoV)

INCUBATION PERIOD

1-14 days

INFECTIOUS PERIOD

Duration of infectiousness for MERS-CoV is unknown. Respiratory secretions from MERS-CoV patients have been shown to contain viable virus up to 4 weeks after symptom onset. Viral RNA can also be detected from hospital environmental surfaces for up to 5 days following last positive PCR from patients' respiratory sample.

TRANSMISSION

Dromedary camels are likely to be the major reservoir for MERS-CoV and the source of animal-to-human transmission in community infected cases. However, the route of transmission is unclear.

Person-to-person transmission is likely through droplets, direct contact or fomites. Limited transmission has occurred among close contacts of confirmed cases in household settings. The majority of transmission has occurred in healthcare settings. Such non-sustained, healthcare-associated outbreaks are a prominent feature of this

virus, and are likely due to inadequate and/or incomplete compliance with infection prevention and control measures and delay in triage or isolation of suspected MERS-CoV patients.

EPIDEMIOLOGY

MERS-CoV was first reported in September 2012 in Saudi Arabia. Most cases occur primarily in countries in the Arabian Peninsula, with the majority of these from Saudi Arabia. Cases reported elsewhere have been linked to travel or residence in the Arabian Peninsula, including the large outbreak which infected 186 people that occurred in South Korea in 2015. There have been no reported cases of MERS in Singapore.

CLINICAL FEATURES

Typical symptoms include fever, cough and shortness of breath progressing to severe pneumonia and acute respiratory distress syndrome, requiring intensive care and intubation. Some have reported gastrointestinal symptoms, including diarrhoea and vomiting. There have also been reports of MERS cases presenting as mild respiratory illness and as an asymptomatic infection. Individuals with comorbidities, such as diabetes mellitus, cardiovascular disease, renal disease and immunosuppression, may be at increased risk for severe disease.

Risk factors for acquiring MERS-CoV include relevant travel, contact with camels, contact with confirmed or suspect cases, especially in healthcare settings.

MICROBIOLOGY INVESTIGATIONS

Collect 2 samples over 2 consecutive days, preferably 24 hours apart. Notify the laboratory of suspect MERS before submitting specimens.

Specimen Type	Tests
Respiratory samples including throat/ nasopharyngeal swabs, endotracheal aspirate, bronchoalveolar lavage	PCR

MANAGEMENT OF PATIENTS

There is no specific antiviral therapy. Management is supportive.

MANAGEMENT OF CONTACTS

Contacts should be placed under active surveillance to monitor for symptoms.

PRECAUTIONS, PREVENTION AND CONTROL

All suspected and confirmed MERS-CoV cases should be isolated and treated in negative pressure isolation rooms. Aside from standard precautions, contact, droplet and airborne precautions should be applied. Eye protection should also be used. Aerosol-generating procedures (e.g. nebuliser therapy) should be avoided if possible. Movement of patients (e.g. for scans or other procedures) within the hospital should be kept to a minimum.

Public health measures to limit transmission include effective contact tracing, early case detection, quarantine of exposed persons, surveillance of fever clusters and atypical pneumonia cases. There is no available vaccine.

Individuals travelling to areas affected by MERS-CoV, particularly those at high risk of severe disease, are advised to adopt the following precautions to reduce their risk of exposure: regular hand washing (e.g. before and after meals), avoiding contact with camels and other live farm or wild animals (hands should be washed thoroughly with soap if contact is made), avoiding consumption of raw camel milk and undercooked meats.

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MONKEYPOX

NOTIFIABLE DISEASE: NO

Although monkeypox is not on the list of notifiable diseases under the Infectious Diseases Act, it is recommended that all suspected or confirmed cases are to be reported to MOH as soon as possible.

Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Call MOH Surveillance Duty Officer and submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Immediately
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Monkeypox virus, member of the *Orthopoxvirus* genus.

INCUBATION PERIOD

Typically, 6-16 days; range is 5 to 21 days.

INFECTIOUS PERIOD

From onset of fever until all scabs have separated.

TRANSMISSION

Animal-to-human transmission may occur by a bite or scratch from an infected animal, bush meat preparation, or direct contact with the blood, body fluids, or skin or mucosal lesions of infected animals.

Human-to-human transmission is limited but can occur via exposure to respiratory droplets or direct contact with an individual with rash or indirect contact with materials contaminated with the virus.

EPIDEMIOLOGY

Following the first case of monkeypox in 1970 in the Democratic Republic of Congo, cases have been reported in West and Central Africa. The first cases outside Africa occurred in 2003 in a United States outbreak arising from exposure to native prairie dogs which had become infected by being housed with imported African rodents at a pet distributor. Imported cases from Nigeria were reported in the United Kingdom and Israel in 2018, and Singapore in 2019.

CLINICAL FEATURES

Early symptoms of monkeypox are non-specific and include fever, headache, myalgia, malaise and lymphadenopathy. Within 1-3 days after the onset of fever, infected persons develop a maculopapular rash, often starting from the face before becoming generalised (centrifugal distribution), including involvement of palms and soles in up to 75% of cases. The lesions progress to become vesicles and then pustules, before crusting occurs in approximately 10 days, which then spontaneously fall off. The disease is typically self-limiting, with symptoms usually resolving spontaneously within 21 days. However, complications such as pneumonia, sepsis, encephalitis and ocular complications (keratitis, corneal ulceration) have occurred. The infection can be fatal, particularly in young children, with a reported mortality rate of 1-10%.

MICROBIOLOGY INVESTIGATIONS

Please contact MOH and NPHL to arrange laboratory tests. Blood is less preferred due to a short viraemic period and lower sensitivity.

Specimen Type	Tests
Vesicle fluid, Blood	PCR

MANAGEMENT OF PATIENTS

There is no specific antiviral therapy. Treatment is supportive.

MANAGEMENT OF CONTACTS

Postexposure prophylaxis with smallpox vaccination may be considered. Vaccination given within 4 days of exposure can prevent the onset of disease. If given 4-14 days after exposure, vaccination may not prevent disease but can reduce disease severity.

PRECAUTIONS, PREVENTION AND CONTROL

Suspected and confirmed cases should be isolated in a negative pressure isolation (NEP) room. Standard, contact, droplet and airborne precautions, with eye protection, should be applied.

Prophylactic vaccination with smallpox vaccine is not routinely recommended as the potential risks outweigh the benefits. The main preventive measure would be to avoid contact with infected persons and potentially infected animals (although this may not be feasible in an endemic setting).

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MUMPS

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Within 72 hours
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Mumps virus

INCUBATION PERIOD

Typically, 16-18 days; range is 12 to 25 days.

INFECTIOUS PERIOD

1 week before and up to 9 days after the onset of parotitis.

TRANSMISSION

Transmitted is by droplet spread and direct or indirect (via fomites) contact with respiratory droplets and saliva of an infected person.

EPIDEMIOLOGY

Mumps occurs worldwide and usually affects children and young adults. In countries that have included mumps vaccination in their immunisation programmes, the incidence of mumps has declined significantly. Humans are the only known reservoirs of the infection.

In Singapore, mumps vaccination has been included as part of the National Childhood Immunisation Programme since January 1990, when the monovalent measles vaccine was replaced by the trivalent measles, mumps, rubella (MMR) vaccine. In 1999 and

2000, there was a significant increase in the number of cases due to the low protective efficacy of vaccines containing the Rubini strain, which had been used in the years 1993-1995. Following the resurgence in cases, a more efficacious vaccine replaced the Rubini strain-containing vaccine. Since then, the incidence of mumps has declined rapidly and remained low since 2010.

CLINICAL FEATURES

About 30% of cases may present with a mild respiratory tract infection with no apparent salivary gland swelling or a subclinical infection. Typically, mumps begins with a prodrome of malaise, headache, fever and anorexia lasting 2-3 days. This is followed by pain and swelling in one or both parotid glands (or other salivary glands), increasing for 2-3 days, then resolving over 1 week. Epididymo-orchitis, usually unilateral, is the most common complication occurring in approximately 15-30% post pubertal males, typically 5-10 days after onset of parotitis. Other complications include oophoritis, meningoen- cephalitis and sensorineural hearing loss.

Differentials for parotid gland swelling include bacterial parotitis, other viral parotitis (parainfluenza, influenza, coxsackievirus), viral lymphadenitis, parotid calculus or tumour. Bilateral parotid swelling can be seen in children with HIV infection.

MICROBIOLOGY INVESTIGATIONS

Specimen Type	Tests
Nasopharyngeal swabs/aspirates, saliva	Immunofluorescence Virus isolation
Blood, CSF, urine	Virus isolation
Serum	IgM, IgG

MANAGEMENT OF PATIENTS

There is no specific antiviral therapy. Treatment is symptomatic.

MANAGEMENT OF CONTACTS

Susceptible contacts should receive MMR vaccination.

PRECAUTIONS, PREVENTION AND CONTROL

Standard and droplet precautions apply in the healthcare settings. Infected individuals should stay away from school or the workplace for 5-9 days from the onset of parotid swelling.

Vaccination is the main preventive measure against mumps (see Public Health Resources section). Currently under the National Childhood Immunisation Schedule, the MMR first dose is given at 12 months and the second dose at 15-18 months.

In an outbreak setting, exposed individuals who are unvaccinated may need to be quarantined from 12 to 25 days after exposure.

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Seletar fishing village, embodying One Health in action

NIPAH VIRUS INFECTION

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Call MOH Surveillance Duty Officer and submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Immediately
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Nipah virus, a member of the *Paramyxoviridae* family.

INCUBATION PERIOD

Typically, 4-14 days; range is up to 2 months.

INFECTIOUS PERIOD

Human-to-human transmission has been reported. Duration of infectiousness is unknown.

TRANSMISSION

Animal-to-human transmission occurs via direct contact with infected pigs or horses and their secretions or tissues or through ingestion of raw fruits contaminated with urine or saliva of infected fruit bats. Human-to-human transmission is believed to occur through direct contact with secretions of infected individuals.

EPIDEMIOLOGY

Nipah virus was first identified in 1999 during an outbreak of encephalitis that occurred among people in close contact with pigs in Malaysia (pig farmers). The outbreak resulted in nearly 300 human cases and more than 100 deaths, and spread to Singapore which experienced 11 cases and 1 death among abattoir workers. More than a million pigs were culled to control the outbreak.

Nipah virus has also caused outbreaks in Bangladesh and India, where human-to-human transmission has been observed. Fruit bats are the natural hosts of Nipah virus. Human infections have resulted from either direct bat-to-human transmission or through an intermediate animal host (e.g. pigs).

CLINICAL FEATURES

The main clinical presentation is of acute encephalitis. The illness initially begins with non-specific symptoms of fever, headache, myalgia, vomiting and sore throat. The disease is then often rapidly progressive with deterioration leading to coma in 5-7 days. Seizures may occur in 20% of patients. Respiratory involvement occurs in up to 69% of cases. Relapsing encephalitis and late-onset encephalitis in those with initial non-encephalitic or asymptomatic diseases have been reported. The CFR ranges from 40-75%. Majority who survive Nipah virus encephalitis make a full recovery, although up to 20% may have long-term neurological sequelae.

MICROBIOLOGY INVESTIGATIONS

Notify the laboratory before submitting specimens.

Specimen Type	Tests
CSF Respiratory samples, including nasopharyngeal swabs, endotracheal aspirate, bronchoalveolar lavage Blood Urine	PCR
Serum	Nipah virus total antibody

Note for laboratories: Refer to the institution's guidelines for handling and testing of specimens from suspect cases.

MANAGEMENT OF PATIENTS

Management of Nipah virus infection is supportive. Ribavirin has been shown to have an in vitro effectiveness, and was used during the Malaysian outbreak where it led to a 36% reduction of mortality among humans, but its clinical utility remains uncertain.

MANAGEMENT OF CONTACTS

No specific management of contacts is required.

PRECAUTIONS, PREVENTION AND CONTROL

Aside from standard precautions, contact and droplet precautions should be applied. N95 masks should be worn by healthcare staff when performing aerosol-generating procedures. Infection control measures should be reinforced when caring for infected patients to prevent nosocomial spread.

Epidemiological investigations into missed cases and animal reservoirs of infection should be carried out. In the event that an intermediate animal host is suspected to be a source of infection, the affected animal premises should be quarantined immediately. Infected animals should be culled to reduce transmission to people.

There is no available vaccine.

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PARECHOVIRUS INFECTION

NOTIFIABLE DISEASE: NO

CAUSATIVE AGENT

Human parechovirus (HPeV), a member of the *Picornaviridae* family.

INCUBATION PERIOD

Unknown

INFECTIOUS PERIOD

Unknown

TRANSMISSION

Person-to-person transmission occurs from both asymptomatic and symptomatic infected persons via contact with respiratory secretions or the faecal-oral route.

EPIDEMIOLOGY

HPeV is found worldwide and occurs throughout the year, with types HPeV1B and HPeV3 being the most common. It can infect all age groups, but particularly affects infants and young children.

CLINICAL FEATURES

HPeV infections feature a wide clinical spectrum ranging from asymptomatic infections to mild self-limiting illness (gastrointestinal and respiratory) to severe disease requiring intensive care. In infants <3 months old, the illness can present as a high fever for 3-5 days without focus. HPeV (along with enteroviruses) are a major cause of aseptic meningitis in children, especially in neonates and young infants.

MICROBIOLOGY INVESTIGATIONS

Specimen Type	Tests
Cerebrospinal fluid Serum	PCR

MANAGEMENT OF PATIENTS

Most infections are self-limiting and do not require any specific treatment. Management is supportive. Those with severe disease will require hospitalisation, with need for intensive care as indicated. Although some case reports suggest benefit, there is no clear evidence to support administration of intravenous immunoglobulin.

MANAGEMENT OF CONTACTS

No specific management of contacts is required.

PRECAUTIONS, PREVENTION AND CONTROL

Standard and contact precautions apply in the healthcare setting.

No vaccine is available. Good hygiene practices should be practised (e.g. hand hygiene; unwell individuals should stay away from young infants).

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PERTUSSIS

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Laboratories	Upon laboratory confirmation	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Within 72 hours

CAUSATIVE AGENT

Bordetella pertussis

INCUBATION PERIOD

Typically, 9-10 days, range is 6 to 20 days.

INFECTIOUS PERIOD

Infectious for about 3 weeks, from the catarrhal stage (about 1 week) through the paroxysmal cough stage (about 2 weeks) in an untreated patient. If antibiotics are initiated, the period of infectiousness is usually ≤ 5 days after onset of treatment. Pertussis is a highly contagious disease.

TRANSMISSION

Transmission occurs via respiratory droplets or direct contact with nasal or throat secretions of an infected person.

EPIDEMIOLOGY

Pertussis occurs worldwide with outbreaks occurring every 3-4 years. In Singapore, pertussis vaccination is part of the National Childhood Immunisation Programme. The highest incidence continues to be in infants who are either unimmunised or incompletely immunised with the primary course of vaccination. Increasing incidence in adolescents and adults (with occasional community and school outbreaks) is noted and likely due to waning immunity. Adolescents and adults with unrecognised

pertussis are a reservoir of infection for infants and children. Humans are the only known reservoir.

CLINICAL FEATURES

The disease can occur in both children and adults. All persons who have not been immunized are susceptible, and pertussis can be severe in immune-naïve individuals of any age. In unvaccinated children, the classic presentation has 3 stages:

1. **Catarrhal stage** (1-2 weeks): similar to an upper respiratory tract infection with coryza and mild cough symptoms. Fever is often absent.
2. **Paroxysmal stage** (2-6 weeks): increased cough with spells of repetitive usually dry cough, followed by sudden inspiratory effort (whoop) and post-tussive emesis.
3. **Convalescent stage** (>2 weeks): decreasing frequency and severity of coughing episodes. Average duration of cough approximately 50 days.

Infants younger than 6 months may have cough without a typical whoop and may have apnoea/respiratory distress. Adolescents and adults can have a prominent hacking cough that lacks the characteristic whoop. Prior immunisation can lead to atypical presentations. Complications of pertussis include urinary incontinence, rib fractures, hernia, pneumonia, pulmonary hypertension, seizures, encephalopathy, failure to thrive (in infants), apnoea and death.

MICROBIOLOGY INVESTIGATIONS

Serology has limited value in diagnosis of pertussis.

Specimen Type	Tests
Respiratory samples including nasal/ nasopharyngeal/ throat swabs, sputum, endotracheal aspirate, bronchoalveolar lavage	PCR

MANAGEMENT OF PATIENTS

Antibiotic treatment is unlikely to shorten the duration of illness if started more than one week after symptom onset, but it is beneficial in shortening the infectious period and decreasing transmission. Macrolides are the recommended first line of therapy.

Recommended antibiotic regimen for adults and adolescents:

- Azithromycin: 500mg oral single dose, then 250mg daily for 4 days; or
- Clarithromycin: 500mg BD for 7 days; or
- Erythromycin: 2g per day in 4 divided doses for 7-14 days.
- Alternative to macrolides: Trimethoprim-sulfamethoxazole (Bactrim) 1 double strength tab BD for 14 days.

Recommended antibiotic regimen for children:

- >1 month old: PO clarithromycin 15mg/kg/day BD for 7 days; or azithromycin 10mg/kg/dose (maximum 500mg/dose) on first day, then 5mg/kg/dose (maximum 250mg/dose) for 4 days.
- ≤1 month old: PO azithromycin 10mg/kg/day daily for 5 days.
- Alternative to macrolides (if ≥2 month): PO Bactrim 8mg/kg/day (TMP component) BD for 14 days.

Infection in infants under age 6 months may require hospitalisation due to complications of hypoxaemia, apnoea or poor feeding.

MANAGEMENT OF CONTACTS

Post-exposure chemoprophylaxis is recommended for household contacts (regardless of immunisation status) and contacts who are personally at high risk of developing severe disease (e.g. children <1 year) or are in close contact with those at high risk of severe disease (e.g. pregnant women in their third trimester who may be a source of pertussis to their neonates) within 3 weeks of exposure. Same drug regime as for treatment of cases can be used for antibiotic prophylaxis.

There is limited evidence for post-exposure vaccination, however contacts are advised to keep up-to-date with their vaccinations to protect against future exposure.

PRECAUTIONS, PREVENTION AND CONTROL

Patients should be isolated. Suspect and confirmed cases should be removed from the presence of young children and non-immunised infants until patients have received at least 5 days of antibiotics. In the healthcare setting, standard and droplet precautions should be applied until 5 days after initiation of effective antibiotic therapy.

Exposed household contacts younger than 7 years of age who are unvaccinated or incompletely immunised may need to be quarantined till 21 days after exposure, or till 5 days after index case and contact have received appropriate antibiotics.

Vaccination is the most effective preventive measure (see Public Health Resources section). Pertussis vaccination is part of the National Childhood Immunisation Schedule (DTaP at 2 months, 4 months, 6 months and 18 months, and Tdap booster at 10-11 years). All adolescents and adults, especially healthcare workers, without documentation of having received a primary series of at least 3 doses of tetanus and diphtheria toxoids should receive a series of 3 doses of tetanus- and diphtheria-containing vaccine, of which 1 dose, preferably the first, should be Tdap.

All pregnant women are recommended to receive Tdap between 16 and 32 weeks of each pregnancy to maximise the maternal antibody response and transfer of passive immunity to their infants, regardless of the interval since the previous Td or Tdap vaccination. Tdap vaccination is recommended in all pregnant women for the protection of infants against pertussis through passive antibody transfer from mother to infant, who are at the highest risk of pertussis-related complications.

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PLAGUE

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Call MOH Surveillance Duty Officer and submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Immediately
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Yersinia pestis

INCUBATION PERIOD

1-7 days

INFECTIOUS PERIOD

Human-to-human transmission occurs only in pneumonic plague. Patients are infectious throughout the duration of illness or until 48 hours after receiving effective antibiotic therapy.

TRANSMISSION

Transmission occurs from rats via flea bites, direct contact with infected animal tissues, or through the inhalation of respiratory droplets from infected animals (e.g. cats) or humans with pneumonic plague.

EPIDEMIOLOGY

Plague is an enzootic disease with wild rodents as the natural hosts. Wild rodent plague exists in the Americas (South America, western part North America), Africa and Asia. Humans are incidental hosts and not part of the natural disease cycle. Urban rat-associated plague has been largely controlled in most parts of the world. Plague epidemics in humans have occurred in Africa, Asia and the Americas, but since the

1990s, most human cases have occurred in Africa. Cases typically occur in more remote, less populated rural regions.

CLINICAL FEATURES

Plague should be suspected in anyone with fever and painful lymphadenopathy who has been to an endemic country.

There are 3 principal clinical presentations:

1. **Bubonic plague:** initial fever, headache, myalgia followed by painful acute regional lymphadenopathy (pathognomonic bubo), typically involving the inguinal, axillary or cervical regions. If left untreated, rapid progression to septicaemia and secondary plague pneumonia occurs (untreated CFR of 50-60%).
2. **Septicaemic plague:** occurs when *Y. pestis* invades the bloodstream. It can follow bubonic plague or occurs without detectable lymphadenopathy (primary septicaemic plague). Complications include septic shock, disseminated intravascular coagulation, meningitis and multiorgan failure.
3. **Pneumonic plague:** the least common but the most dangerous and fatal form of the disease. It can develop as a complication of septicaemic plague or be acquired directly by inhalation of aerosols from a human or animal with pneumonic plague. The signs include severe pneumonia, fever, dyspnoea and often haemoptysis. Patients who do not receive treatment within 18 hours of onset of respiratory symptoms are unlikely to survive.

MICROBIOLOGY INVESTIGATIONS

Notify laboratory when plague is suspected.

Specimen Type	Tests
Blood Respiratory specimens Bubo fluid	Bacterial culture

Note for laboratories: *Yersinia pestis* is a biothreat organism and also a WHO Risk Group (RG) 3 organism. Laboratories should take additional precautions and perform all testing in a biosafety cabinet (BSC). Please contact MOH and NPHL for further identification and confirmation of the pathogen.

MANAGEMENT OF PATIENTS

All cases should receive prompt initiation of antibiotics (aminoglycosides such as streptomycin or gentamicin, alternatively, doxycycline or tetracycline) and should be hospitalised.

MANAGEMENT OF CONTACTS

Post-exposure chemoprophylaxis should be offered to close contacts of patients with pneumonic plague (including healthcare workers). They should be placed under surveillance for 7 days to monitor for symptoms. For adults, doxycycline 100mg BD or Ciprofloxacin 500 mg BD for 7 days can be considered.

Contacts of patients with bubonic or septicaemic plague should be monitored but chemoprophylaxis is unnecessary.

PRECAUTIONS, PREVENTION AND CONTROL

Patients with uncomplicated infection who are promptly treated present no health hazard to others. Strict isolation is required only for patients with pneumonic plague. Droplet precautions should be instituted until 48 hours of effective antibiotic therapy. Standard precautions apply for all forms of plague. Bubo aspirate and blood must be handled with gloves and aerosolization of these materials should be avoided. In the event of death, proper disposal of the body must be observed.

Quarantine of close contacts of a case with pneumonic plague should be required if the contact refuses chemoprophylaxis.

Anti-flea and rodent control measures should be implemented if they are the likely source of infection. No licensed plague vaccine is currently available.

Chemoprophylaxis should be offered to persons exposed to bites of wild rodent fleas during an outbreak or to tissues/fluids of a plague-infected animal, and to persons travelling to highly endemic area for short duration.

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PNEUMOCOCCAL DISEASE, INVASIVE

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Laboratories	Upon laboratory confirmation	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Within 72 hours

CAUSATIVE AGENT

Streptococcus pneumoniae, also known as pneumococcus.

INCUBATION PERIOD

Typically, 1-3 days. Uncertainty exists as invasive disease progresses from an asymptomatic nasopharyngeal carrier state after a variable duration.

INFECTIOUS PERIOD

Presumably infectious as long as pneumococci are present in oral-nasal secretions. With antimicrobial treatment, persons infected with susceptible strains are rendered non-infectious within 24-48 hours. However, the main reservoir for transmission is asymptomatic carriers. Carriage rates are higher in children than adults, and in developing than developed countries.

TRANSMISSION

Transmission occurs via droplet spread as well as direct and indirect contact with respiratory secretions of an infected person, but usually requires frequent or prolonged close contact.

EPIDEMIOLOGY

Pneumococcal disease occurs worldwide. *S. pneumoniae* is one of the most common causes of invasive infections such as bacteraemia and meningitis. Invasive pneumococcal disease (IPD) is defined as the isolation of *S. pneumoniae* from normally

sterile sites such as blood, pleural fluid and cerebrospinal fluid. The highest risk is in young children, the elderly and those with chronic illness or immunosuppression. The number of identified serotypes is increasing although vast majority of infections is still caused by a few serotypes. The main serotypes have been incorporated into multivalent pneumococcal vaccines. The worldwide emergence of pneumococcal resistance to antibiotics is of concern, as is the replacement of vaccine serotypes by the emergence of non-vaccine serotypes. Pneumococcal vaccination is included in the immunisation schedule for both children and adults.

CLINICAL FEATURES

Infection is often preceded by a respiratory viral illness before local disease (from congestion and concentration of virulent pneumococci) or invasion leading to systemic or invasive disease that can potentially involve any organ. Clinical manifestations depend on the site of infection. Common clinical syndromes include meningitis and bacteraemia. Pneumococcal pneumonia is not considered an invasive disease unless blood or pleural fluid cultures are positive for the organism. Otitis media is not considered an invasive disease, but may be included if *S. pneumoniae* is isolated from normally sterile middle ear fluid.

Less commonly, IPD can also present as osteomyelitis, pyogenic arthritis, endocarditis, myocarditis, pericarditis, bacterial peritonitis, endophthalmitis and salpingitis. In immunocompromised patients, infections may be fulminant and present with overwhelming sepsis and multiorgan failure.

Risk factors for IPD include: age <5 years and ≥65 years; chronic lung, heart, renal or liver disease; diabetes mellitus; immunocompromised states; cochlear implants; cerebrospinal fluid leaks; and functional or anatomic asplenia.

MICROBIOLOGY INVESTIGATIONS

Specimen Type	Tests
Blood CSF Pleural fluid Joint fluid	Bacterial culture
CSF	PCR

Urinary antigen test offers presumptive diagnosis but lacks sensitivity and specificity. Carriage is common in children and may give rise to false positive results.

Note for laboratories: Isolates from all positive cases from invasive samples only, including CSF, blood and other sterile sites, should be sent to NPHL for serotyping.

MANAGEMENT OF PATIENTS

Patients will require hospitalisation. Appropriate antibiotics should be given. Empirical antibiotics should be guided by local guidelines before adjusting according to microbiological and susceptibility test results. Source control (e.g. drainage of abscesses) is often critical.

MANAGEMENT OF CONTACTS

No specific management of contacts is required.

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions apply in the healthcare settings.

Under the National Childhood Immunisation Schedule, children <1 year old should receive 2 primary doses at 4 months and 6 months followed by a booster at 12 months. Children aged 1 to 5 years with incomplete vaccination should be given catch-up vaccination - the catch-up number of doses and intervals between doses will depend on the child's age when vaccination begins.

All adults ≥ 65 years old are recommended to receive 1 dose each of PCV13 and PPSV23. Under the National Adult Immunisation Schedule, adults who are immunocompromised or with other medical conditions such as cochlear implants, cerebrospinal fluid leaks, anatomic or functional asplenia, are recommended to receive one dose of PCV13, a first dose of PPSV23 at least 8 weeks after PCV13, and a second dose of PPSV23 at least 5 years after the first dose of PPSV23. Adults ≥ 18 years old with chronic conditions such as chronic lung, heart, kidney or liver and diabetes mellitus are recommended to receive PPSV23 or PCV13 depending on the specific condition.

For more information on vaccination, see Public Health Resources section of this book.

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POLIOMYELITIS

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Call MOH Surveillance Duty Officer and submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Immediately
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Poliovirus, types 1, 2 and 3.

INCUBATION PERIOD

Typically, 7-14 days; range 3 to 35 days.

INFECTIOUS PERIOD

From 7-10 days before till 1-2 weeks after onset of illness (may be up to 6 weeks as the virus can continue to be excreted in the faeces of an infected person).

TRANSMISSION

Principally transmitted person-to-person through the faecal-oral route.

EPIDEMIOLOGY

Humans are the only reservoir for poliovirus. Since the introduction of poliovirus vaccine, most countries have eradicated poliomyelitis. To date, only 2 countries still have ongoing transmission of wild polioviruses (Pakistan and Afghanistan). The last indigenous case of poliomyelitis in Singapore was notified in 1973. Polio vaccination is part of the National Childhood Immunization Programme in Singapore.

CLINICAL FEATURES

Poliovirus infection has a wide clinical spectrum. The majority are asymptomatic. About 25% will have a mild flu-like illness that is self-limiting. A small proportion of infected cases go on to develop more serious manifestations (including paralysis).

Depending on the part of the spinal cord or brainstem affected, three forms of paralytic polio have been seen:

1. **Spinal paralytic polio:** This is preceded by a “minor” illness with fever, muscle pain, headache, nausea, vomiting and stiff neck/back and less frequently, signs of aseptic meningitis. The minor illness lasts 1-3 days followed by a symptom-free period of 1-5 days before the onset of “major” illness of paralysis. Paralysis which varies from single muscle involvement to quadriplegia, is usually asymmetric and typically flaccid with loss of tendon reflexes. There is no accompanying sensory loss.
2. **Bulbar paralytic polio:** Paralysis of the soft palate, pharynx and larynx resulting in dysphagia, nasal speech and dyspnea.
3. **Polio encephalitis:** Encephalitis is manifested by confusion and change in sensorium. This is an uncommon form of polio seen in infants. Seizures are common and there may be spastic paralysis as opposed to flaccid paralysis.

The most common differential diagnoses for an acute flaccid paralysis include transverse myelitis, Guillain-Barré Syndrome, and infection by EV-A71 or West Nile virus.

Poliomyelitis should be suspected in an individual with a history of incomplete immunization against polio or travel history to countries with ongoing or recent transmission of polio in the past 35 days, and compatible clinical features.

MICROBIOLOGY INVESTIGATIONS

Initial tests for enteroviruses via PCR may be considered. Under acute flaccid paralysis (AFP) surveillance, please inform laboratory to send stool sample to SGH Virology Laboratory for virus isolation.

Specimen Type	Tests
Respiratory samples, including throat swabs Stool CSF	PCR
Stool	Virus isolation

MANAGEMENT OF PATIENTS

There is no specific antiviral therapy. Management is supportive and symptomatic.

MANAGEMENT OF CONTACTS

Case investigation and contact tracing will be carried out to identify unrecognized and unreported cases. Contacts below 12 years old without complete immunization should be referred to the nearest Polyclinic or School Health Clinic for vaccination.

PRECAUTIONS, PREVENTION AND CONTROL

The patient should be isolated. Standard and contact precautions should be applied.

The WHO should be notified under the International Health Regulations of poliomyelitis from wild poliovirus as this constitutes a public health emergency.

Vaccination is the most effective preventive measure for polio (see Public Health Resources section). Under the National Childhood Immunisation Schedule, children in Singapore receive IPV (inactivated vaccine) at 2 months, 4 months, 6 months, and boosters at 18 months and 10-11 years.

Among adults, vaccination is recommended in the following at-risk groups only:

- Travellers to areas where polio is endemic or where there is current polio transmission. This should be decided in consultation with a travel medicine practitioner.
- Those handling poliovirus isolates.
- Unvaccinated contacts of the vaccine recipient.

Only a single dose is required for previously vaccinated adults. For unvaccinated adults, give three doses, with the second and third dose given after 1-2 and 6-12 months after the first dose. If an accelerated schedule is necessary, each dose should be spaced 4 weeks apart.

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RABIES

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Call MOH Surveillance Duty Officer and submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Immediately
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Viruses from the *Lyssavirus* genus, including the classical rabies virus.

INCUBATION PERIOD

Typically, 3-8 weeks, range is few days to several years.

INFECTIOUS PERIOD

Infected person not usually contagious, person-to-person transmission is rare.

TRANSMISSION

Transmission most commonly occurs through exposure to saliva from infected mammals (usually dogs) through a bite or scratch. Rarely, it can occur through droplet transmission and organ transplantation.

EPIDEMIOLOGY

Rabies is a zoonotic disease prevalent in many parts of the world. It is estimated to cause tens of thousands of deaths every year, particularly in developing countries in Asia and Africa. Although many mammalian species serve as reservoirs for rabies, dog bites account for the majority of human infections. Rabies has not been endemic in Singapore since 1953.

CLINICAL FEATURES

Rabies usually begins with a non-specific prodrome of 2-10 days with symptoms of fever, malaise, fatigue, anorexia, cough, sore throat, abdominal pain, nausea, vomiting or diarrhoea. The first rabies-specific symptom is pain or paraesthesia at the site of the bite. The disease progresses to the acute neurological period, which manifests as either a hyperactive (furious) form in 80% with hydrophobia, aerophobia, pharyngeal spasms, opisthotonos, hyperactivity or a paralytic (dumb) form in 20% with ascending flaccid paralysis with loss of sphincter tone. Autonomic instability is often prominent (hyperthermia, hypersalivation, hypertension and tachycardia). The neurological phase lasts 2-7 days before development of coma, and then death.

Symptoms of fever, headache, seizures, confusion, or other symptoms of viral encephalitis together with a history of mammal bite from a rabies-endemic country without appropriate post-exposure prophylaxis should raise clinical suspicion of rabies.

MICROBIOLOGY INVESTIGATIONS

Rabies is a clinical diagnosis, and does not depend laboratory confirmation. Currently available diagnostic tests are unsuitable for the diagnosis of rabies before the onset of symptoms. For clinically diagnosed rabies cases, please contact MOH and the NPHL to arrange specialized tests on saliva, skin biopsy, serum or CSF. Diagnosis in the human patient may also be confirmed by post-mortem tests on tissue from the euthanized suspected rabid animal.

MANAGEMENT OF PATIENTS

There is no specific treatment for clinical human rabies. Intensive supportive care in the ICU is often used although mortality is virtually 100%.

MANAGEMENT OF CONTACTS

No specific management of contacts is required unless contact has been bitten by patient and requires post-exposure prophylaxis (see Public Health Resources section).

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions apply in the healthcare settings. Healthcare workers should wear gowns, masks, gloves, eye/face protection when there is risk of aerosols and splashes (e.g. intubation, suctioning). There is no documented case of rabies virus transmission from patient to health care worker.

Pre-exposure rabies vaccination should be discussed with individuals travelling to rabies-affected countries. They should also be advised not to touch or go near mammals (including wildlife), where possible. If scratched or bitten, they should immediately wash the wound with soap and water and seek medical attention.

All mammal scratch or bite wounds should be immediately and thoroughly cleansed with soap and water. If available, a viricidal agent, such as povidone iodine solution, should be used to irrigate the wound(s).

If a patient presents with mammal scratches/bites, or a cut/wound that has been exposed to mammal saliva in rabies-affected countries, further details about the mammal which had bitten, scratched or licked them should be obtained regarding signs of rabies (e.g. anxiety, agitation and aggression). If there are any concerns or suspicion that the mammal may have been rabid, patients should be urgently referred to a public hospital for appropriate assessment and treatment.

Rabies post-exposure prophylaxis (PEP) after animal bites in unvaccinated individuals consists of 4-5 doses of rabies vaccine as well as rabies immunoglobulin. Patients requiring PEP should be urgently referred to a public hospital for appropriate assessment and treatment.

In Singapore, strict control on importation and quarantine of dogs, cats and wild animals and intensive control of stray dog and cat population is exercised.

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RUBELLA

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Submit MD131 Notification Form via CDLENS (http://www.cdzens.moh.gov.sg) or fax (6221 5528/38/67)	Within 24 hours
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Rubella virus

INCUBATION PERIOD

Typically, 14–17 days, range is 2 to 3 weeks.

INFECTIOUS PERIOD

7 days before to 7 days after onset of rash. Infants with congenital rubella syndrome (CRS) may shed the virus up to 1 year after birth.

TRANSMISSION

Occurs through droplet spread and direct contact with nasopharyngeal secretions. Maternal-foetal transmission may occur, with the highest risk of congenital rubella syndrome (CRS) ensuing if infection occurs in the first trimester.

EPIDEMIOLOGY

Majority of countries worldwide have included rubella vaccination as part of their national immunisation programme. Countries with good vaccination coverage have seen a significant decline in the incidence of rubella and CRS. Incidence of CRS is highest in areas of Africa and Southeast Asia where vaccine coverage is low. Humans are the only reservoir of rubella.

Rubella immunisation in Singapore was introduced in 1976 and included as part of the trivalent measles, mumps, rubella (MMR) vaccine in 1990. A two-dose MMR vaccine regime was introduced in 1998 under the National Childhood Immunisation Schedule, in which the first dose is given at 12 months and the second dose at 15-18 months.

CLINICAL FEATURES

Many cases are subclinical. Rubella is a mild self-limiting viral illness. Infection usually starts with a prodrome that lasts 1-5 days with symptoms that include low grade fever, headache, malaise, anorexia, coryza and conjunctivitis. Tender occipital, post-auricular and cervical lymphadenopathy is a characteristic feature, and precedes the appearance of rash. These symptoms subside rapidly after the rash appears. The rash progresses in a cephalo-caudal direction and usually subsides in 3 days. By the end of the first day of rash, the body is covered with red, discrete maculopapules. By the third day, the rash disappears without any staining or desquamation.

Complications such as arthralgia and arthritis, which are more common in adults, clear in about 5-10 days. Encephalitis and thrombocytopenia are rare. The risk of foetal infection and congenital anomalies depends on the stage of pregnancy at which infection occurs (risk is highest in the first trimester). Differentials for rubella rash include roseola infantum, drug rash, infectious mononucleosis, enteroviral infections, mild measles and scarlet fever.

MICROBIOLOGY INVESTIGATIONS

Caution is advised in interpretation of rubella IgM antibody tests since false positive results are not uncommon. They may arise during other virus infections such as those due to parvovirus B19, cytomegalovirus or Epstein-Barr virus.

Specimen Type	Tests
Throat/ nasopharyngeal swabs Urine	PCR
Serum	Rubella IgM

Note to laboratories: All clinical samples collected for PCR and IgM testing should be sent to the NPHL for further testing.

MANAGEMENT OF PATIENTS

Management is symptomatic. If infection occurs in early pregnancy, the patient should be referred to a gynaecologist or an infectious disease physician who can provide advice and counselling on the possible risks of congenital malformation and appropriate management at that point in pregnancy.

MANAGEMENT OF CONTACTS

Pregnant contacts should be identified, particularly those in the first trimester, and offered serological testing. See Public Health Resources section for post-exposure prophylaxis.

PRECAUTIONS, PREVENTION AND CONTROL

Standard and droplet precautions should be applied until 7 days after onset of rash.

Vaccination is the main preventive measure against rubella (as the MMR vaccine). The vaccine should be avoided in pregnancy, and women who received rubella vaccine should be advised to avoid pregnancy for 1-3 months after vaccination. However, the currently recognized theoretical risk does not mandate automatic termination of pregnancy if a woman has been inadvertently vaccinated with rubella vaccine.

The MMR vaccine is included under the National Adult Immunisation Schedule and recommended for adults without evidence of immunity and/or prior disease.

Infected children should stay away from school for one week after onset of rash. See Public Health Resources section for details on post-exposure prophylaxis and vaccination.

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SALMONELLOSIS, NON-TYPHOIDAL

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Laboratories	Upon laboratory confirmation	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Within 72 hours

CAUSATIVE AGENT

Non-typhoidal *Salmonella* serotypes, most commonly Typhimurium and Enteritidis.

INCUBATION PERIOD

Typically, 12-36 hours; range is 6-72 hours.

INFECTIOUS PERIOD

Throughout the course of infection and carriage. Patients can have asymptomatic faecal shedding of the organism for a median duration after infection of 5 weeks in adults and 7 weeks in children <5 years of age. Some individuals can develop chronic carriage and shed the organism for more than a year after acute infection.

TRANSMISSION

Usually occurs through the ingestion of contaminated food or water, including raw and undercooked food (e.g. milk, meat, poultry, egg products). Person-to-person transmission through the faecal-oral route can occur, especially when diarrhoea is present. Zoonotic transmission from contact with infected animals (e.g. live poultry, reptiles) has been reported as well.

EPIDEMIOLOGY

Salmonella is a major cause of diarrhoeal disease and outbreaks in restaurants, schools, and institutional settings result from inadequately cooked food contaminated at source, from cross-contamination between ready-to-eat and raw foods, or from an unhygienic infected food handler. Infections can also result from direct contact with infected animals or their environments. Poultry has been implicated in many outbreaks.

CLINICAL FEATURES

Salmonellosis presents with symptoms that include fever, diarrhoea, vomiting, and abdominal cramps. While most cases of salmonellosis are mild, severity depends on host factors and the serotype. Complications include dehydration, and under 10% of patients develop invasive infections (e.g. bacteraemia, mycotic aneurysm, focal infections such as meningitis, osteomyelitis and septic arthritis). At-risk individuals are the young, elderly and immunocompromised patients with HIV, organ transplant, or immunosuppressive therapy.

MICROBIOLOGY INVESTIGATIONS

Disease	Specimen Type	Tests
Gastroenteritis	Stool	Stool culture for <i>Salmonella</i> , <i>Shigella</i> and <i>Campylobacter</i>
Invasive disease	Blood Sterile fluids/ tissues	Culture

MANAGEMENT OF PATIENTS

For uncomplicated gastroenteritis, no treatment is required except ensuring adequate hydration.

In high risk individuals at risk of invasive disease and in those with severe disease, antibiotics are indicated. Appropriate antibiotic choices include fluoroquinolones such as PO ciprofloxacin, PO trimethoprim-sulfamethoxazole, PO azithromycin or IV ceftriaxone.

Duration of therapy for immunocompetent individuals with non-bacteraemic *Salmonella* infection is 3-7 days. In immunosuppressed individuals with salmonellosis, a longer duration of therapy up to 14 days or longer is recommended to prevent relapse.

MANAGEMENT OF CONTACTS

No specific management of contacts is required.

PRECAUTIONS, PREVENTION AND CONTROL

Standard and contact precautions (if active diarrhoea) apply in the healthcare setting. There is no available vaccine. Preventive measures include avoiding food and drinks at high risk of contamination, good hand hygiene and proper food handling practices

When an outbreak of foodborne illness is suspected, the aim of investigations is to identify the source and contain/control the outbreak. Epidemiological investigations will be conducted to obtain information on food history, onset of illness and symptoms. Microbiological (e.g. stool samples from cases, food samples) and environmental investigations (e.g. food preparation practices, environmental sanitation) are also conducted. Implicated food handlers will be referred to the designated referral laboratory for stool cultures.

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SEVERE ACUTE RESPIRATORY SYNDROME (SARS)

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Call MOH Surveillance Duty Officer and submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Immediately
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

SARS coronavirus (SARS-CoV)

INCUBATION PERIOD

Typically, 2-7 days; range up to 10-14 days.

INFECTIOUS PERIOD

Throughout the symptomatic phase of the disease, usually less than 21 days. Rarely, there may be persistent viral shedding in the stool for up to 6 weeks after onset of clinical illness, but transmission of the disease has not been documented from asymptomatic nor convalescent individuals.

TRANSMISSION

Respiratory droplet spread and less often by direct contact with respiratory secretions or indirect contact with objects contaminated by respiratory secretions. Faecal-oral and airborne transmission may occur under certain circumstances.

EPIDEMIOLOGY

SARS first occurred in Guangdong, China in 2002, and spread worldwide the following year. By the end of July 2003, a total of 8,096 cases were reported in 29 countries, with 774 deaths, representing a CFR of 9.6%. In Singapore, 238 cases with 33 deaths were reported in March-May 2003. The median age of all cases was 36 (range 4-90) years; 41% of infections involved healthcare workers. Subsequent laboratory-acquired infections were reported in 2003 (Singapore, Taiwan) and 2004 (China).

CLINICAL FEATURES

The clinical presentation is non-specific and resembles other influenza-like illnesses. The prodrome lasts 3-7 days and is characterized by fever, malaise, headache and myalgia. Respiratory symptoms and diarrhoea, if present, typically occur a few days after the onset of fever. Physical examination is not helpful except as a gauge of severity of illness. Clinical manifestations vary from mild infection (80%) to severe disease (20%) with respiratory failure and death. Death is usually caused by a combination of respiratory and multiorgan failure. The clinical course is marked by deterioration in the second week of illness and recovery by the third week in the majority of cases. Children have a shorter and milder course of illness. There is no evidence at present of intra-partum infection.

Chest X-ray may be normal early in the course of the disease. However, the more distinct radiographic features include: a predominantly peripheral location of air-space opacity; progression from unifocal to multifocal or bilateral lung involvement during treatment; and a lack of cavitation, lymphadenopathy and pleural effusion.

MICROBIOLOGY INVESTIGATIONS

Collect 2 samples with 24 hours apart to increase sensitivity. Notify the laboratory of suspected SARS case before submitting specimens.

Specimen Type	Tests
Respiratory samples including throat/ nasopharyngeal swabs, endotracheal aspirate, bronchoalveolar lavage	PCR

MANAGEMENT OF PATIENTS

Clinical management is symptomatic and supportive treatment for all cases. Ribavirin which was initially used during the pandemic has been shown to be ineffective in vitro. There is no clinical evidence of the effectiveness of ribavirin against SARS-CoV, and its use is associated with significant toxicities. Other treatments used were corticosteroids, lopinavir, immunoglobulins and interferon, although conclusive evidence of benefit is lacking.

MANAGEMENT OF CONTACTS

Contacts should be placed under active surveillance to monitor for symptoms.

PRECAUTIONS, PREVENTION AND CONTROL

All suspected and confirmed SARS cases should be isolated and treated in negative pressure isolation rooms. Aside from standard precautions, contact, droplet and airborne precautions should be applied. Eye protection should also be used. Aerosol-generating procedures (e.g. nebuliser therapy) should be avoided if possible. Movement of patients (e.g. for scans or other procedures) within the hospital should be kept to a minimum.

Public health measures to limit transmission include effective contact tracing, early case detection, quarantine of exposed persons, surveillance of fever clusters and atypical pneumonia cases. There is no available vaccine.

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Singapore River bumboat ride and skyline

SEVERE FEVER WITH THROMBOCYTOPENIA SYNDROME

NOTIFIABLE DISEASE: NO

Although the syndrome is not on the list of notifiable diseases under the Infectious Diseases Act, it is recommended that all suspected or confirmed cases be reported to MOH as soon as possible.

Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Call MOH Surveillance Duty Officer and submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Immediately
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Severe fever with thrombocytopenia syndrome (SFTS) virus, a member of the *Bunyaviridae* family.

INCUBATION PERIOD

Typically, 9 days; range is 5 to 14 days.

INFECTIOUS PERIOD

Not known.

TRANSMISSION

Transmitted from infected animals (e.g. goats, sheep, cattle) to humans via a tick bite. The virus has been isolated most commonly in *Haemaphysalis longicornis* ticks. Person-to-person transmission can occur through close contact with blood and respiratory secretions of an infected person.

EPIDEMIOLOGY

SFTS has been reported in rural China (Henan, Shandong, Hubei, Anhui, Liaoning, Zhejiang and Jiangsu provinces) in 2009, and South Korea (Jeju) in 2013. In Japan, animal to human transmission implicated an infected stray cat in 2016 and pet dog in 2017. The incidence of cases appears to follow a seasonal variation, with cases occurring from March to November, peaking in May to July, which coincides with high tick density during these months. To date, there have been no reported cases of SFTS in Singapore.

CLINICAL FEATURES

SFTS can affect persons of all age groups, but persons aged ≥ 50 years are most likely to be infected with higher risk of complications and death. There are three phases of illness:

1. **Febrile phase (5-11 days):** SFTS begins with a non-specific prodrome, with fever, anorexia, myalgia and gastrointestinal symptoms such as nausea, vomiting and diarrhoea. Regional lymphadenopathy is common.
2. **Critical phase (7-14 days):** In the second week of illness, complications of multiorgan dysfunction can occur - acute renal failure, cardiac arrhythmias, myocarditis and meningoencephalitis. Patient may develop haemorrhagic manifestations with mucosal bleeding or disseminated intravascular coagulopathy.
3. **Convalescent phase (11-19 days):** Clinical symptoms and biochemical abnormalities resolve during this phase.

SFTS has a high mortality rate, ranging from 6-30%. The manifestations of SFTS are non-specific and very similar to other viral haemorrhagic syndromes. Locally, other conditions such as dengue fever, Zika virus infection, rickettsiosis and leptospirosis should be considered as differential diagnoses. In the appropriate epidemiological setting and with positive travel or exposure history, other less common conditions such as yellow fever, Ebola, Marburg and Crimean-Congo haemorrhagic fever should be considered.

MICROBIOLOGY INVESTIGATIONS

Notify the laboratory of suspect SFTS case before submitting specimens. Please contact MOH and NPHL to arrange SFTS PCR.

Specimen Type	Tests
Blood	PCR

MANAGEMENT OF PATIENTS

There is no specific antiviral treatment available and management is supportive. Some observational studies have reported use of ribavirin, but it has not been shown to have therapeutic effect. Suspect cases with signs of severe illness should be hospitalised and monitored for complications. Suspect cases well enough can be managed outpatient.

MANAGEMENT OF CONTACTS

Close contacts should be placed under surveillance until the end of the incubation period and monitored for the development of symptoms.

PRECAUTIONS, PREVENTION AND CONTROL

Persons who are suspected or confirmed to have SFTS do not require isolation and should strictly be placed on standard precautions, with droplet precautions for aerosol-generating procedures.

There is no vaccine available for prevention of SFTS. Preventive measures to prevent tick bites for persons at risk should be instituted i.e. using repellents such as >20% DEET, wearing long-sleeved clothing and long pants, sleeping under permethrin-impregnated bed netting, and treating clothes with permethrin-based products, checking one's entire body during and after outdoor activity and removing any attached ticks promptly.

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SEXUALLY-TRANSMITTED INFECTIONS

NOTIFIABLE DISEASE: – YES for the following diagnoses:

- chlamydial genital infection
- gonorrhoea
- syphilis
- HIV

Who should notify	When to notify	How to notify	Notification time line
Medical practitioners (only for syphilis)	On clinical suspicion	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Within 72 hours
Laboratories (all four infections)	Upon laboratory confirmation		

CAUSATIVE AGENT

The important agents of sexually-transmitted infections (STIs) in Singapore are:

- *Chlamydia trachomatis* (infection of the urethra, cervix, pharynx and rectum)
- *Neisseria gonorrhoeae* (infection of the urethra, cervix, pharynx and rectum)
- *Treponema pallidum* (syphilis)
- Human papilloma virus (HPV) (anogenital warts)
- Herpes simplex virus types 1 and 2 (anogenital herpes)
- *Trichomonas vaginalis* (infection of the urethra and vagina)
- *Mycoplasma genitalium* (emerging)
- HIV (this is discussed in a separate chapter)

INCUBATION PERIOD

See Table.

INFECTIOUS PERIOD

See Table.

TRANSMISSION

STIs are infections caused by different pathogens which spread from person-to-person primarily through sexual contact.

CLINICAL FEATURES

Many STIs may be asymptomatic and can be detected only if the appropriate laboratory screening tests are performed.

STI may present with:

- Genital discharge (gonorrhoea, trichomoniasis, chlamydial or mycoplasma infections)
- Anogenital ulcers/ vesicles or erosions (herpes, syphilis)
- Anogenital growths (warts, molluscum contagiosum)
- Rashes (syphilis, scabies)
- Pelvic inflammatory disease (gonorrhoea, chlamydial infection)
- Epididymo-orchitis (gonorrhoea, chlamydial infection).

Genital discharge due to gonorrhoea presents is purulent and often associated with dysuria in males, with a history of recent unprotected sexual intercourse, while non-gonococcal urethritis (NGU) usually presents with mucopurulent or whitish discharge from urethra associated with dysuria or urethral discomfort/itch in males and a history of recent unprotected sexual intercourse.

Infectious syphilis manifests as primary chancre which is usually solitary, indurated, non-tender (but the ulcer may also be atypical), with inguinal lymphadenopathy; or presents with clinical features of secondary syphilis e.g. rash especially on palms and soles, ano-genital patches and growths, generalized lymphadenopathy, and patchy hair loss.

Non-infectious syphilis is characterised by the presence of clinical features of tertiary syphilis (viz. cardiovascular syphilis, central nervous system syphilis), while congenital syphilis presents with clinical features of active disease (e.g. muco-cutaneous signs, bone changes, hepatosplenomegaly).

MICROBIOLOGY INVESTIGATIONS

Disease	Specimen Types	Tests
Chlamydial infection	Pharyngeal specimen Urine	Nucleic acid amplification test (NAAT)
	Ano-genital specimen	Nucleic acid amplification test (NAAT) Antigen detection (e.g. EIA, IF)
Gonorrhoea	Genital discharge	Gram-stained smear Culture on selective media for <i>N. gonorrhoeae</i>
	Urine	Nucleic acid amplification test (NAAT)
Anogenital herpes	Vesicular lesions	Nucleic acid amplification test (NAAT) Virus isolation/culture, Direct immunofluorescence (DIF), Serology - Enzyme-linked immunosorbent assay (EIA) or type-specific serological test against glycoprotein gG1 (HSV-1) & gG2 (HSV-2)
Infectious syphilis	Exudate from primary or secondary anogenital lesions	Dark-field microscopic examination for spirochaetes
Infectious/ congenital syphilis	Blood	Reactive blood tests for syphilis: <ul style="list-style-type: none"> • Non-specific treponemal tests (RPR/VDRL) • Specific treponemal tests (TPPA/TPHA, LIA, Syphilis EIA, CMIA)
Trichomoniasis	Genital discharge	Direct wet-mount microscopy Culture
Non-gonococcal urethritis	Genital discharge	Gram-stained smear
	Urine	A 2-glass urine test.

Reactive blood tests for syphilis without symptoms indicates non-infectious syphilis. Patients with treated syphilis may have persistent reactive serology, an indication of a serological scar.

Congenital syphilis is confirmed by reactive blood tests syphilis in infants symptomatic with active disease.

Asymptomatic infection in infant born to infected mother is diagnosed with:

- Detectable LIA IgM in infant; or
- RPR/VDRL titre in infant fourfold or greater than in mother; or
- RPR/VDRL titres show serial rise; or
- Reactive CSF-VDRL or abnormal CSF FEME in infant.

Serology is not useful:

- for first episode infection of anogenital herpes as it takes between 6 and 8 weeks for serological detection following a first episode;
- for chlamydial infection as it does not distinguish between past or current infection; there is also cross-reactivity with other *Chlamydia* species;
- for gonorrhoea due to lack of sensitivity and specificity; and
- for trichomoniasis.

MANAGEMENT OF PATIENTS

All patients with an STI should be screened for syphilis, hepatitis B/C and HIV infection. Patients should receive recommended antimicrobials. Test-of-cure is important to assess for treatment efficacy, particularly for gonorrhoea and syphilis. Patients are encouraged to seek early treatment, not to self-medicate and to complete all prescribed medications. Self-medication with antibiotics may result in the emergence of drug-resistant strains. See Table.

MANAGEMENT OF CONTACTS

Partner management/contact tracing should be conducted to diagnose and treat infections in sex partners, to prevent complications and further transmission.

PRECAUTIONS, PREVENTION AND CONTROL

Patients with STI should be educated on safer sex (e.g. correct and consistent condom use) to prevent future infections. Partner management/contact tracing should be conducted to diagnose and treat infections in sex partners, to prevent complications and further transmission. Medical practitioners should not dispense antibiotic chemoprophylaxis as there is no one universally effective antibiotic. This may also result in a false sense of security and may be dangerous. Pre-exposure prophylaxis

(PrEP) is available for HIV prevention, but requires counselling and follow up by a specialist familiar with PrEP (see chapter on HIV).

Pregnant women should be routinely screened for chlamydia, syphilis, hepatitis B and HIV infection. Hepatitis B vaccination is recommended for all who are negative for HBV markers. HPV vaccination is recommended (preferably before the onset of sexual activity) for females age 9-26 years to reduce the risk of cervical cancer, and has been included in both the National Adult Immunisation Schedule and the National Childhood Immunisation Schedule. Since April 2019, opt-in HPV vaccination (with Cervarix) has been offered to Secondary 1 (13-year-old) females for free. Cervarix however does not offer protection for anogenital warts, but other vaccines (Gardasil 4 and Gardasil 9) do. Males can also get vaccinated, although HPV vaccine for males is not included under the NCIS or subsidised.

Brothel-based sex workers are provided with STI/HIV educational information and taught negotiation skills to achieve 100% condom use. They are screened routinely for syphilis, gonorrhoea, chlamydia, HIV and hepatitis B infections. Targeted STI/HIV education for at-risk groups e.g. youth, MSM, military personnel, and clients of sex workers should be conducted regularly.

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EPIDEMIOLOGICAL FEATURES AND MANAGEMENT OF COMMON STIs

STI	Incubation Period	Infectious Period	Management
Chlamydial infections	5-14 days	During active infection, whether symptomatic or asymptomatic.	<ul style="list-style-type: none"> ● Doxycycline 100mg bid x 7days (avoid if pregnant) ● Erythromycin ethylsuccinate 800 mg qid x 7days ● Azithromycin 1gm x 1 dose (useful if adherence is an anticipated problem)
Gonorrhoea	3-5 days	During active infection, whether symptomatic or asymptomatic.	<p>Antibiotics. Fluoroquinolones are not recommended due to high prevalence of resistance in <i>N. gonorrhoeae</i>.</p> <p>Repeat smears and cultures should be performed on or around the 14th post-treatment day</p> <p>All patients with gonorrhoea should be given concurrent treatment for Chlamydia.</p> <ul style="list-style-type: none"> ● For those with penicillin allergy, IM spectinomycin can be used. Or consider allergy testing and desensitization. Specialist consultation recommended. ● Uncomplicated (pharynx/ urethra/ rectum/ cervix): IM Ceftriaxone 500mg x 1 dose AND Azithromycin 1g stat ● Severe or Disseminated Gonococcal Infections (DGI): IV Ceftriaxone 1-2g daily. Duration depending on site of infection and response, AND Azithromycin 1g stat.
Anogenital herpes	2-14 days	When there is presence of vesicles and erosions. Asymptomatic viral shedding is also an important route of transmission.	Cases of first-episode genital herpes should be treated with acyclovir or related medications.

STI	Incubation Period	Infectious Period	Management
Anogenital warts	1-6 months (mean 3 months)	More infectious with presence of active lesions. Subclinical infections are common.	Anogenital warts can be treated medically or surgically. Patients should be followed up till all visible warts are cleared.
Syphilis	10-90 days (mean 21 days)	During primary and secondary stages.	<p>In primary and secondary syphilis, antibiotic (intramuscular benzathine penicillin) therapy is given.</p> <ul style="list-style-type: none"> ● IM Benzathine Penicillin G 2.4 million units x 1 dose. (Some authorities use 2 doses for secondary syphilis); or ● IM Aqueous Procaine Penicillin G 600,000 units daily x 10 days (neurosyphilis) ● For penicillin allergic patients, consider Doxycycline 100mg bid x 14 days; or Azithromycin 500mg daily x 10 days <p>Patients should have serological tests repeated at 3 months, and then every 6 months for 2 years.</p> <p>Suspected cases of neurosyphilis should have a lumbar puncture performed.</p> <p>For late latent syphilis, syphilis of unknown duration, congenital syphilis, neurosyphilis or syphilis in pregnancy, the treatment recommendations are different and relevant expert advice should be sought.</p>
Trichomoniasis	5-28 days	During active infection, whether symptomatic or asymptomatic.	Antibiotics (metronidazole).

SHIGELLOSIS (BACILLARY DYSENTERY)

NOTIFIABLE DISEASE: NO

CAUSATIVE AGENT

Shigella strains - *S. dysenteriae*, *S. flexneri*, *S. boydii* and *S. sonnei*.

INCUBATION PERIOD

Typically, 1-3 days; up to 1 week for *S. dysenteriae*.

INFECTIOUS PERIOD

Throughout duration of acute illness and until the organism is no longer present in the stool, usually within 4 weeks after illness. Rarely, an asymptomatic carrier state may persist for months. Appropriate antimicrobial treatment reduces duration of carriage to a few days.

TRANSMISSION

Person-to-person, mainly via the faecal-oral route. This may be direct, such as from a symptomatic person or asymptomatic carrier, or indirect, such as via faecally-contaminated water, milk or food, or by houseflies (which can act as a mechanical vector that transfers organisms from human faeces to uncovered food). Transmission through sexual contact, especially among men who have sex with men, has been documented.

EPIDEMIOLOGY

Shigellosis is a major cause of diarrhoeal disease and outbreaks are more likely to occur in overcrowded settings with poor hygiene conditions. The disease is an important cause of fatality in children <5 years of age. Breastfeeding is protective. *S. dysenteriae* serotype 1 (Sd1) is responsible for epidemics and for the most severe clinical illness of *Shigella* species. The severity of symptoms is related to its production of Shiga toxin, a neurotoxin and enterotoxin that is associated with haemolytic uremic syndrome.

Rarely, other species have been associated with Shiga toxin production. All *Shigella* spp. secrete enterotoxins responsible for the watery diarrhoea.

CLINICAL FEATURES

Shigella causes a spectrum of illness from watery diarrhoea to classical dysentery. The spectrum of disease severity varies according to the host's immunity and serogroup of the infecting organism. *S. sonnei* commonly causes mild disease, which may be limited to watery diarrhoea, while *S. dysenteriae* or *S. flexneri* commonly causes dysenteric symptoms. In a normal healthy host, the course of disease is generally self-limited, lasting no more than seven days when left untreated.

Diarrhoea is of sudden onset, with voluminous watery stool (small intestine phase) and subsequent presence of blood and mucus (colonic phase). Fluid depletion is uncommon. Other symptoms include fever, nausea, vomiting, abdominal cramps, and tenesmus (common). Complications, usually associated with Sd1 serotype, are toxic megacolon, intestinal perforation, seizures (particularly in young children), reactive arthritis, and haemolytic uraemic syndrome.

MICROBIOLOGY INVESTIGATIONS

Culture is the gold standard for the detection of *Shigella* species and is required to perform antimicrobial susceptibility testing.

Specimen Type	Tests
Stool	Stool culture for <i>Salmonella</i> , <i>Shigella</i> and <i>Campylobacter</i>

MANAGEMENT OF PATIENTS

Mild infections are usually self-limiting and most patients recover without antibiotic treatment. However, if stool cultures are positive for *Shigella*, patients should be treated as antibiotics shorten the duration of fever, diarrhoea and shedding of *Shigella* in stool. Anti-diarrhoeal agents can make the illness worse and should be avoided. Infected food handlers should refrain from food preparation until their stool cultures are no longer positive.

MANAGEMENT OF CONTACTS

No specific management, but hygiene practices should be reinforced.

PRECAUTIONS, PREVENTION AND CONTROL

Standard and contact precautions (if active diarrhoea) apply in the healthcare setting.

There is no available vaccine. Preventive measures include good hand hygiene and proper food handling practices. In addition, sexual activity with those who have diarrhoea or who recently (several weeks) recovered from shigellosis should be avoided.

When an outbreak of foodborne illness is suspected, the aim of investigations is to identify the source and contain/control the outbreak. Epidemiological investigations will be conducted to obtain information on food history, onset of illness and symptoms. Microbiological (e.g. stool samples from cases, food samples) and environmental investigations (e.g. food preparation practices, environmental sanitation) are also conducted. Implicated food handlers will be referred to the designated referral laboratory for stool cultures.

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SMALLPOX

NOTIFIABLE DISEASE: NO

Although smallpox is not on the list of notifiable diseases under the Infectious Diseases Act, it is recommended that all suspected or confirmed cases are to be reported to MOH as soon as possible.

Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Call MOH Surveillance Duty Officer and submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Immediately
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Variola virus, a species of *Orthopoxvirus*.

INCUBATION PERIOD

Typically, 10-14 days; range is 7 to 19 days.

INFECTIOUS PERIOD

From fever onset (usually 2-4 days before rash) until last scab has separated, with duration of about 3 weeks.

TRANSMISSION

Transmission occurs via droplet spread from respiratory tract and contact with skin lesions or contaminated articles.

EPIDEMIOLOGY

Smallpox was previously endemic worldwide. The last naturally acquired human case in the world occurred in Somalia in 1977. Global eradication was certified by the WHO two years later, and a declaration of smallpox eradication in 1980 led to discontinuation of the worldwide vaccination campaign.

There are at least 2 strains, variola major and the variola minor. Variola major is the more severe form with CFR of 20-50% (average 30%) in susceptible populations. Variola minor is the milder form of the disease with more diminutive pox lesions, with CFR of <1% in susceptible populations.

CLINICAL FEATURES

The characteristic rash appears 2-4 days after a non-specific flu-like prodrome (fever and headache). A maculopapular rash begins on mucosa of mouth and pharynx, face, hands, forearms and spreads to legs and centrally to trunk. Lesions are more predominant on the face and extremities than on the trunk (centrifugal). Lesions progress synchronously on any given part of the body from macules to papules to vesicles to pustules and to crusty scabs. There were two rare forms of smallpox (haemorrhagic and flat type) that were invariably fatal.

Differential diagnosis for smallpox includes chickenpox, monkeypox and disseminated herpes zoster. Features that distinguish smallpox from chickenpox include:

1. smallpox lesions are synchronous in their stage of development
2. smallpox lesions appear more on the face and extremities than trunk (centrifugal spread)
3. smallpox lesions are more common on palms and soles
4. lesions are more deeply imbedded in the dermis compared with the superficial lesions of chickenpox.

MICROBIOLOGY INVESTIGATIONS

Notify laboratory when smallpox is suspected. Contact MOH and NPHL for further identification and confirmation of the pathogen.

Specimen Type	Tests
Vesicle fluid	PCR

MANAGEMENT OF PATIENTS

Management is supportive care.

MANAGEMENT OF CONTACTS

Vaccination should be offered. Vaccination within 3 days of exposure may significantly ameliorate or prevent smallpox. Vaccination 4-7 days after exposure likely still offers some protection or modification of disease severity.

PRECAUTIONS, PREVENTION AND CONTROL

Suspected/confirmed cases will be managed at NCID. Patients will need to be isolated in a negative pressure isolation room with standard, contact and airborne precautions applied. Patients are considered infectious until all scabs separate and should be isolated during this period.

All persons in direct contact with the index case should be quarantined and placed under droplet and airborne precaution for a minimum of 17 days following exposure.

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TETANUS

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Within 72 hours

CAUSATIVE AGENT

Clostridium tetani

INCUBATION PERIOD

Typically, 3-21 days; range is 1 day to several months.

INFECTIOUS PERIOD

There is no person-to-person transmission.

TRANSMISSION

Transmission occurs when spores of *C. tetani*, which may be found in the gut of mammals and the environment (soil, dust or manure), enter the body through breaks in the skin, usually cuts or puncture wounds caused by contaminated objects.

EPIDEMIOLOGY

C. tetani spores are ubiquitous in the soil. They are also found in the gut of some livestock and pets. Infection occurs worldwide and is more common in agricultural areas where there is likely to be more contact with animal faeces. It is relatively rare in Singapore and developed countries where immunisation programmes are well established.

CLINICAL FEATURES

An exotoxin produced by *C. tetani* at the site of an injury affects the motor system and less commonly, the autonomic and sensory system. It causes hyperactivity of voluntary muscles in the form of rigidity and spasms, autonomic dysfunction (irritability, restlessness, sweating, tachycardia, labile blood pressure) and altered sensation (pain and allodynia). Patients do not have impairment of consciousness or awareness. There are 4 distinct clinical patterns:

1. **Generalised tetanus:** the most common and severe form of tetanus affecting muscles of the whole body. The classical findings are
 - Risus sardonius (sardonic smile as a result of sustained spasm of facial muscles)
 - Opisthotonus (the backward arching of the column due to rigidity of the extensor muscles of the neck and back)
 - Board like rigid abdomen which may mimic an acute abdomen
 - Respiratory failure and dysphagia due to rigidity and spasms of the laryngeal and respiratory muscles
 - Positive spatula test – a clinical test that involves touching the posterior pharyngeal wall with a soft tipped instrument. A positive result is the reflex spasm of masseters causing a “bite down” action versus a negative result of a gag reflex (with attempted expulsion of the instrument).
2. **Local tetanus:** only affecting one extremity or body region but may progress to generalised tetanus.
3. **Cephalic tetanus:** a localised form of tetanus only involving cranial nerves e.g. dysphagia, trismus, focal craniopathies. The facial nerve is most commonly affected.
4. **Neonatal tetanus:** Generalised form of tetanus occurring in children aged <1 month old. This most commonly occurs 5-7 days following birth, often as a result of non-sterile handling of the neonatal umbilical stump. Features are similar to those of generalised tetanus, but the disease progresses more rapidly than in older individuals.

MICROBIOLOGY INVESTIGATIONS

The diagnosis of tetanus is made based on history, clinical findings and immunisation history. Laboratory tests are generally not helpful in diagnosis of tetanus.

MANAGEMENT OF PATIENTS

There should be adequate wound cleaning and debridement of any inoculating injury. Human tetanus immune globulin (HTIG) should be given to neutralise unbound toxin, with part of dose infiltrated into wound. All patients with active tetanus should be vaccinated (tetanus toxoid should be administered at a different site from HTIG). Antibiotics are universally recommended. Metronidazole is the most appropriate antibiotic. Supportive measures are provided, including medications for control of muscle spasms (e.g. benzodiazepines), autonomic lability (e.g. magnesium sulphate) and endotracheal intubation for airway support.

MANAGEMENT OF CONTACTS

No specific management of contacts is required.

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions apply in the healthcare setting.

Post-Exposure Prophylaxis: If a person sustains a tetanus-prone wound and has unknown vaccination status or has not completed the primary vaccination series, they should receive HTIG up to 21 days following the injury. Tetanus toxoid vaccination should be given at the same time but at a different site from HTIG. Refer to the table below.

Tetanus post-exposure prophylaxis recommendation in adults

Tetanus vaccination status	Clean, minor wound	Tetanus-prone wound*
<ul style="list-style-type: none"><3 tetanus doses or unknown	<ul style="list-style-type: none">Tetanus toxoid only	<ul style="list-style-type: none">Tetanus toxoid and TIG
<ul style="list-style-type: none">3 or more tetanus doses, ≥ 10 years since last dose	<ul style="list-style-type: none">Tetanus toxoid only	<ul style="list-style-type: none">Tetanus toxoidTIG if contaminated by manure, with extensively devitalised tissue, or patient is immunocompromised
<ul style="list-style-type: none">3 or more tetanus doses, <10 years since last dose	<ul style="list-style-type: none">No toxoid or TIG	<ul style="list-style-type: none">Tetanus toxoidTIG if contaminated by manure, with extensively devitalised tissue, or patient is immunocompromised

TIG -tetanus immunoglobulin

* contaminated with dirt, faeces, soil and saliva, puncture wounds, avulsions, and wounds resulting from missiles, crushing, burns, and frostbite

Vaccination remains the main preventive measure (see Public Health Resources section). Tetanus vaccination is part of both the National Childhood Immunisation Schedule (DTaP at 2 months, 4 months, 6 months and 18 months, and Tdap booster at 10-11 years). The National Adult Immunisation Schedule recommends vaccination for pregnant women (a dose of Tdap between 16 and 32 weeks of every pregnancy). Adults should receive a Td booster every 10 years.

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TUBERCULOSIS

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion or upon laboratory confirmation	Submit MD532 Notification of Tuberculosis Form via CDLENS (http://www.cdlenz.moh.gov.sg) or fax (6221 5528/38/67)	Within 72 hours

CAUSATIVE AGENT

Mycobacterium tuberculosis complex (most commonly *M. tuberculosis*, rarely *M. bovis* or *M. africanum*).

INCUBATION PERIOD

Weeks to years.

Persons with latent tuberculosis infection (LTBI) are asymptomatic and have no clinical manifestation of active tuberculosis (TB). Approximately 10% of immunocompetent adults with LTBI will progress to active TB, and half of them do so in the first 2 to 3 years following infection. In immunocompromised patients (e.g. HIV infection, transplant patients, diabetes mellitus) and very young children, the risk for developing active TB is even higher.

INFECTIOUS PERIOD

Considered infectious when sputum is bacteriologically positive and the patient is untreated. Can be considered non-infectious after two weeks of effective therapy for drug-susceptible pulmonary TB. Multi-drug resistant TB (MDR-TB), i.e. TB resistant to rifampicin and isoniazid, the two key first-line anti-TB drugs, may require a longer period of effective therapy before cases become non-infectious.

Non-pulmonary tuberculosis (except for laryngeal TB) is not infectious.

TRANSMISSION

Airborne transmission. Rarely through ingestion of unpasteurised milk (*M. bovis*).

EPIDEMIOLOGY

TB is a major cause of death and disability in many parts of the world, especially in developing countries.

The National TB Programme was established in the late 1950s with the setting up of the TB Control Unit (TBCU) and a National TB registry. The programme was enhanced with the launch of the Singapore TB Elimination Programme (STEP) IN 1997. The main aim of STEP is to eliminate TB in Singapore by detection, diagnosing and treating all infectious TB cases, identifying and treating TB contacts, and preventing the emergence of multidrug-resistance TB (MDR-TB).

CLINICAL FEATURES

Clinical presentation depends on the site of TB.

1. **Pulmonary TB:** Common symptoms are prolonged cough (>3 weeks), chest pain and haemoptysis. Patients with miliary TB may have minimal respiratory symptoms and present with systemic complaints. Patients may also be asymptomatic and present with incidental chest X-ray abnormalities.
2. **Extra-pulmonary TB:** Lymphadenitis (especially cervical), pleural effusion, osteomyelitis, meningitis or gastrointestinal involvement.

Patients may have systemic symptoms, which include fever, night sweats, loss of appetite, loss of weight and fatigue. Risk factors for HIV and examination for signs of advanced HIV (e.g. oral candidiasis) should be sought.

MICROBIOLOGY INVESTIGATIONS

All persons with CXR findings suggestive of tuberculosis should have sputum specimens submitted for microbiological examination.

All patients suspected of having pulmonary tuberculosis should have at least 2, preferably 3, sputum specimens obtained for microscopic examination, molecular testing and tuberculosis culture (with drug susceptibility testing), with at least 1 early morning specimen where possible.

Patients with newly diagnosed active TB should be screened for HIV and diabetes mellitus.

Disease	Specimen Types	Tests
Pulmonary TB	Respiratory samples – e.g. sputum, bronchoalveolar lavage, Gastric lavage, Pleural fluid	Nucleic acid amplification tests, e.g. Xpert MTB/ RIF assay
Extra-pulmonary (central nervous system, lymphatic system, gastrointestinal tract, urogenital tract)	CSF, Biopsy tissue/ fluid from site of disease	AFB smear and culture Nucleic acid amplification tests, e.g. Xpert MTB/ RIF assay Histology and AFB staining and culture
Latent tuberculosis infection	Blood specimens for Interferon Gamma Release Assay (IGRA) Skin test	IGRA (T-Spot.TB® or QuantiFERON-TB Gold Plus®) Mantoux test

MANAGEMENT OF PATIENTS

Any physician treating a patient for tuberculosis is assuming an important public health responsibility; s/he must not only prescribe an appropriate regimen but also be capable of assessing adherence of the patient to the regimen, and addressing poor adherence when it occurs.

Uncomplicated, drug-susceptible pulmonary TB is treated with 4 drugs (rifampicin, isoniazid, pyrazinamide and ethambutol) in the intensive phase of 2 months, followed by rifampicin and isoniazid in the continuation phase of four months. It is recommended that the treatment duration be extended by three months in persons with cavitory disease and whose sputum cultures remain positive at two months of treatment.

Patients with TB at certain sites (e.g. meningitis and skeletal TB) would require a longer course of treatment. Persons with MDR-TB require to be treated with multiple second-line drugs for 18-20 months.

The treating physician should be alert to the tuberculosis culture and drug susceptibility results which may take several weeks to be available. There should be an index of suspicion for the possibility of drug-resistant tuberculosis in patients who were

previously treated, who fail treatment, who are known contacts of MDR-TB cases, or who come from countries with high prevalence of tuberculosis drug resistance.

Non-adherence because of adverse reactions and prolonged therapy is a major problem, and can lead to treatment failure and acquired drug resistance. Directly Observed Therapy (DOT) is recommended for all pulmonary TB patients as it allows for closer monitoring and better treatment adherence. DOT is available at the TBCU and polyclinics.

All patients should be issued with medical leave for at least two weeks, after which they may be considered non-infectious. Follow-up appointments should be at no longer than monthly intervals for patients on tuberculosis treatment. Patients should be asked about clinical response to treatment, adherence to therapy and any adverse drug effects, particularly hepatitis.

Response to treatment is best monitored bacteriologically with repeat sputum examination at the very least at 2 months (end of intensive phase) and at the end of treatment.

A record of all medications given, bacteriological response, and adverse reactions should be maintained for all patients.

Sputum smear-positive cases, relapsed cases, those with risk factors for drug-resistant tuberculosis and those with drug-resistant TB should be referred to the TBCU. Non-compliance to TB treatment should be detected promptly, and these cases should be referred to TBCU.

MANAGEMENT OF CONTACTS

Close contacts of infectious (i.e. sputum bacteriologically positive) TB cases should be screened for LTBI and evaluated for possible active TB at the TBCU Contact Clinic. Contacts found to have LTBI should be offered preventive treatment with rifampicin for 4 months or isoniazid for 6 or 9 months. Before initiation of preventive treatment, it is imperative to rule out active TB by patient history, physical examination and chest X-ray.

PRECAUTIONS, PREVENTION AND CONTROL

In hospitals, smear-positive patients with pulmonary and laryngeal TB should be isolated for at least 2 weeks after initiation of appropriate drug therapy. Standard and airborne precautions should be applied.

BCG vaccination is given at birth to reduce the incidence of miliary tuberculosis and tuberculous meningitis in childhood. See vaccination programme implementation under Public Health Resources section.

According to WHO guidelines, people with infectious or potentially infectious TB should not travel by commercial air transportation on a flight of any duration, until there is no longer a risk of transmitting infection to others.

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Field investigations and community case finding, Kampung Glam

TULAREMIA

NOTIFIABLE DISEASE: NO

Although tularemia is not on the list of notifiable diseases under the Infectious Diseases Act, it is recommended that all suspected or confirmed cases be reported to MOH as soon as possible.

Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Call MOH Surveillance Duty Officer and submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Immediately
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Francisella tularensis - subspecies *tularensis*, *holarctica*, *philomiragia*, *hispaniensis* and *novicida*.

INCUBATION PERIOD

Typically, 3-5 days; range is 1 to 14 days.

INFECTIOUS PERIOD

No human-to-human transmission.

TRANSMISSION

Humans can become incidentally infected through diverse routes of exposures: bites of infective arthropods (primarily ticks and mosquitoes), handling infectious animal tissue or fluids, ingestion of contaminated water, or inadequately cooked meat of infected animals, and inhalation of dust from contaminated soil. Laboratory infections occur through accidental inoculation or by inhaling aerosolised organisms.

One of the most infectious pathogenic bacteria known, inoculation or inhalation of as few as 10 organisms may cause disease. The primary public health concern is intentional infection through the inhalational route after aerosol dissemination of bacteria (bioterrorism).

EPIDEMIOLOGY

The disease occurs naturally predominantly in the northern hemisphere. *F. tularensis* is found in widely diverse animal hosts and habitats and can be recovered from contaminated water, soil, and vegetation. A variety of small mammals such as mice, rabbits and squirrels are natural reservoirs of infection. Tularemia is almost entirely a rural disease, though exposure in urban or suburban settings does occur. Certain activities, such as hunting and farming are associated with transmission risk. Tularemia is not endemic locally and bioterrorism should be suspected if this disease is diagnosed in Singapore in persons without a relevant travel history.

CLINICAL FEATURES

Clinical forms vary in presentation and severity depending on virulence of the infecting organism, dose and site of inoculation. The main forms of disease are:

1. **Pneumonia:** Pleuropneumonitis with hilar lymphadenitis (through airborne or haematogenous routes). Occurs more often in the elderly and has a higher mortality rate. Radiographic features of tularemic pneumonia include patchy unilateral or bilateral infiltrates, lobar or segmental opacities, hilar adenopathy, pleural effusions, cavitory lesions and occasionally a miliary pattern.
2. **Ulceroglandular (60-80%):** Patients typically present with fever and a single erythematous papuloulcerative lesion with a central eschar accompanied by tender regional lymphadenopathy. Patients usually report recent handling of an animal, an animal bite (especially cat bites), or exposure to potential vectors, particularly ticks.
3. **Oculoglandular (1-2%):** Chemosis/conjunctivitis with regional lymphadenitis (through inoculation of conjunctiva).
4. **Oropharyngeal (1-4%):** Exudative pharyngitis/tonsillitis with cervical adenitis (through inoculation of oropharyngeal mucosa). Diagnosis should be considered in patients with pharyngitis unresponsive to penicillin.
5. **Glandular (3-15%):** Enlargement of a single or multiple lymph nodes without an identifiable skin lesion.
6. **Typhoidal:** Typhoidal tularemia with or without pneumonia is an uncommon presentation. Characterised by systemic illness with non-localising fever.

Onset of illness is usually abrupt, with fever (38-40°C), headache, chills, coryza and sore throat. Pulse-temperature dissociation has been noted in as many as 42% of patients. A dry or slightly productive cough and substernal pain or tightness frequently occur with or without objective signs of pneumonia. Nausea, vomiting, and diarrhoea sometimes occur. Sweats, fever and chills, progressive weakness, malaise, anorexia, and weight loss characterise the continuing illness. Any form of tularemia may be

complicated by hematogenous spread, resulting in secondary pleuro-pneumonia, sepsis and rarely, meningitis.

MICROBIOLOGY INVESTIGATIONS

Notify the laboratory when tularemia is suspected before submitting specimens.

Specimen Type	Tests
Respiratory specimens Wound tissue/fluids Blood	Bacterial culture
Paired sera	Serology

Note for laboratories: *F. tularensis* is a biothreat organism and also a WHO Risk Group (RG) 3 organism. Laboratories should take additional precautions and perform all testing in a biosafety cabinet. Please contact MOH and NPHL to arrange further testing by serology.

MANAGEMENT OF PATIENTS

Streptomycin or gentamicin for severe illness; doxycycline or ciprofloxacin for mild or moderate disease. A common complication is persistent lymphadenopathy with suppuration which may require drainage.

MANAGEMENT OF CONTACTS

No specific management of contacts is required. No quarantine of contacts is required.

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions in the healthcare setting. Respiratory isolation is not necessary given the lack of human-to-human transmission. Bodies of patients who die of tularemia should be handled using standard precautions. Autopsy procedures likely to produce aerosols or droplets should be avoided.

There is no available vaccine. Post-exposure prophylaxis with antibiotics (doxycycline or ciprofloxacin) for high risk persons (e.g. laboratory workers) is indicated. In those with lower-risk exposures, watchful waiting for symptoms is appropriate.

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TYPHOID AND PARATYPHOID FEVER (ENTERIC FEVERS)

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Laboratories	Upon laboratory confirmation	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Within 24 hours

CAUSATIVE AGENT

Typhoid fever: *Salmonella* serotype Typhi.

Paratyphoid fever: *Salmonella* serotype Paratyphi A, B and C.

INCUBATION PERIOD

Typhoid fever: Typically, 8-14 days; range is 3 to 60 days.

Paratyphoid fever: 1-10 days

INFECTIOUS PERIOD

During acute infection, until stool and urine clearance.

TRANSMISSION

Occurs through faecal-oral route via contaminated food or water. Transmission through sexual contact, especially among men who have sex with men, has been documented.

EPIDEMIOLOGY

Occurs worldwide and is more prevalent in developing countries. Cases occurring in Singapore are usually associated with travel to areas where these diseases are endemic. Majority of these cases were imported from South Asia and Southeast Asia.

CLINICAL FEATURES

The enteric fevers are systemic bacterial diseases characterised by an insidious onset of fever, headache and malaise. Typhoid fever classically begins with a “stepwise” fever (that rises over the course of the day before dropping in the subsequent morning) in the first week of illness. Diarrhoea (about 80% of children) or constipation (more frequent in adults) may also feature. Subsequently in the second week, abdominal pain and “rose spots” (salmon-coloured blanching truncal maculopapules) develop. In the third week, abdominal discomfort worsens and patient becomes more toxic.

Other features that have been noted include relative bradycardia, splenomegaly and a non-productive cough in the early stage of illness. Complications, which are rare if diagnosed and treated early, include intestinal bleeding and perforation, confusion, seizures and encephalitis. Paratyphoid fever presents with a clinically milder disease compared to typhoid fever.

MICROBIOLOGY INVESTIGATIONS

Blood culture usually positive for the first two weeks only. Stool and urine culture are positive from the 2nd to 4th weeks. Bone marrow culture may be considered as it is usually positive even after antibiotics have been initiated.

Disease	Specimen Types	Tests
First 2 weeks from onset of symptoms	Blood	Culture
2nd to 4th week from onset of symptoms	Stool Urine	Culture

The Widal test is unreliable in itself, but may provide additional support for the diagnosis when the clinical picture is suggestive.

MANAGEMENT OF PATIENTS

Appropriate antibiotics should be started. Patients with severe typhoid fever should be hospitalised. Dexamethasone for severe typhoid fever with neurological manifestations (delirium and altered mental status) may decrease mortality.

Current antibiotics of choice (depending on antimicrobial susceptibility) in adults:

- IV Ceftriaxone 50-100mg/kg body weight (up to 2g BD) for 10-14 days.
- PO Ciprofloxacin 500mg BD for 7-10 days (if sensitive to ciprofloxacin and nalidixic acid).
- Alternative: PO Azithromycin 1g once, then 500mg once daily for 5-7 days.

Note: 70-90 % of isolates in some parts of Nepal, India and Vietnam are nalidixic acid resistant strains.

Current antibiotics of choice (depending on antimicrobial susceptibility) in children:

- IV Ceftriaxone 75 mg/kg body weight (up to 2g) once daily for 10-14 days.
- PO Azithromycin 10 mg/kg body weight (up to 500mg) once daily for 5-7 days.
- Alternative: PO Ciprofloxacin 10mg/kg body weight (up to 500mg) BD for 7-10 days (if sensitive to ciprofloxacin and nalidixic acid).

After successful treatment, patients should be followed up for relapse, chronic carriage or complications. Relapse rate is 1-6% for fluoroquinolones, ceftriaxone or azithromycin. Chronic carriers (positive stool samples after 6 months) may be treated with a prolonged course of antibiotics. Abdominal ultrasound should be performed and cholecystectomy may be necessary if gallstones are present and prolonged antibiotic treatment fails.

MANAGEMENT OF CONTACTS

No specific management of contacts is generally required.

PRECAUTIONS, PREVENTION AND CONTROL

Standard and contact precautions (if active diarrhoea) apply in the healthcare setting.

When an outbreak of foodborne illness is suspected, the aim of investigations is to identify the source and contain/control the outbreak. Epidemiological investigations will be conducted to obtain information on food history, onset of illness and symptoms. Microbiological (e.g. stool samples from cases, food samples) and environmental investigations (e.g. food preparation practices, environmental sanitation) are also conducted. Implicated food handlers will be referred to the designated referral laboratory for stool cultures.

Vaccination is not routinely given but should be considered for travellers to high risk endemic areas.

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TYPHUS

I. FLEA-BORNE TYPHUS FEVER (MURINE TYPHUS)

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Laboratories	Upon laboratory confirmation	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Within 24 hours

CAUSATIVE AGENT

Rickettsia typhi, *Rickettsia felis*

INCUBATION PERIOD

Typically, 12 days; range is 1-2 weeks.

INFECTIOUS PERIOD

There is no person-to-person transmission.

TRANSMISSION

Transmitted via flea bites. Infective fleas defecate rickettsiae while taking a blood meal, which contaminates the bite site and other fresh skin wounds.

EPIDEMIOLOGY

This is a zoonotic disease that occurs worldwide. Rats and mice serve as hosts for infected fleas. Majority of cases found in areas where there is a rat infestation.

CLINICAL FEATURES

Murine typhus is generally a mild infection. Symptoms include fever, headache and myalgia. Rash occurs in majority of patients although it is usually not present at onset of illness. Other symptoms reported include abdominal pain, nausea and vomiting.

The disease is usually recognised when clinicians correlate the presence of compatible clinical signs, symptoms, and laboratory features, with epidemiologic clues.

MICROBIOLOGY INVESTIGATIONS

Specimen Type	Tests
Serum	Serology (immunofluorescent antibody test) (acute and convalescent samples)

The Weil-Felix test is not recommended due to poor sensitivity and specificity.

MANAGEMENT OF PATIENTS

Antibiotics should be started upon clinical suspicion of murine typhus. Doxycycline remains the drug of choice (100 mg BD for 5-10 days or for ≥ 3 days after defervescence occurs). Fever usually resolves within 72 hours of treatment initiation.

For select groups of patients in whom doxycycline is not suitable, including pregnant women, children, those with allergy/intolerance to doxycycline or doxycycline resistant typhus: PO azithromycin 500mg as a single dose.

MANAGEMENT OF CONTACTS

No specific management of contacts is required.

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions apply in the healthcare setting. Anti-flea and rodent control measures should be implemented.

There is no available vaccine. Preventive measures include impregnating clothes with miticidal chemicals (e.g. permethrin) and application of mite repellent (e.g. containing >20% DEET) on skin.

II. MITE-BORNE TYPHUS FEVER (SCRUB TYPHUS)

NOTIFIABLE DISEASE: NO

CAUSATIVE AGENT

Orientia tsutsugamushi

INCUBATION PERIOD

Typically, 11 days; range is 6-21 days.

INFECTIOUS PERIOD

There is no human-to-human transmission.

TRANSMISSION

Transmitted via the bite of infected larval mites, also known as chiggers.

EPIDEMIOLOGY

Scrub typhus is endemic to the “Tsutsugamushi Triangle” which extends from northern Japan and far-eastern Russia in the north, to northern Australia in the south, and to Pakistan in the west. Occupational exposure to mite habitats in long grass (e.g. among hikers, soldiers) are risk factors.

CLINICAL FEATURES

A characteristic feature is an eschar corresponding to the site of the chigger bite. Not all patients have the eschar. The illness presents with an acute onset of fever, with headache, profuse sweating, conjunctival injection, and lymphadenopathy. Severe infections may be complicated by pneumonitis, acute respiratory distress syndrome, respiratory failure, and confusion. Death may occur as a result of these complications, usually late in the second week of the illness.

The disease is usually recognised when clinicians correlate the presence of compatible clinical signs, symptoms, and laboratory features, with epidemiologic clues.

MICROBIOLOGY INVESTIGATIONS

Specimen Type	Tests
Serum	Serology (immunofluorescent antibody test) (acute and convalescent samples)

The Weil-Felix test is not recommended due to poor sensitivity and specificity.

MANAGEMENT OF PATIENTS

Early treatment should be initiated as soon as the diagnosis is suspected to prevent adverse outcomes. Doxycycline remains the drug of choice. Antibiotic regimen is the same as that for murine typhus.

MANAGEMENT OF CONTACTS

No specific management of contacts is required. However, where there are others who may have shared a similar exposure to the index patient (e.g. hikers, soldiers), they should be monitored for fever and treatment initiated promptly if necessary.

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions apply in the healthcare setting.

Preventive measures include impregnating clothes with miticidal chemicals and application of mite repellent on skin. Travellers to endemic areas should avoid areas with lots of vegetation where chiggers may be found.

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VIRAL HEPATITIS

NOTIFIABLE DISEASE – YES for the following diagnoses:

- A) Acute Hepatitis A
- B) Acute Hepatitis B
- C) Acute Hepatitis C
- D) Acute Hepatitis E

Chronic viral hepatitis does NOT require notification.

Who should notify	When to notify	How to notify	Notification time line
Laboratories	Upon laboratory confirmation	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Within 72 hours

CAUSATIVE AGENT

Hepatovirus (Hepatitis A virus, HAV), *Orthohepadnavirus* (Hepatitis B virus, HBV), *Hepacivirus* (Hepatitis C virus, HCV), *Deltavirus* (hepatitis D virus, HDV) and *Orthohepevirus* (Hepatitis E virus, HEV).

INCUBATION PERIOD

See Table.

INFECTIOUS PERIOD

See Table.

TRANSMISSION

See Table.

EPIDEMIOLOGY

Hepatitis A, B, C and E are endemic in Singapore. Hepatitis A and E are transmitted by consumption of contaminated food and water while Hepatitis B and C are transmitted through blood, blood products, and other body fluids. Incidence of Hepatitis A, B,

C and E remains low in Singapore. Majority of Hepatitis A cases in Singapore are imported and involved the consumption of contaminated food or water in countries where food and water safety standards are not adequate.

CLINICAL FEATURES

Clinical presentation of acute viral hepatitis includes fever, anorexia, nausea, vomiting, right hypochondrial pain, jaundice, pruritus, dark urine, pale stools and hepatomegaly. See Table below for clinical sequelae.

MICROBIOLOGY INVESTIGATIONS

Causal Agent	Specimen Types	Tests for Acute Hepatitis
HAV	Blood	IgM
HBV		HBc IgM, HBs antigen, nucleic acid amplification test (NAAT)
HCV		Total antibody, IgM, NAAT
HEV		IgM, IgG, NAAT

MANAGEMENT OF PATIENTS

There is no specific anti-viral therapy indicated for acute hepatitis A and the role of treatment for acute hepatitis E is not established. Management is symptomatic and supportive.

Treatment of hepatitis B is available for chronic carriers and selected cases of acute hepatitis. Treatment of hepatitis C has been revolutionised since the introduction of directly acting antivirals. All patients should be considered for treatment, but urgency with which to treat chronic hepatitis C infection and which regimen to use is multifactorial.

MANAGEMENT OF CONTACTS

Post-exposure prophylaxis (PEP) (vaccine and/or immunoglobulin) may be indicated in contacts of cases with hepatitis A and B. See also Public Health Resources section for hepatitis B PEP in healthcare workers with percutaneous exposure.

Hepatitis A vaccine may be used for postexposure prophylaxis in healthy persons 12 months through 40 years of age who have been exposed to HAV but are not symptomatic and who have not received hepatitis A vaccine previously. It should ideally be administered within 2 weeks of exposure. Immunoglobulin is preferred for persons older than 40 years of age, children younger than 12 months of age, immunocompromised persons, persons with chronic liver disease, and people who are allergic to a vaccine component or elect not to receive vaccine.

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions apply for all types of hepatitis cases. In addition, contact precautions should be observed for hepatitis A and E if there is active diarrhoea.

Vaccination is available for hepatitis A and B. Travellers to areas where hepatitis A is endemic should be encouraged to receive vaccination. Hepatitis B vaccination is included in both the National Childhood Immunisation Schedule and National Adult Immunisation Schedule, and is routinely given to all neonates, healthcare workers and other population groups at risk. Seronegative contacts of acute hepatitis B cases and carriers should also be vaccinated.

In outbreaks of hepatitis A, attention should be given to contaminated food, especially shellfish. When an outbreak of acute Hepatitis A is suspected, the aim of investigations is to identify the source and contain/control the outbreak. Epidemiological investigations will be conducted to obtain information on food history, onset of illness and symptoms. Microbiological (e.g. stool samples from cases, food samples) and environmental investigations (e.g. food preparation practices, environmental sanitation) are also conducted. Implicated food handlers will be referred to the designated referral laboratory for stool cultures.

Prevention of hepatitis B requires the use of disposable needles and syringes and use of sterile equipment for parenteral injections, acupuncture, tattooing and other procedures where skin is punctured. Observing standard precautions is the cornerstone of prevention in the healthcare setting.

Transfusion hepatitis B and C are prevented by screening of blood donors. Pre-dialysis as well as routine screening for hepatitis B and C should be performed for all patients undergoing dialysis. Pregnant mothers should also be screened for hepatitis B.

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CLINICAL FEATURES OF COMMON VIRAL HEPATITIS

Hepatitis	Incubation Period	Infectious Period	Clinical Sequelae	Transmission Route	Microbiology Investigations	Remarks
A	28 days (range 15- 50 days)	2 weeks before and 7-10 days after onset of jaundice	No chronic sequelae.	Food and water borne, sexual	Blood sample IgM	PEP/ vaccine available
B	90 days (range 45- 180 days)	Up to 2 months before onset of symptoms to months or years after jaundice in chronic carriers	Sequelae of chronic HBV infection includes liver cirrhosis, chronic active hepatitis (CAH), chronic persistent hepatitis (CPH) and hepatocellular carcinoma (HCC) as well as hepatitis D superinfection.	Blood and body fluids, parenteral, perinatal, sexual	Blood sample HBc IgM, HBs antigen, NAAAT	PEP/ vaccine available
C	45 days (range 14 - 180 days)	As in HBV	Sequelae of chronic HCV infection includes HCC, CAH, CPH and liver cirrhosis.	Blood and body fluids, parenteral, perinatal (uncommon), sexual (not well defined)	Blood sample Total antibody, IgM, NAAAT	No PEP/ vaccine available
E	6 weeks (range 2-9 weeks)	As in HAV	No chronic sequelae of HEV in immunocompetent individuals. Higher incidence of fulminant disease than hepatitis A. High mortality in pregnant women. Food and water borne	Food and water borne	Blood sample IgM, IgG, NAAAT	No PEP/ vaccine available

HAV - Hepatitis A virus
HBV - Hepatitis B virus

HCV - Hepatitis C virus
PEP - Post-Exposure Prophylaxis

HEV - Hepatitis E virus

WEST NILE VIRUS INFECTION

NOTIFIABLE DISEASE: NO

Although West Nile Virus infection is not on the list of notifiable diseases under the Infectious Diseases Act, it is recommended that all suspected or confirmed cases are to be reported to MOH as soon as possible.

Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Call MOH Surveillance Duty Officer and submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Immediately
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

West Nile virus, a member of the *Flaviviridae* family.

INCUBATION PERIOD

Typically, 2-6 days; up to 21 days in immunocompromised persons.

INFECTIOUS PERIOD

Not generally considered contagious.

TRANSMISSION

Transmitted by *Culex* mosquito bites. Rare reports of transmission via blood transfusion, organ transplants and from symptomatic mothers via vertical transplacental transmission or breastfeeding to neonates.

EPIDEMIOLOGY

West Nile virus (WNV) is commonly found in Africa, Europe, the Middle East, North America, and West Asia. The natural cycle of the virus involves birds and mosquitoes; infections in humans and other mammals are incidental. The virus, first isolated in a patient from the West Nile district of Uganda in 1937, came to prominence in 1999

when it caused an outbreak in New York, USA. Subsequently, large outbreaks of WNV in Europe and USA have been reported along major routes of migratory birds.

CLINICAL FEATURES

Majority (70-80%) of cases are asymptomatic. In the 20-30% of infected people that have symptoms, the illness can be clinically indistinguishable from other viral syndromes such as dengue fever. The disease usually presents with abrupt onset of fever, myalgia, malaise, headache, backache, anorexia - symptom duration ranges from 3 to 10 days. Less than 1% develop neuro-invasive disease. These patients present with fever in conjunction with meningitis, encephalitis, flaccid paralysis, or a mixed pattern of disease. Patients at risk of neuro-invasive disease include older patients and those with malignancy. Mortality rate is about 10% for neuro-invasive disease. Ocular manifestations such as chorioretinitis and vitritis have also been described. Following acute West Nile virus infection, patients commonly report persistent symptoms including fatigue, headache, balance and memory problems which may be prolonged.

MICROBIOLOGY INVESTIGATIONS

Short period of viremia limits the usefulness of polymerase chain reaction (PCR) tests. Please contact MOH and NPHL to arrange further laboratory tests.

Specimen Types	Tests
Blood, CSF, urine	PCR
Serum, CSF	Total antibody by IF

MANAGEMENT OF PATIENTS

Treatment is mainly supportive. Treatment agents that have been tried in neuro-invasive disease include interferon alpha, ribavirin and intravenous immunoglobulin therapy but these options have very limited supporting data and hence are generally not recommended.

MANAGEMENT OF CONTACTS

No specific management of contacts is required.

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions apply in healthcare settings.

Solicit travel history. For travel-associated cases from unexpected destinations, as a public health measure, a search for other unreported or undiagnosed cases in areas where the patient may have been exposed during the 2 weeks prior to onset should be considered.

There is no available vaccine. Travellers to endemic areas should be advised on measures to avoid mosquito bites (e.g. using repellents containing $\geq 20\%$ DEET, wearing long-sleeved clothing and long pants, sleeping under permethrin-impregnated mosquito netting, and treating clothes with permethrin-based products).

Potential blood donors with a history of travel to WNV endemic areas are advised against blood donation within 4 weeks of return from travel.

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YELLOW FEVER

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Call MOH Surveillance Duty Officer and submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Immediately
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Yellow Fever Virus (YFV), a member of the *Flaviviridae* family.

INCUBATION PERIOD

3-6 days

INFECTIOUS PERIOD

Infectious to mosquitoes from shortly before onset of fever to 5 days after onset (when the patient is viraemic).

TRANSMISSION

Vector-borne transmission occurs via the bite of an infected mosquito, primarily *Aedes* or *Haemogogus* spp. Individuals infected by YFV experience high levels of viremia making blood-borne transmission possible (via transfusion, needle stick, and intravenous drug abuse).

EPIDEMIOLOGY

Yellow fever occurs in sub-Saharan Africa and tropical South America, where it is endemic with intermittent epidemics. In Africa, natural immunity increases with age, thus infants and children are at greatest risk for disease. In 2016, China reported Asia's first imported cases in travellers returning from Angola during a large yellow fever outbreak.

CLINICAL FEATURES

Yellow fever should be suspected in a febrile traveller who has been to an endemic country during the preceding 6 days and has not been vaccinated against the disease.

The clinical spectrum of yellow fever includes subclinical infection, mild non-specific self-limiting febrile illness without jaundice, and life-threatening illness with fever, jaundice, renal failure and haemorrhage. 5-20% infections result in clinical disease with jaundice, the rest are self-limiting or subclinical.

The disease has three phases:

1. **Early phase** viraemic stage characterised by fever, chills, headache, backache, myalgia, prostration with bradycardia, conjunctival injection and coated tongue.
2. **Period of "remission"** occurring over next several days with transient recovery and remission of fever lasting up to 48 hours. Patients with self-limiting infections recover at this stage. Approximately 15% of individuals infected with YFV enter the third stage of the disease.
3. **Period of "intoxication"** begins on the 3rd to the 6th day of infection with increasing systemic symptoms, jaundice, albuminuria, oliguria, haemorrhagic complications (black vomit), delirium, stupor, acidosis and shock.

The case fatality rate varies widely. Of the 15% of individuals who develop the severe form of illness, about 20-50% die 10-14 days after the onset of illness. The differential diagnoses for yellow fever include viral hepatitis, leptospirosis, malaria, typhoid and other viral haemorrhagic fevers.

MICROBIOLOGY INVESTIGATIONS

Short period of viremia (early stage of disease) limits the usefulness of PCR.

Specimen Types	Tests
Blood, urine	PCR
Serum	Serology

MANAGEMENT OF PATIENTS

Treatment is supportive and directed at the management of the complications of yellow fever. There is no specific antiviral therapy.

MANAGEMENT OF CONTACTS

No specific management of contacts is generally required.

PRECAUTIONS, PREVENTION AND CONTROL

Patients should be isolated and standard precautions applied.

Yellow fever vaccine consists of a live attenuated virus preparation, and is recommended for persons older than 9 months of age who are travelling to or living in areas with risk of yellow fever virus transmission. Travellers to regions that are endemic are required to be vaccinated against yellow fever under the Infectious Diseases Act. A valid yellow fever vaccination certificate is required from travellers (over 1 year of age) to enter Singapore who, within the preceding 6 days have been in or have passed through any country endemic for yellow fever.

Travellers should be advised on measures to avoid mosquito bites (e.g. using repellents containing $\geq 20\%$ DEET, wearing long-sleeved clothing and long pants, sleeping under permethrin-impregnated mosquito netting, and treating clothes with permethrin-based products).

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Epidemic vector control, back alley search and destroy operations, Katong

ZIKA VIRUS INFECTION

NOTIFIABLE DISEASE: YES			
Who should notify	When to notify	How to notify	Notification time line
Medical practitioners	On clinical suspicion	Submit MD131 Notification Form via CDLENS (http://www.cdLens.moh.gov.sg) or fax (6221 5528/38/67)	Within 24 hours
Laboratories	Upon laboratory confirmation		

CAUSATIVE AGENT

Zika virus, a member of the *Flaviviridae* family.

INCUBATION PERIOD

3-14 days

INFECTIOUS PERIOD

From two days before onset of illness up to three months after onset.

TRANSMISSION

Vector-borne transmission occurs via bite of an infected mosquito, primarily *Aedes* (both *A. aegypti* and *A. albopictus*). The virus can also be transmitted through sexual contact, from mother to child during pregnancy, blood product transfusion, and organ transplantation.

EPIDEMIOLOGY

Outbreaks of Zika have occurred in the Americas, Africa and Asia-Pacific. Zika virus infection rose to prominence during the 2015-2016 epidemic in Brazil when it was associated with microcephaly in babies born to mothers who had been infected. In Singapore, an outbreak of Zika occurred in 2016. There have been no local cases of microcephaly linked to the Zika virus infection.

CLINICAL FEATURES

The illness is usually mild, with symptoms resolving within 2-7 days. Zika virus infection usually presents with low-grade fever, a maculopapular rash on the face, trunk, extremities, palms and soles, which is often pruritic, arthralgia of the small joints of hands and feet, and non-purulent conjunctivitis.

Other symptoms include myalgia, headache, retro-orbital pain, oedema, and vomiting. High-grade fever and severe symptoms should alert the physician to co-infections, including dengue and chikungunya virus infections. Complications are rare but include Guillain-Barré syndrome, meningoencephalitis, acute myelitis, and adverse foetal outcomes in women infected during pregnancy, including foetal loss, congenital microcephaly, other cerebral structural abnormalities, visual and hearing deficits and seizures. The time window for adverse foetal outcomes in utero appears to occur throughout pregnancy.

A wide spectrum of viral, bacterial and parasitic infections may mimic Zika virus infection, including dengue fever, chikungunya, parvovirus, rubella, measles, malaria, leptospirosis and rickettsial infection.

MICROBIOLOGY INVESTIGATIONS

Zika virus can be identified in blood or urine samples of symptomatic individuals via polymerase-chain reaction (PCR). Zika serological tests should not be used for diagnosis of Zika virus infection due to cross-reactivity with dengue virus.

Specimen Type	Test
Blood, urine	PCR

MANAGEMENT OF PATIENTS

Management is supportive with rest and symptomatic treatment. Pregnant women with symptoms of possible Zika virus infection should seek medical attention immediately and consult their obstetrician. Routine testing for Zika virus in asymptomatic pregnant women is not recommended.

MANAGEMENT OF CONTACTS

No specific management of contacts is required.

PRECAUTIONS, PREVENTION AND CONTROL

Standard precautions apply in the healthcare setting.

There is no available vaccine. Vector control remains the mainstay in reducing the spread of mosquito-borne diseases. Individuals can avoid exposure to mosquito bites by using insect repellents containing $\geq 20\%$ DEET, wearing long-sleeved clothes and long pants, and sleeping in air-conditioned or insect-screened rooms.

Couples planning to conceive should practice safer sex (e.g. condom use) or abstain from sexual intercourse if either partner is confirmed to have Zika virus infection – for at least 8 weeks after recovery if the woman was infected, and for at least 3 months after the man was infected. Individuals living in an affected area, who are sexual partners of pregnant women, should adopt safer sex practices or consider abstinence throughout the pregnancy.

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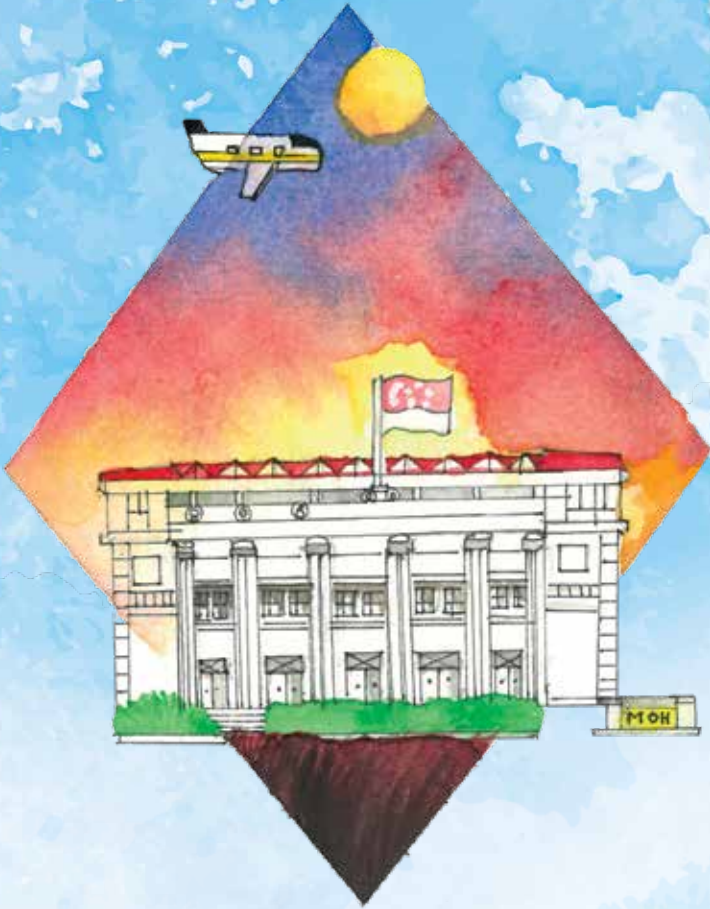
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Bookend of Public Health Resources



**"Keep calm
and Hero on!"**

COMMUNICABLE DISEASES NOTIFICATION

NOTIFICATION TIMELINE

Under the Infectious Diseases Act, all legally notifiable infectious diseases should be reported at the earliest opportunity, within the timelines indicated.

Infectious Disease	Notifiable by		Notification Timeline
	Doctors upon Clinical Diagnosis	Laboratories upon Test Confirmation ¹	
Avian Influenza	✓	✓	Immediately via phone call, followed by MD131 notification
Ebola Virus Disease	✓	✓	
MERS-CoV Infection	✓	✓	
Nipah Virus Infection	✓	✓	
Plague	✓	✓	
Poliomyelitis	✓	✓	
Rabies	✓	✓	
SARS	✓	✓	
Yellow Fever	✓	✓	
Botulism	✓	✓	Within 24 hours
Chikungunya Fever	✓	✓	
Coronavirus Disease 2019	✓	✓	
Dengue Fever and Dengue Haemorrhagic Fever	✓	✓	
Diphtheria	✓	✓	
Japanese Encephalitis	✓	✓	
Malaria	✓	✓	
Measles	✓	✓	
Rubella	✓	✓	
Zika Virus Infection	✓	✓	
Cholera		✓	
<i>Haemophilus Influenzae</i> Type b Disease		✓	
Leptospirosis		✓	
Meningococcal Disease		✓	
Murine Typhus		✓	
Paratyphoid and Typhoid Fever		✓	

¹ Doctors performing confirmatory point-of-care tests (POCTs) are required to notify these diseases as well. Please indicate “confirmed by laboratory tests” when notifying MOH.

Infectious Disease	Notifiable by		Notification Timeline
	Doctors upon Clinical Diagnosis	Laboratories upon Test Confirmation ¹	
Tetanus	✓		Within 72 hours
Mumps	✓	✓	
Syphilis	✓	✓	
Tuberculosis	✓	✓	
Campylobacteriosis		✓	
Chlamydia Genital Infection		✓	
Gonorrhoea		✓	
Hepatitis A, acute		✓	
Hepatitis B, acute		✓	
Hepatitis C, acute		✓	
Hepatitis E, acute		✓	
HIV Infection		✓	
Legionellosis		✓	
Leprosy		✓	
Melioidosis		✓	
Pertussis		✓	
Pneumococcal Disease (Invasive)		✓	
Salmonellosis (non-typhoidal)		✓	

¹ Doctors performing confirmatory point-of-care tests (POCTs) are required to notify these diseases as well. Please indicate “confirmed by laboratory tests” when notifying MOH.

Serious Infectious diseases which are non-endemic in Singapore (e.g. MERS-CoV infection) require urgent preventive actions to be taken upon clinical suspicion. For such urgent cases of emerging infectious diseases or suspected bioterrorism agents, medical practitioners should notify MOH immediately upon clinical suspicion.

Medical practitioners should continue to notify MOH of events of public health significance (e.g. clusters of infectious disease) immediately.

MODE OF NOTIFICATION

For urgent cases of infectious disease, medical practitioners should call the surveillance duty officer of the Communicable Diseases Division (CDD), MOH at 9817 1463 directly. These phone calls will be considered timely notifications and formal notifications can follow later for more complete data and documentation.

All formal notifications have to be made on the MD131 or MD532 form via the online Communicable Diseases Live and Enhanced Surveillance System (CD-LENS) (www.cdLens.moh.gov.sg) or by fax. To simplify reporting, there is a single fax point for all hardcopy notifications, regardless of the type of ID with three fax numbers available (6221 5528, 6221 5538 and 6221 5567).

Under the Infectious Diseases Act, cases or clusters which are not currently listed in the First Schedule but may present significant risk to human health should be notified under the category 'other significant disease' on the MD131 form.

Medical practitioners and laboratories who wish to report suspected clusters of infectious diseases in the community can do so via email (ReportIDcluster@moh.gov.sg - email address is not case-sensitive). Formal notifications may be requested later for more complete data and documentation.

MOH's latest circulars and guidelines on the notification of infectious diseases in Singapore are available for medical practitioners and clinical laboratories online at www.cdLens.moh.gov.sg.

Sample notification forms in hard copy are shown on the following pages.

USEFUL CONTACT NUMBERS

Relevant queries may be clarified at the following:

- National Centre for Infectious Diseases
Operator: 62566011
- Ministry of Health, Singapore
Operator: 63259220
- National Environment Agency Call Centre Hotline
Operator: 1800-CALL NEA (1800-2255632)
- Singapore Food Agency Hotline
Operator: 1800-2262250



Ministry of Health
Singapore

**NOTIFICATION OF TUBERCULOSIS
(MD 532)**

1. Notification date (dd/mm/yy)

--	--	--	--	--	--	--	--

This notification form must be submitted not later than 72 hours from the time of diagnosis, to:

Fax Nos:
62215528 or
62215538 or
62215567

E-notification system is available at
<https://www.cdms.moh.gov.sg>

PERSONAL PARTICULARS

2. Name (as in NRIC/Passport/other document)

3. NRIC/ Passport/ Foreign Identification No.

4. Gender Male Female

5. Ethnic group

Chinese Indian Caucasian

Malay Eurasian Others (please specify) _____

6. Date of birth (dd/mm/yy) /
(if unknown please specify age)

--	--	--	--	--	--	--	--

9. Residence

Name (if place of residence is long-term care facility)

House / Bldg no.

Unit no.

Contact no.

Street name

(Pg/HP)

10. Housing type

- HDB 1&2 rm
 HDB 3 rm
 HDB 4 rm
 HDB 5 rm & above
 HUDC
 Private condominium/apartment
 Landed property
 Others (specify) _____

11. Workplace/School (if applicable)

Name

House / Bldg no.

Unit no.

Contact no.

Ext.

Street name

Postal code

12a. Residential status

(tick all that apply)

- Singapore citizen (pink NRIC)
 Permanent resident (blue NRIC)
 Short-term social visitor
 Illegal immigrant
 Others (please specify) _____

Holder #

Applicant #

- Work permit
 Employment pass
 Student pass
 Dependant pass
 Long-term social visit pass
 Professional visit pass
 Special pass

12b. If PR applicant, tick here

*Please indicate pass no.

--	--	--	--	--	--	--	--

7. Marital Status

- Single Widowed
 Married Divorced
 Separated Unknown

8. Occupation

13. Country of citizenship

14. Country of birth

15. When first arrived in Singapore
(if not born in Singapore)

16. Type of long-term care facility (if applicable)

- Home for the aged/aged sick
 Psychiatric hospital
 Prison or other correctional facility
 Others (please specify) _____

DIAGNOSIS

17a. Patient category*

- New case
 Relapse (state year previously treated) _____
 Reinstatement
 Uncertain

17b. If transferred from overseas, tick here

18. Case diagnosed through

- Symptoms of disease Incidental finding
 Screening of contacts Mobile CXR
 Pass application/renewal Others# _____

Please Specify

19.a Status at diagnosis

- Alive Dead

19.b If patient died, please
indicate date (dd/mm/yy)

--	--	--	--	--	--	--	--

*** DEFINITIONS**

Patient category

New: Patient who never previously received treatment for more than 1 month.

Relapse: Patient who previously completed treatment or was treated and declared cured prior to developing active TB again.

Reinstatement: Patient who previously had not completed treatment and now returns after one year of last being on medication.

Treatment delivery mode

DOT: Directly Observed Treatment, i.e. a health care worker watches as the patient swallows each dose of TB medication.

Polyclinic DOT: DOT carried out by the nurses at the government polyclinics.

Institutionalised DOT: DOT carried out by health care workers at hospitals, nursing or community homes or correctional facilities.

Outreach DOT: DOT carried out by health care workers at the patient's home.

Other DOT: e.g. DOT carried out by a health care workers at general practitioner clinic, school, army camp.

SAT: Self Administered Treatment

PTO

NRIC/ Passport/ Foreign Identification No. _____		21. No. of BCG scars <input type="checkbox"/> 0 <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> Unknown		23. CXR Date: _____ <input type="checkbox"/> Normal <input type="checkbox"/> Scar (old TB) <input type="checkbox"/> Active TB (with cavitation) <input type="checkbox"/> Active TB (without cavitation) <input type="checkbox"/> Milinary TB <input type="checkbox"/> Not done <input type="checkbox"/> Others (Specify) _____																																	
20. Concurrent medical conditions (Tick all that apply) <input type="checkbox"/> Diabetes mellitus <input type="checkbox"/> Steroid therapy <input type="checkbox"/> End stage renal failure <input type="checkbox"/> Impaired immunity other than HIV <input type="checkbox"/> Cancer <input type="checkbox"/> Others (please specify) _____ <input type="checkbox"/> HIV test done: Yes/No _____ If Yes, result of latest test: Reactive/Non-reactive Date of test _____		22. Cough <input type="checkbox"/> No <input type="checkbox"/> Yes (state duration) _____ weeks																																			
24. Site(s) of disease (Tick all that apply) <input type="checkbox"/> Pulmonary <input type="checkbox"/> Extrapulmonary <input type="checkbox"/> Laryngeal <input type="checkbox"/> Pleura <input type="checkbox"/> Lymphatic system <input type="checkbox"/> Skeletal system <input type="checkbox"/> Genitourinary system <input type="checkbox"/> Central nervous system <input type="checkbox"/> Disseminated <input type="checkbox"/> Gastro-intestinal system (including mesenteric glands & peritoneum) <input type="checkbox"/> Others (please specify) _____ (i) _____ (ii) _____		25. Result of initial smear* <table border="1"> <thead> <tr> <th></th> <th>Lab no.</th> <th>Date</th> <th>Result</th> </tr> </thead> <tbody> <tr> <td>• Pulmonary (specify specimen type, eg. sputum)</td> <td></td> <td></td> <td></td> </tr> <tr> <td>• Extra-pulmonary Pleural fluid / tissue</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Lymph node</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Urine</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Endometrium</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Spinal fluid</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Others : _____</td> <td></td> <td></td> <td></td> </tr> </tbody> </table> * Please use the following codes: Not done = -- 1 = + 3 = +++ Negative = 0 2 = ++ 4 = ++++ Note : Results of initial smear MUST be provided if done.					Lab no.	Date	Result	• Pulmonary (specify specimen type, eg. sputum)				• Extra-pulmonary Pleural fluid / tissue				Lymph node				Urine				Endometrium				Spinal fluid				Others : _____			
	Lab no.	Date	Result																																		
• Pulmonary (specify specimen type, eg. sputum)																																					
• Extra-pulmonary Pleural fluid / tissue																																					
Lymph node																																					
Urine																																					
Endometrium																																					
Spinal fluid																																					
Others : _____																																					
CHEMOTHERAPY																																					
26. Treatment started			27. Treatment NOT started yet																																		
26a. Date started (dd/mm/yy) _____		27a. State reason <input type="checkbox"/> Patient referred to other treatment centre (complete item 27b,c,d) <input type="checkbox"/> Patient recalled for treatment (complete item 27d) <input type="checkbox"/> Not suitable for treatment due to medical contraindication (please specify) _____ <input type="checkbox"/> Others (please specify) _____																																			
26b. Treatment centre <input type="checkbox"/> TBCU <input type="checkbox"/> SATA <input type="checkbox"/> TTSH <input type="checkbox"/> Polyclinic <input type="checkbox"/> NUH <input type="checkbox"/> General practitioner (please specify) _____ <input type="checkbox"/> SGH <input type="checkbox"/> CGH <input type="checkbox"/> Private hospital/specialist (please specify) _____ <input type="checkbox"/> AH		27b. Name of hospital/centre/clinic referred to _____																																			
26c. Intended duration <input type="checkbox"/> 6 months <input type="checkbox"/> 18-24 months <input type="checkbox"/> Others _____ months <input type="checkbox"/> 9 months <input type="checkbox"/> Unknown		27c. Name of physician referred to _____																																			
26d. Intended regimen (e.g. 2HRZ/4H _r) _____ Tick if Fixed Dose Combination used <input type="checkbox"/>		27d. Appointment date (dd/mm/yy) _____																																			
26e. Treatment delivery mode : * <input type="checkbox"/> Polyclinic DOT <input type="checkbox"/> SAT <input type="checkbox"/> Outreach DOT <input type="checkbox"/> Institutionalised DOT																																					
PARTICULARS OF NOTIFYING DOCTOR																																					
28. Name and Signature of Notifying Doctor: _____		30. Name of clinic/hospital/institution: Department / Ward (if applicable) : _____																																			
29. MCR NO: _____		31. Address of clinic/hospital/institution: (Tel) _____ (Fax) _____ Postal code _____																																			

POST-EXPOSURE PROPHYLAXIS

PREVENTING INFECTIONS AFTER EXPOSURE

Post-exposure prophylaxis (PEP) is any preventive medical treatment started after exposure to a pathogen in order to prevent the infection from occurring. The table below provides a summary on the administration of PEP under specific circumstances.

Legend

- HepB vac = Hepatitis B vaccine
- HCWs = Health-care workers
- HDCV = Human diploid cell vaccine
- HIV = Human immunodeficiency virus
- HRIG = Human rabies immunoglobulin
- IG = Immunoglobulin
- MDR-TB = Multi-drug resistant tuberculosis
- NSI = Needlestick injury
- PEP = Post-exposure prophylaxis
- VZIG = Varicella zoster immune globulin

Infection	Indications for PEP	PEP	Contra-Indications/ Remarks
Chickenpox	<p>Susceptible persons where risk of complications is high e.g. immunocompromised patients, neonates of mothers infected up to 5 days before and 2 days after delivery.</p> <p>Susceptible persons without contra-indications who have been exposed.</p>	<p>VZIG should be administered as soon as possible, though may be effective up to 96 hours after exposure.</p> <p>Dose of 125U/ 10 kg BW (min dose 125U - max of 625U).</p> <p>Varicella vaccination can prevent or ameliorate disease if given within 72 hours of exposure.</p>	<p>Varicella vaccine should not be given to immunocompromised individuals, patients with history of anaphylaxis to neomycin, severe illness, and pregnant females.</p>

Infection	Indications for PEP	PEP	Contra-Indications/Remarks
Hepatitis A	Household and homosexual /sexual contacts. During outbreaks in day-care centres or hospitals when there may be exposure to faeces.	One dose of single-antigen hepatitis A vaccine or IG (GamaSTAN S/D) at dose of 0.1 ml/kg (IM) within 2 weeks of exposure will ameliorate or prevent disease. Late administration of IG will still attenuate disease.	IG should be used for children aged <12 months, immunocompromised persons, persons with chronic liver disease, and persons who are allergic to the vaccine or a vaccine component.
<i>Haemophilus influenzae</i> type b meningitis	Household or day-care contacts residing with index case > 4 hours for 5-7 days before onset of illness.	Rifampicin 20mg/kg once-daily (max 600mg) x 4 doses.	Contraindicated in pregnancy.
HIV	Individuals exposed to discrete NSI/splash/mucous contact, ideally within 4 hours, of exposure.	3 antiretroviral drug regime for 28 days depending on type of exposure, index patient's stage of disease and experience with antiretroviral treatment.	Evaluate type of exposure and source patient if HIV status unknown. Specialist advice should be sought.
Influenza	Antiviral drugs considered for the chemoprophylaxis of unvaccinated high-risk persons aged > 1 year in community influenza outbreaks and influenza outbreaks in other settings unvaccinated health care workers who have close contact with influenza-infected patients.	Treatment should be started within 48 hours of illness onset and continue for 5 days. Oseltamivir, zanamivir, peramivir.	Common reported side effects are nausea and vomiting.

Infection	Indications for PEP	PEP	Contra-Indications/Remarks
Measles	<p>Infants <12months, immuno-compromised children and adults exposed to measles.</p> <p>Susceptible healthy persons who have been exposed.</p>	<p>IG to be given within 6 days of exposure.</p> <p>Healthy infant <1year: 0.25 ml/kg IM (followed by MMR at 12 months and 15 -18 months). Immunocompromised children: 0.5 ml/kg (max of 15ml).</p> <p>Live measles vaccine can be used within 72 hours of exposure as an alternative to IG.</p>	<p>Measles vaccine should not be given to individuals with egg allergy, pregnant women, immunocompromised hosts.</p>
Meningococcal meningitis	<p>HCWs involved in resuscitation, intubation and suction of secretions without respiratory protection. Close contact ≥4 hours the week before onset of illness (house-mates, day-care contacts, cell-mates).</p>	<p>Rifampicin 10 mg/kg (max 600 mg) bd (children < 1mth 5mg/kg bd) x 4 doses</p> <p>or</p> <p>Ciprofloxacin 500 mg oral X 1 dose</p> <p>or</p> <p>Ceftriaxone 250 mg (children <15yr- 125mg) X 1 IM dose when other antibiotics contraindicated.</p>	<p>Ciprofloxacin contraindicated in pregnancy and in children. Rifampicin contraindicated in pregnancy.</p> <p>Vaccination has been used in conjunction with chemoprophylaxis in PEP but value unknown.</p>

Infection	Indications for PEP	PEP	Contra-Indications/ Remarks
Rabies	Both immunised and non-immunised individuals with suspected or confirmed contact.	<p>If completed pre-exposure vaccination, give two boosters at days 0 and 3 of HDCV IM (deltoid). No HRIG needed.</p> <p>If unimmunised, start 4 dose HDCV or PCECV and HRIG. HRIG should be infiltrated into wound and remainder into gluteal area.</p>	Besides rabies PEP treatment, wound management with cleansing, antibiotics and tetanus immunisation may be required.
Rubella	Pregnant females exposed to rubella who refuse to have an abortion if rubella develops.	IG may be given (0.55 ml/kg IM) within 72 hours of rubella exposure.	May reduce but will not eliminate the risk for rubella.
Tuberculosis	Individuals exposed to a confirmed case.	After excluding active TB, isoniazid for 6 months-1 year.	Risk factors for hepatotoxicity have to be considered. Consult ID/TBCU for MDR-TB.

**RECOMMENDATIONS FOR HEPATITIS B PROPHYLAXIS FOR HEALTHCARE WORKERS
FOLLOWING PERCUTANEOUS EXPOSURE**

Hepatitis B virus status of exposed HCW	When source is found to be:		
	HBsAg positive	Unknown source	HBsAg negative source
Known HepB vaccine responder (anti-HBs ≥ 10 mIU/mL after ≥ 3 doses of HepB vaccine)	No treatment	No treatment	No treatment
Documented non-responder after 6 doses of vaccine (anti-HBs < 10 mIU/mL after ≥ 6 doses of HepB vaccine)	HBIG ¹ x2 separated by 1 month	HBIG ¹ x2 separated by 1 month	No treatment
Response unknown after 3 doses of HBV vaccine	Test exposed person for anti-HBs. 1. If anti-HBs ≥ 10 mIU/mL, no prophylaxis needed 2. If anti-HBs ≤ 10 mIU/mL, administer HBIG plus HepB vaccine booster dose	Test exposed person for anti-HBs. If anti-HBs ≥ 10 mIU/mL, no prophylaxis needed If anti-HBs ≤ 10 mIU/mL and unknown source is low risk, - Administer booster of HepB vaccine. If anti-HBs ≤ 10 mIU/mL and unknown source is high risk, may treat as if source were HBsAg positive. - Administer HBIG1 plus HepB vaccine booster dose	No treatment

Hepatitis B virus status of exposed HCW	When source is found to be:		
	HBsAg positive	Unknown source	HBsAg negative source
Unvaccinated/incompletely vaccinated	HBIG ¹ x 1 and initiate complete HepB vaccination series	Initiate complete HepB vaccination series If unknown source is high risk, may treat as if source were HBsAg positive and concurrently administer HBIG.	Initiate complete HepB vaccination series

¹ Hepatitis B Immunoglobulin (HBIG) should be administered intramuscularly as soon as possible after exposure when indicated. The effectiveness of HBIG when administered >7 days after percutaneous, mucosal, or non-intact skin exposures is unknown. The HBIG dose is 0.06 mL/kg.

Reference: Schillie S, Murphy TV, Sawyer M, et al. CDC guidance for evaluating health-care personnel for hepatitis B virus protection and for administering postexposure management. MMWR Recomm Rep. 2013;62:1-19

VACCINATION PROGRAMME IMPLEMENTATION

CHILDHOOD IMMUNISATION SCHEDULE

The National Childhood Immunisation Schedule (NCIS) comprises childhood vaccinations recommended as the standard of care for protection against vaccine preventable diseases that are of significant healthcare burden to Singapore or would be so without these vaccinations.

In consultation with the Expert Committee on Immunisation, the Ministry of Health regularly reviews vaccination policies and inclusion of vaccines into the schedule, taking into consideration local disease burden, vaccine safety, efficacy and cost effectiveness of the vaccines. This ensures that the national recommendations for childhood vaccination are up to date.

The NCIS is implemented for all children through services provided by:

- (a) public and private hospitals with neonatal immunisation services
- (b) National Healthcare Group polyclinics
- (c) National University polyclinics
- (d) Singhealth polyclinics
- (e) paediatric clinics in KK Women's and Children's Hospital
- (f) paediatric clinics in National University Hospital
- (g) private general practitioner (GP) clinics
- (h) private paediatric clinics
- (i) Health Promotion Board (HPB)

Vaccination of neonates for birth doses is carried out at public and private hospitals with neonatal immunisation services. Vaccination of infants and preschool children is carried out in polyclinics, private GP clinics, and paediatric clinics in public and private sectors. The target population for preschool children is based on notifications of births obtained from the Registry of Births and Deaths.

Vaccination of primary school children is mainly carried out by HPB, as is for HPV vaccination of female secondary school students. These target population groups are based on student population data obtained from the Ministry of Education.

Currently, the NCIS covers vaccinations against 12 diseases – tuberculosis, hepatitis B, diphtheria, tetanus, pertussis, poliovirus, Haemophilus influenzae type b, measles, mumps, rubella, pneumococcal disease and human papillomavirus. From 1 November 2020, the NCIS will also cover vaccinations against two more diseases, i.e. varicella (chickenpox) and influenza.

Of these, vaccinations against measles and diphtheria are compulsory for children under the Infectious Diseases Act.

The full childhood immunisation schedule is outlined in the summary table on the next page.

NATIONAL CHILDHOOD IMMUNISATION SCHEDULE

(from birth to age 17 years, effective 1 Nov 2020)

Vaccine	Birth	2 month	4 months	6 months	12 months	15 months	18 months	2-4 years	5-9 years	10-11 years	12-13 years	13-14 years	15-17 years
Bacillus Calmette-Guérin (BCG)	D1												
Hepatitis B (HepB)	D1	D2		D3									
Diphtheria, tetanus and acellular pertussis (paediatric) (DTaP)		D1	D2	D3	B1								
Tetanus, reduced diphtheria and acellular pertussis (Tdap)										B2			
Inactivated poliovirus (IPV)		D1	D2	D3	B1					B2			
Haemophilus influenzae type b (Hib)		D1	D2	D3	B1								
Pneumococcal conjugate (PCV10 or PCV13)			D1	D2	B1								
Pneumococcal polysaccharide (PPSV23)													One or two doses for children and adolescents, 2-17 years with specific medical condition or indication.
Measles, mumps and rubella (MMR)					D1	D2							
Varicella (VAR)					D1	D2							
Human papillomavirus (HPV2 or HPV4)											D1 (Females)	D2 (Females)	
Influenza (INF)								Annual vaccination or per season for all children age 6 months to <5 years (6-59 months).					Annual vaccination or per season for children and adolescents, 5-17 years with specific medical condition or indication.

Recommended ages and doses for all children

Recommended for persons with specific medical condition or indication

FOOTNOTES:

- **D1, D2, D3:** Dose 1, Dose 2, Dose 3
- **B1, B2:** Booster 1, Booster 2
- **10-11, 12-13, 13-14 years:** Primary 5, Secondary 1, Secondary 2 (Tdap, IPV, HPV (for females) and MMR (as catch-up) vaccines are provided as part of Health Promotion Board's school-based vaccination programme)
- **HepB:** Doses 2 and 3 are recommended to be given as part of the 6-in-1 vaccine at 2 and 6 months, respectively
- **MMR:** Only the dose 2 is recommended to be given as part of the MMRV vaccine

ADULT IMMUNISATION SCHEDULE

The National Adult Immunisation Schedule (NAIS) provides guidance to the public and healthcare professionals on the:

- (a) recommended adult vaccines
- (b) target population groups
- (c) schedule and frequency of vaccinations

The NAIS was established by the Ministry of Health in November 2017 to provide guidance on vaccinations that persons age 18 years or older should adopt to protect against vaccine- preventable diseases.

Vaccination for adults is increasingly recognised as a public health priority, especially in countries with ageing populations. The NAIS was formulated based on international best practice and in consultation with a panel of medical specialists who serve in the Ministry's Expert Committee on Immunisation.

Considerations for the recommendations have included: local disease burden; specific adult groups' vulnerability to vaccine-preventable diseases e.g. age, occupation, pre-existing medical conditions and vaccination history; and factors such as vaccine safety, efficacy and cost effectiveness of the vaccines.

Currently, the NAIS comprises recommendations for vaccinations against 11 diseases. Many of the vaccinations under the NAIS are also included in the recommended vaccinations for healthcare workers.

The NAIS is meant to serve as a useful reference for the public to be aware of important vaccinations for adults, and for healthcare professionals in recommending vaccinations to their patients. Medical doctors are encouraged to routinely review their patients' vaccination status and offer these recommended vaccinations.

The full adult immunisation schedule is outlined in the summary table on the next page.

NATIONAL ADULT IMMUNISATION SCHEDULE

(for age 18 years or older)

Vaccine	18-26 years	27-64 years	≥ 65 years
Influenza (INF)	1 dose annually or per season		1 dose annually or per season
Pneumococcal conjugate (PCV13)			1 dose
Pneumococcal polysaccharide (PPSV23)	1 or 2 doses (depending on indication)		1 dose
Tetanus, reduced diphtheria and acellular pertussis (Tdap)	1 dose during each pregnancy		
Human papillomavirus (HPV2 or HPV4)	3 doses (Females)		
Hepatitis B (HepB)	3 doses		
Measles, mumps and rubella (MMR)	2 doses		
Varicella (VAR)	2 doses		

	Recommended for adults who meet age requirement
	Recommended for adults with specific medical condition or indication
	Recommended for adults who have not been previously vaccinated, or lack evidence of past infection or immunity

GLOBAL HEALTH MAPS

SITUATIONAL RISK ASSESSMENTS

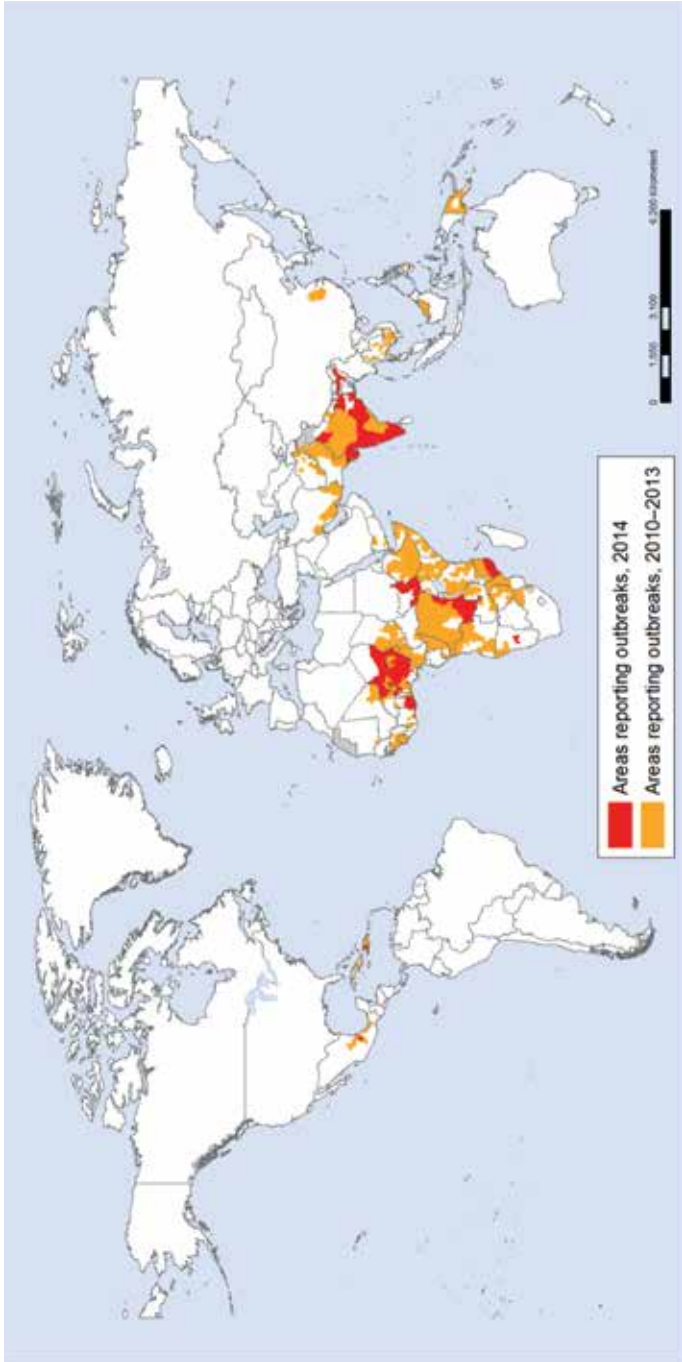
The World Health Organization (WHO) and the US Centers for Disease Control and Prevention (CDC) monitor for changing trends in the geographical distribution of specific infectious diseases of public health importance. Refer to their online publications and website for latest updates. More information on the general and emerging infectious diseases situation can be found at the following websites:

1. <http://www.cdc.gov/> (US CDC website)
2. <http://www.cdc.gov/mmwr> (Morbidity and Mortality Weekly Report)
3. <http://www.who.int/en/> (WHO website)
4. <http://www.promedmail.org> (International Society for Infectious Diseases)

Sample situational risk assessments provided by WHO are shown in the subsequent pages of this section as follows:

- Cholera, areas reporting outbreaks
- Dengue, countries or areas at risk
- Hepatitis A, countries or areas at risk
- HIV, estimated prevalence
- Japanese encephalitis, countries or areas at risk
- Malaria, countries or areas at risk of transmission
- Meningococcal meningitis, countries or areas at high risk
- Yellow fever vaccination recommendations in Africa
- Countries with risk of yellow fever virus transmission
- Yellow fever vaccination recommendations in the Americas
- Countries and territories with current or previous Zika virus

CHOLERA, AREAS REPORTING OUTBREAKS



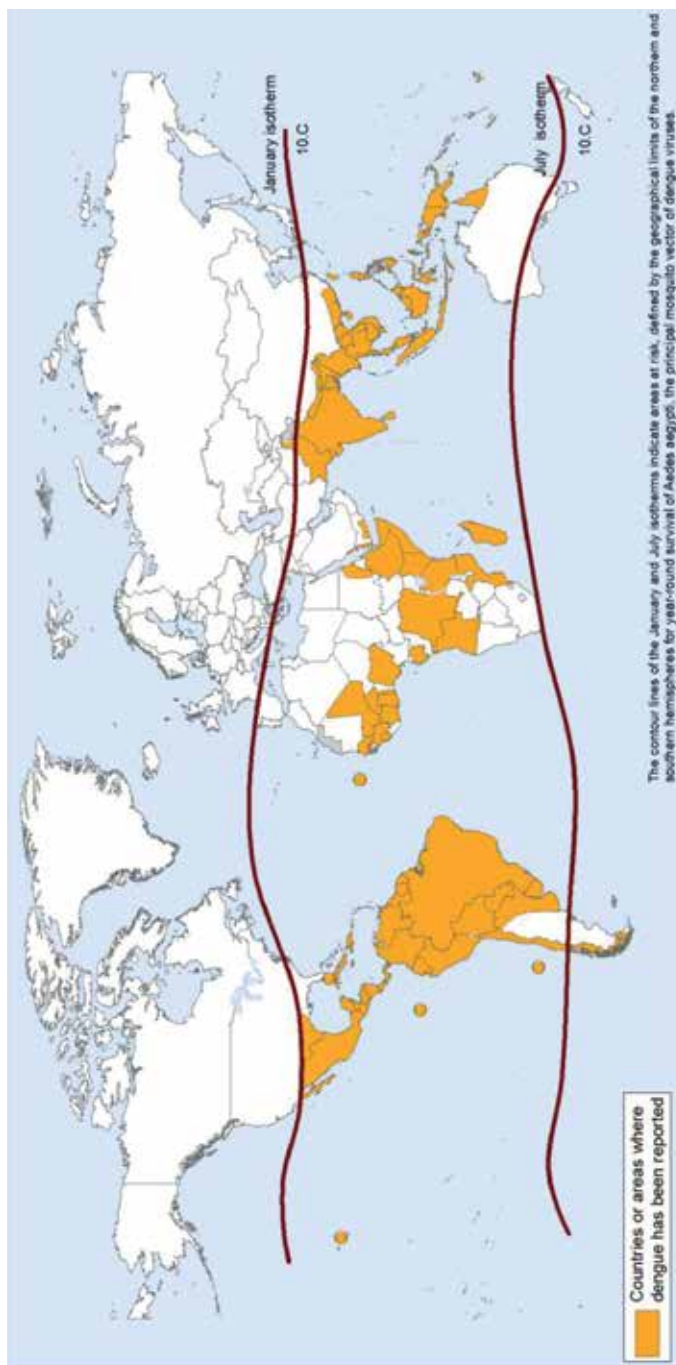
The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization
Map Production: Health Statistics and
Information Systems (HSI)
World Health Organization



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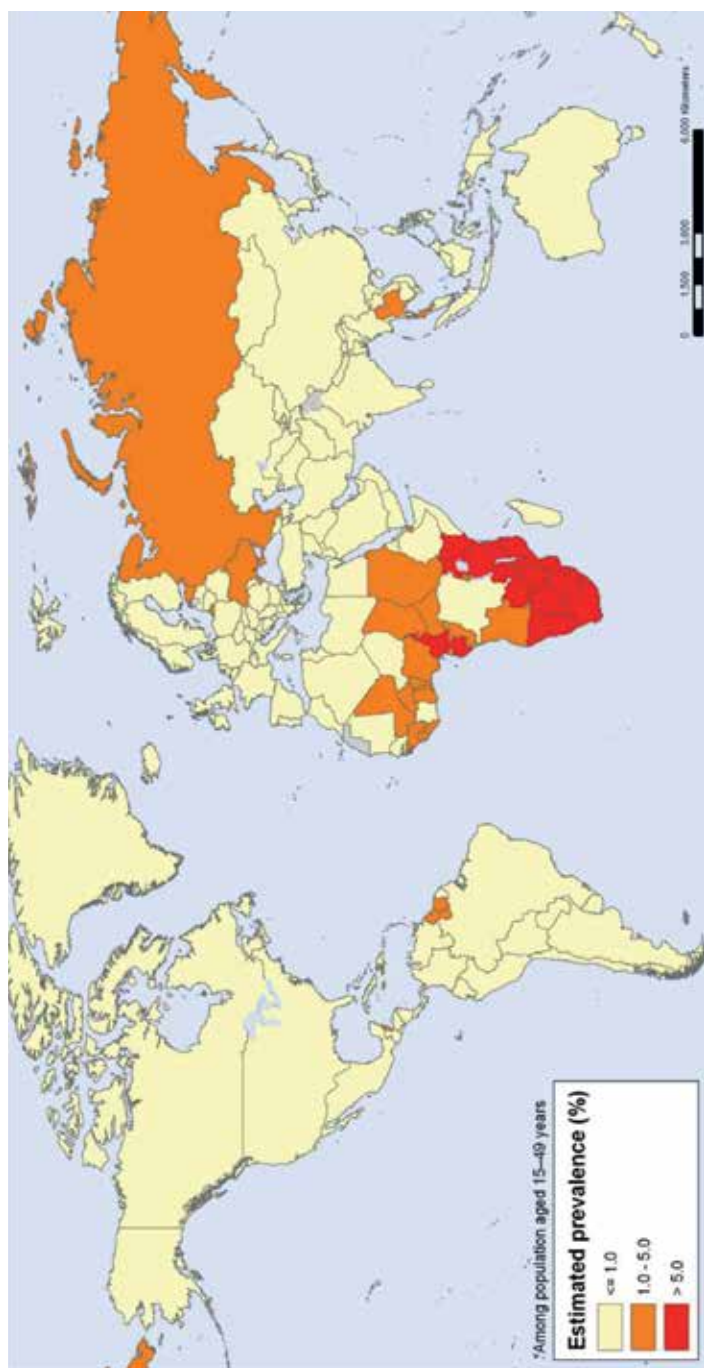
DENGUE, COUNTRIES OR AREAS AT RISK



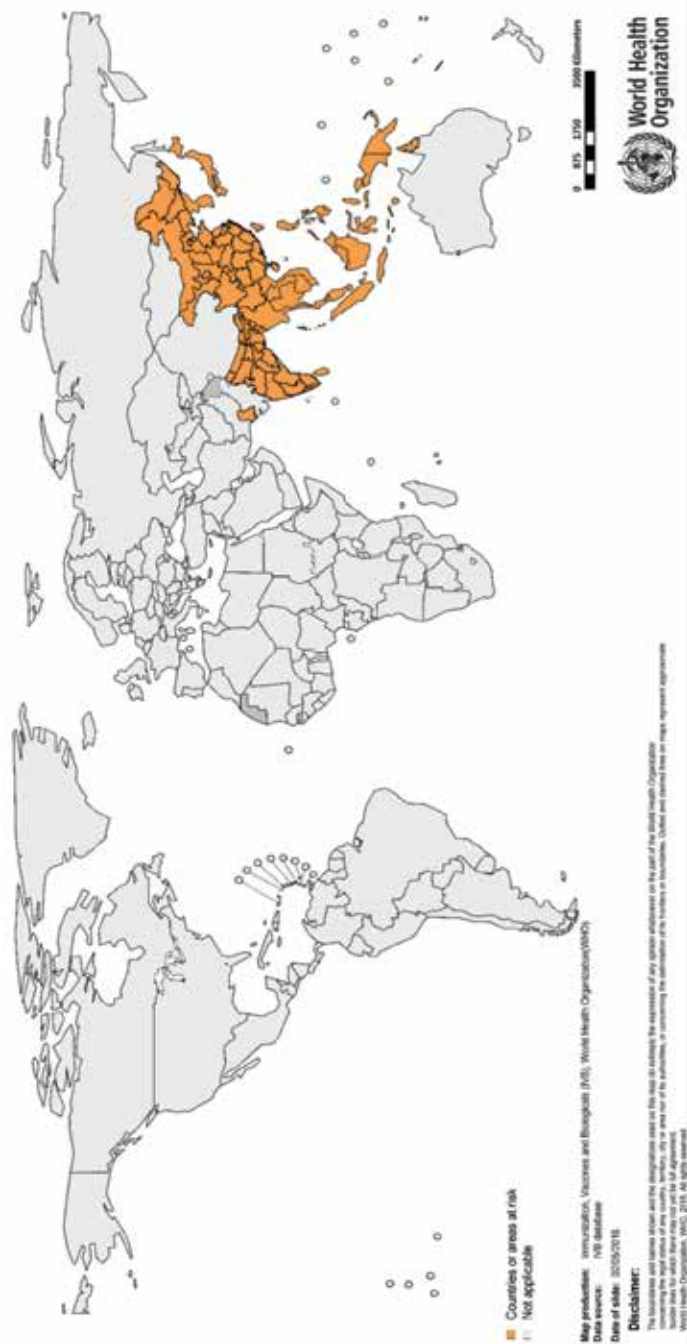
HEPATITIS A, COUNTRIES OR AREAS AT RISK



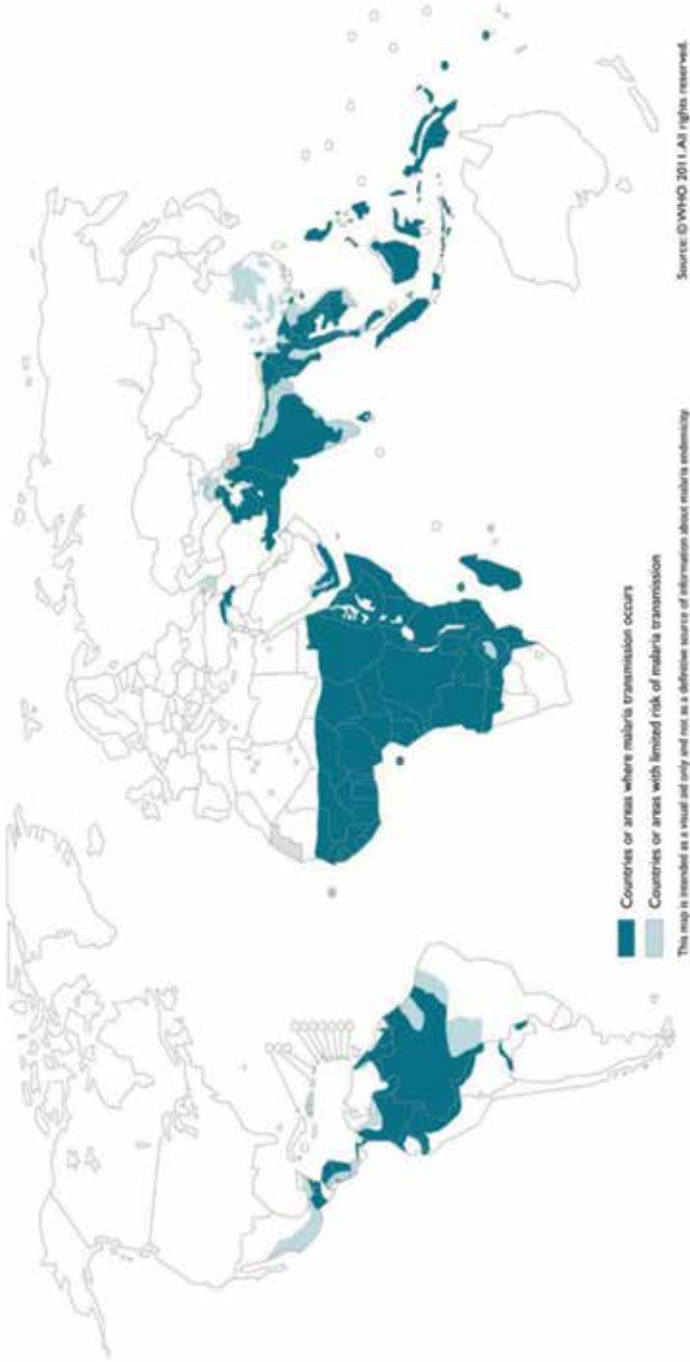
HIV, ESTIMATED PREVALENCE



JAPANESE ENCEPHALITIS, COUNTRIES OR AREAS AT RISK

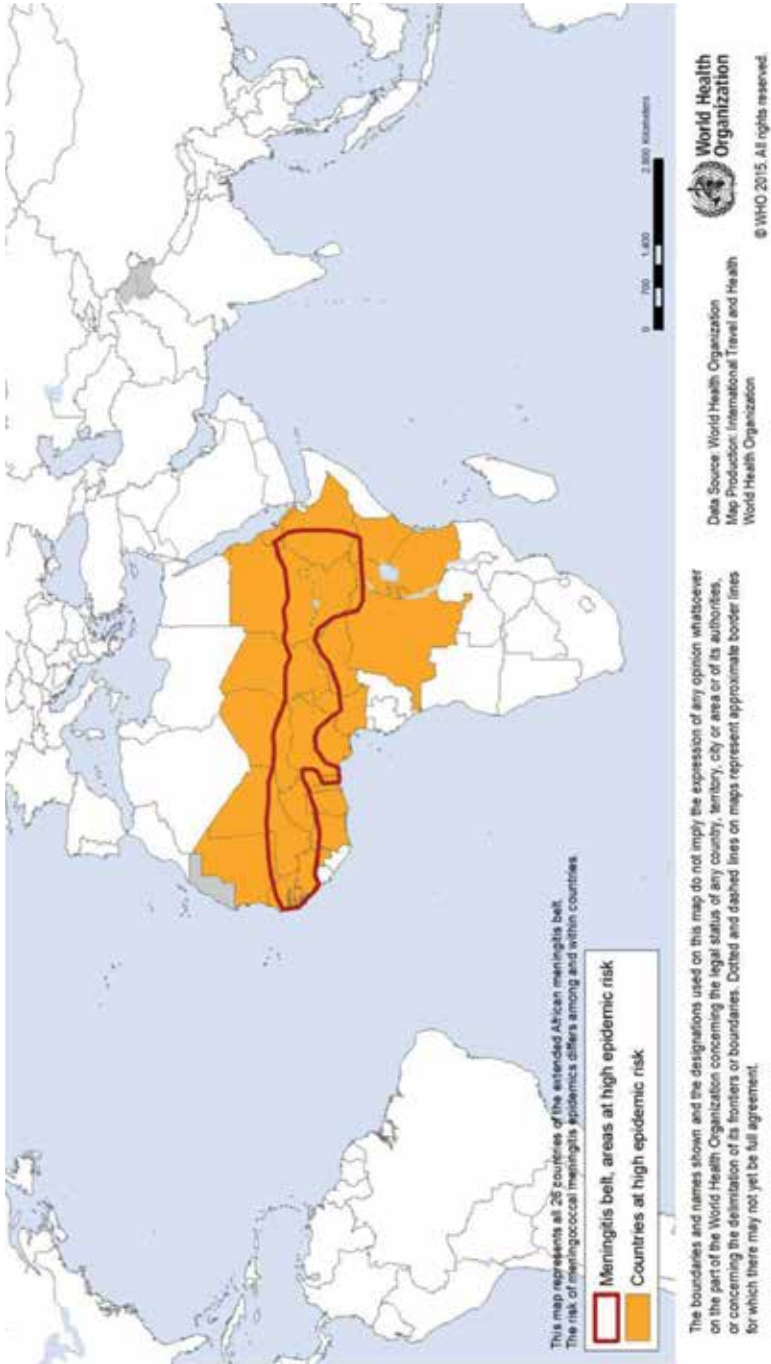


MALARIA, COUNTRIES OR AREAS AT RISK OF TRANSMISSION



The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

MENINGOCOCCAL MENINGITIS, COUNTRIES OR AREAS AT HIGH RISK



COUNTRIES WITH RISK OF YELLOW FEVER (YF) VIRUS TRANSMISSION¹

AFRICA			AMERICAS
Angola	Ethiopia ²	Nigeria	Argentina ²
Benin	Gabon	Senegal	Bolivia ²
Burkina Faso	The Gambia	Sierra Leone	Brazil ²
Cameroon	Ghana	South Sudan	Colombia ²
Central African Republic	Guinea	Sudan ²	Ecuador ²
Chad ²	Guinea-Bissau	Togo	French Guiana
Congo, Republic of the	Kenya ²	Uganda	Guyana
Côte d'Ivoire	Liberia		Panama ²
Democratic Republic of the Congo ²	Mali ²		Paraguay
Equatorial Guinea	Mauritania ²		Peru ²
	Niger ²		Suriname
			Trinidad and Tobago ²
			Venezuela ²

- ¹ Defined by the World Health Organization as countries or areas where YF “has been reported currently or in the past and vectors and animal reservoirs currently exist.” See country list on the WHO International Travel and Health webpage at www.who.int/ith/en/index.html.
- ² These countries are not holoendemic (only a portion of the country has risk of YF virus + transmission).

YELLOW FEVER VACCINATION RECOMMENDATIONS IN THE AMERICAS



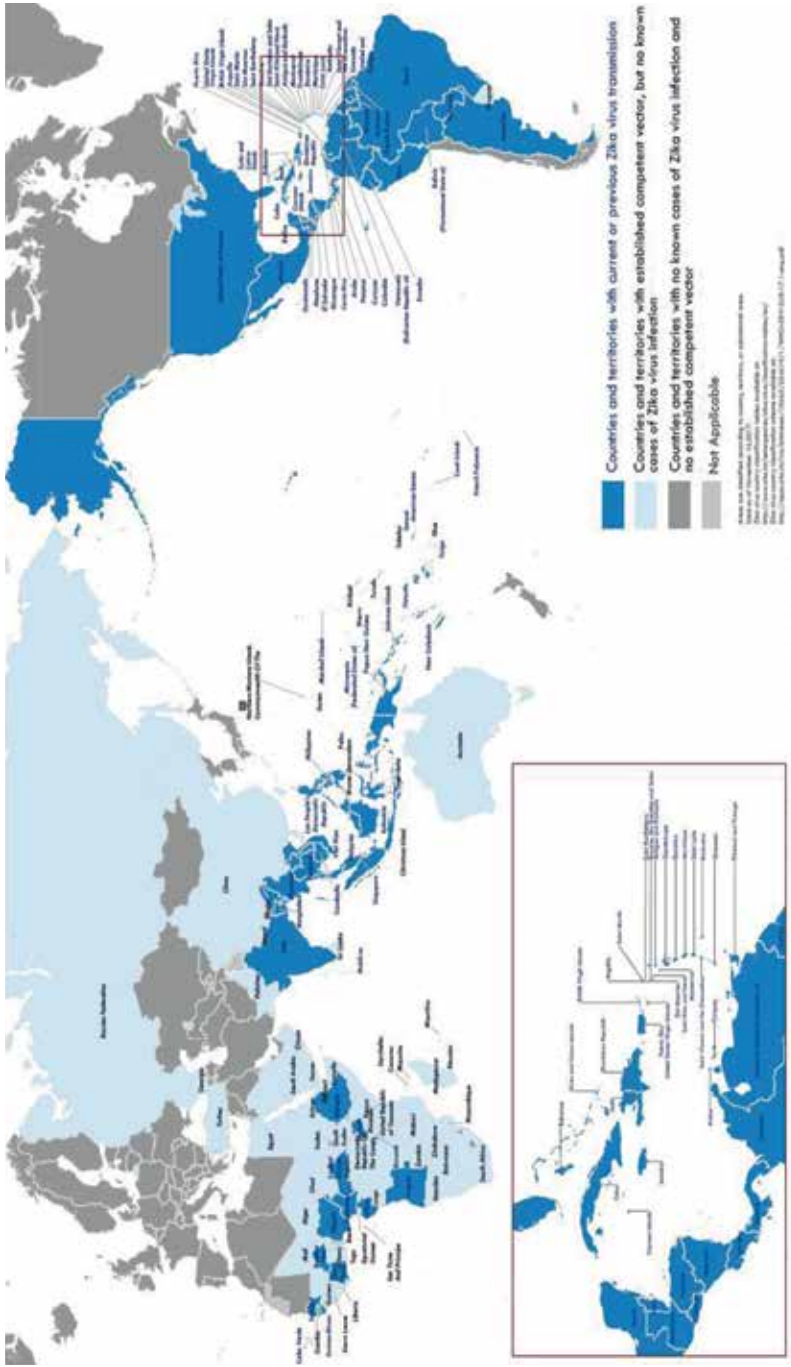
The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Sources: Pan American Health Organization World Health Organization
 Map Production: WHO Health Emergencies Department (PHE)



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COUNTRIES AND TERRITORIES WITH CURRENT OR PREVIOUS ZIKA VIRUS



Afterword

COVID-19 CRISIS AND PUBLIC HEALTH YOUNG PRACTITIONERS REFLECT

THE END OF THE BEGINNING...

When COVID-19 first came to the shores of Singapore, our healthcare system responded swiftly, pooling resources to stand guard against this pandemic. Every hospital department, including mine, rose to the challenge. Resources, manpower and time were contributed. Many of my counterparts, regardless of seniority, were, and still are, involved in fighting this pandemic. Despite hospitals calling out for volunteers, I could not leave for the frontlines as I had no cover, and my department was operating at skeletal numbers. I watched on as my colleagues were called to the frontlines, facing the pathogen a cough away.

Soon, my daily workflow drastically changed. We postponed elective surgeries, with extensive discussions held daily, rationalising every single operation on our list. Our patients had to be turned away, apologetically. While there were disappointments, I received plenty of reassurances and appreciation from our patients, for they knew this pandemic, and our national interests came before theirs. Clinics, surgeries, elective work came almost to a complete halt. The hospital fell silent. The usual buzz and chatter disappeared, leaving us with the soul above our face masks. All it revealed was the uncertainty of whether it would be like SARS in 2003, or worse.

As the numbers rose, my peers and I mentally prepared for the worst. We knew a lockdown would be inevitable, similar to how other countries have responded. It made sense, as this coronavirus transmits via contact. We had to go the other direction, and that is to avoid contact. With the circuit breaker in place, it was uncharted new territory. Our country depends mainly on trade, and with ourselves to fend on our own, I found myself on the verge of unease.

I was not deployed to the frontlines despite volunteering my name a few times, but I am now privileged to be part of a team managing the frontlines. Our healthcare system has made difficult decisions. Everyone had a role to play. It is an honour to be given the opportunity to contribute as part of the healthcare team. We can only hope this pandemic will ease up globally, and then perhaps we can venture out of our homeland safely, with our masks off!

Dr Calida Chua, Preventive Medicine Residency Year 1

WORKING AT OUTBREAKS CENTRAL...

I was rotated to MOH's Communicable Diseases Division in January 2020, right before Singapore confirmed our first COVID-19 case on 23 January. This gave me the opportunity to witness and participate in the management of the COVID-19 pandemic right from the beginning.

When it first started, nobody knew how far COVID-19 would spread or how long it would take to contain it. Given the lack of knowledge, decisions and policies were made on a best estimate basis after balancing the risks and benefits.

Weekdays and weekends soon blurred into a continuous never-ending firefight as more cases were imported and seeded local clusters. The situation changed rapidly and required swift responses given that the cases seen today are representative of the situation 1-2 weeks ago due to the incubation period, and the actual situation on the ground might have already spread beyond what we are seeing.

A few months into the outbreak, fatigue was starting to set in, not only for the teams working on the ground and in the various Ministries, but also for the general public. It seemed like this outbreak was not going to end anytime soon. My team settled into a more stable and sustainable pace as we became familiar with the rhythm of the outbreak management. We also adapted to working completely online from home, some of us never having met our team members face-to-face or knowing what each other looked like, as we joked about whether our mental images of each other matched the actual person.

Despite the fast pace, having the opportunity to witness and understand the considerations behind the policies, and its intersection with society, public communications, and politics, gave me new insights and a different point-of-view. This has truly been a once-in-a-lifetime opportunity, to be given the chance to participate in the policy making process and learn from the crisis of our generation, as we continue to hope that vaccine trials will bring us some light at the end of the tunnel and ease us into a new normal, while we “dance” to maintain our control over the outbreak.

Dr Li Zongbin, Preventive Medicine Residency Year 2

LIVING THE CRISIS OF A GENERATION...

In February 2020, when SARS-CoV2 started to spread locally following imported cases from Wuhan, China, many people thought that the outbreak would be over within a few months, drawing parallel to SARS. Little did we know that SARS-CoV2 is more transmissible compared to SARS-CoV, and we were oblivious that the novel virus could spread through asymptomatic cases and cases were infectious prior to onset of symptoms.

By March, Singapore was dealing with several clusters within the community and in the dormitories, and a high number of imported cases from Europe and the United States. It was then clear that control measures including contact tracing deployed during SARS in 2003 were insufficient to curb the virus from spreading. Similar to what many countries had adopted, Singapore put up advisories against travel, enforced social distancing and compulsory donning of face mask, and implemented our version of lockdown known as circuit breaker.

With strict control measures implemented and enforced, the number of community cases began to decline, although the number of infections in dormitories remained high despite intensive testing, quarantine, decanting of migrant worker who tested negative, and gazettement of dormitories.

While we are now well into phase 2 of post circuit breaker and gearing towards phase 3, the virus continues to circulate in the community and in the dormitories. After all dormitories were announced to be cleared on August 7, new clusters started to re-emerge from previously cleared dormitories. The number of community cases are relatively low compared to pre-circuit breaker period. However, there remains unlinked cases, which suggests silent transmission in the community that are not detected through our enhanced surveillance and intensive testing as well as extensive contact tracing.

Another emerging trend from this COVID-19 outbreak is the unknown of re-infection. Many of the recovered COVID-19 cases continue to shed non-viable RNA after 21 days, which is the time point of recovery. This poses a challenge to determine if a person who develops respiratory symptoms and tests positive for COVID-19 is deemed as a re-infection or coincidental prolonged shedding of the virus. This problem is expected to grow as the number of recovered cases increases and routine testing becomes more regular.

As the COVID-19 operations proceed, drawing away human and financial resources from peacetime work and straining the economy, what is not clear is if there is an end point to this operation, the steps to move towards the end point (if there is any), and if we will resign to the fact that COVID-19 may become endemic like another common respiratory virus such as influenza.

Ms See Wan Han, S-FETP Residency Year 2

MANAGING THE VULNERABLE AMONG US...

The COVID-19 pandemic occurred during my posting with the health services and outcomes research department at the National Healthcare Group. We transformed rapidly-changing local and international information into policy-relevant evidence for Singapore in trend monitoring and predictions, case identification tools and projected resource demands. One such project was the seroprevalence and seroconversion rates among migrant workers.

Singapore's response resulted in good control during the early stages of the pandemic. However, case counts spiralled soon after. Our response seemed to have overlooked the risks of transmission in our sizable workforce of migrant workers living in large purpose-built dormitories. The rapid spread among dormitory-residents triggered a drastic intervention redesign specifically for this subpopulation's circumstances.

A major component of Singapore's COVID-19 response relied on individuals adopting protective behaviours (personal hygiene and social distancing, isolation and quarantine of cases/contacts). However, migrant workers in Singapore are socially and economically disadvantaged with unique circumstances. They have lower health literacy with language barriers. Their living environment is crowded with shared facilities; isolation areas are absent or suboptimal. They are paid on a daily basis and work in sectors that expose them to potential infection.

Failure is not the end-state. Knowing the "whys" of intervention failure allowed for more accessible and effective interventions such as new living environments encouraging protective behaviours, dedicated case-finding and isolation/treatment facilities for dormitory residents, wage support and mandatory employer compliance with public health measures. By August, the results were obvious.

Public health crises highlight deficiencies in systems and responses. These are opportunities for improvement!

Dr Aidan Tan, Preventive Medicine Residency Graduate

DEPLOYMENT IN A COVID-19 WARD...

“Switch on, calibrate, filter check.” This was my morning mantra during my COVID-19 ward deployment. Having failed my N95 mask fit, I had to don the positive air pressure respirator (PAPR) for duty. Very soon after, I was nicknamed, quite aptly, “Darth Vader” as not only did the mask cover two thirds of my face, it also made a rumbling noise every time I breathed. Imagine the apprehension on patients’ faces when they see a “Darth Vader” clad in yellow cape approach them!

But as soon as I shouted (above the rumblings of my PAPR), “*Vannakam, eppadi irrukinge*” (hello, how are you?), I could see their worried expressions soften. They shared with us their journey, their anxieties and their gratitude. It was in that moment I truly understood the power of words, especially those spoken in their own tongue in a foreign land. Words indeed have the adhesive power to fix the divisive cracks that isolate a patient from a doctor, a Singaporean from a foreign worker. But sometimes, words are just not enough.

During my deployment, I was informed of a distressed worker. The team went into the cubicle to find a well-built man with his hands on his head. In his broken English, he explained that his sister had passed away back home. Due to travel restrictions imposed on him, he would not be able to say his goodbye. No words, no matter the language, could heal his broken heart. I could only stand by him, holding his fingers between my glove-clad hands as I listened to his loud wails above the churning of the PAPR.

We arranged for him to video call his family back home whilst the medical social workers continued to provide psychosocial support throughout his stay. And on the day of his discharge, he emerged from his room, his face hidden behind his blue tinged mask. He placed his hand on his chest as if to feel the beating of his heart. It was as if he was seeking confirmation that he had indeed survived this ordeal. We clapped. We cheered. For him. For all of them. And at that moment, perhaps, maybe for us too – as a reminder that we too will survive this tumultuous time, and this too shall pass.

Dr Zeenathnisa Aribou, Preventive Medicine Residency Year 2



Biome of friendly fauna and flora

REFLECTIONS AS A COVID-19 PATIENT...

Serving my national service as a medical officer in the infectious diseases branch, Biodefence and Medical Policy Centre, I did not know whether it was divine intervention, irony or pure bad luck, but I was confirmed positive for COVID-19 in March 2020. I remember the fateful day when it started with a mild throat discomfort, which progressed quickly to a fever and cough.

The initial few days of hospitalisation were extremely difficult and emotional. There were so many unknowns running through my mind. How did I get the infection? Did I pass the infection to any of my friends, colleagues and family who interacted with me while I was symptomatic? What will happen to me and will I recover from the infection? These crippling thoughts repeated non-stop and I felt utterly defeated.

It was also during this period that the COVID-19 situation had dramatically worsened. Daily cases started rising in the hundreds, infecting tens of thousands of Singapore's migrant workers and it was pushing our healthcare system to the limits. I had the opportunity to have a few migrant workers as my roommates during my hospitalisation in Mount Alvernia. My roommates were understandably worried and fearful of the hospitalisation. I felt responsible not just as their roommate, but also as a doctor, to take the time to explain to them about their condition, the ongoing COVID-19 situation and the ongoing policies laid out by the government.

The migrant workers also shared with me their insights on how they felt about the handling of the COVID-19 situation, their life stories and the dreams and aspirations they have for the future. It provided plenty of introspective moments as I watched the segregation between “them” and “us” that had surfaced with the COVID-19 pandemic, particularly on social media. I learnt of the humanity of the migrant worker – a father, a brother, a son, a partner and a friend, and that Singaporeans can all afford to be kinder, more tolerant and more accepting.

We are currently living through a phenomenon which had uprooted and disrupted many of our daily routines. It will serve as a reminder to count all the blessings in my life and not to take them for granted. I now appreciate the value of time and that I should make the best out of it. I have learnt to cherish all the relationships that I have, and to always tell my loved ones how much I love and care for them because life is unpredictable.

Dr Alvin Tan, Preventive Medicine Residency Year 1

IMPROVING THE PUBLIC HEALTH TRUST...

The COVID-19 crisis tested our public health system's abilities to manage a pandemic on all fronts. One stark practical lesson for me was in the challenging area of public health trust.

Although my specific tasks at the Ministry evolved from handling calls by healthcare professionals to managing laboratory notifications, my primary role throughout this pandemic remained in surveillance and case reporting. It provided me with a first-hand opportunity to observe the impact on stakeholders of our policies to deal with this crisis.

We saw a rapid decline in the number of reported community cases following installation of travel restrictions and the circuit breaker. Interestingly, such restrictions also impacted other diseases and syndromes, for example, seeing one of the lowest weekly diarrhoeal numbers in years. Preparations made post-SARS in anticipation of another major devastating outbreak appeared insufficient, contributed in part by the peculiar nature of COVID-19 and a specific group of people it afflicted viz. migrant workers. While our response has been brave and swift, the protracted nature of this pandemic carried harmful social and economic costs.

Our evolving understanding of infection, changing suspect case definitions, and multiple layers of call and electronic notifications, further added to a great deal of anxiety on the ground among doctors and laboratories. Voices echoed loudly in the operations room which experienced the deluge of calls and queries. As we improved by sharpening our guidance and streamlining our mode of notification, these voices quietened. As we moved along this pandemic, leadership from the Ministry is key to soothing stakeholders. Trust had to be maintained for some, regained for others.

For public health to work, trust in the notification processes is key to a successful surveillance system. We needed to project and provide confidence to our colleagues on the ground so that they continue to trust in the system. This has been paramount in ensuring positive cases are promptly notified with swift institution of control measures to impede further transmission.

Indeed, this pandemic truly tested our abilities as public health professionals to maintain and even improve the public health trust.

Mr Imran Roshan Muhammad, S-FETP Residency Year 2

RECOLLECTION OF AN EPIC EXPERIENCE...

I have been active at the National Contact Tracing Centre. The past eight months of COVID-19 operations was an epic experience for someone like me who is relatively new in the field of public health. And the learning still continues! I have drawn hard earned lessons on the importance of maintaining a good healthcare system, and of ensuring that we have enough resources to handle a pandemic.

In peacetime at the communicable diseases division of the Ministry, I used to be the Executive Officer (Training) for contact tracing and was familiar with the contact tracing workflow. But when it came to the pandemic with its massive scaling up of surge capacity, and actual running of the complex COVID-19 operations, I quickly realized that there is still so much more room to grow!

As the situation evolved, for Singapore to adapt, we had to continue changing our standard operating procedures in order to keep up with the changes in policies. In addition, we also had to consider how our policies affected all the other parties which were also heavily involved in COVID-19 operations. This is the first time I am involved in a whole-of-government effort to control a pandemic.

One important insight into the workings of government is that all the different agencies and Ministries have their own mission needs and concerns, and so policy changes which are proposed purely based on public health grounds may not fit with overall national needs and result in pushbacks from some agencies. It can be frustrating at times but this is the reality we have to work in to achieve consensus. For the various agencies to find common ground working together, we have to practice give and take.

I am impressed by the many commitments and sacrificial efforts put in by the many people who have been involved in our COVID-19 operations. It has not been an easy journey but we managed to pull through the difficulties so far. This has been an invaluable experience for me and I am glad to be part of the team!

Ms Peh Xin Yi, S-FETP Residency Year 2

TOGETHER, OUR ENTERPRISE CAN DO MUCH...

I was redeployed early in the outbreak from the Health Promotion Board to the Ministry of Health as a resident to join national efforts in battling the COVID-19 pandemic, and was placed into the epidemiology investigation team. Little did I know what was in store.

The team was set up to establish the epidemiological linkages in community transmission by looking into the backward tracing efforts for all cases and clusters. When we first started, the number of cases was small. Our team worked with the Singapore Police Force and enjoyed quick successes, such as with the connection of two church clusters through serology testing that made national headlines. However, as the number of cases started rising rapidly with the outbreak at the foreign worker dormitories, so also the occasions requiring field epidemiology, on-site visits and risk assessment.

Our understanding of the local virus-human interactions evolved rapidly because we were seeing more and more asymptomatic cases and unlinked cases. Contact tracing by the Ministry underwent a massive transformation in surge capacity with the assistance of manpower from other agencies, and we too had our workload scaled up to a different magnitude. Serology testing became a mainstay in our investigations in order to detect past infections and link cases. Our team had to adapt in order to meet the growing needs of our pandemic response, including contributing to data analysis, for a better understanding of the epidemiologic triad to guide policy-making.

The only way to sustainably and efficiently investigate the large number of cases involved the use of data and IT solutions. Together with the Defence Science and Technology Agency, a social network analysis tool was developed to aid in backward tracing investigations. Through this tool, we were able to analyse large numbers of cases at the same time and connect them through common places visited and common close contacts who were quarantined. Through our collaborations, we managed to connect numerous cases and clusters in a timely manner. Such collaborations and teamwork became imperative in our fight against COVID-19.

While the pandemic has been an inconvenient truth and a cause for much suffering among Singaporeans and global citizens worldwide, it has also allowed us to learn and re-evaluate our priorities as individuals and society. For me, personally, to be able to contribute to our national efforts against COVID-19 is a privilege I do not take lightly, and I will never forget this experience. Alone we can do so little, together we can do so much!

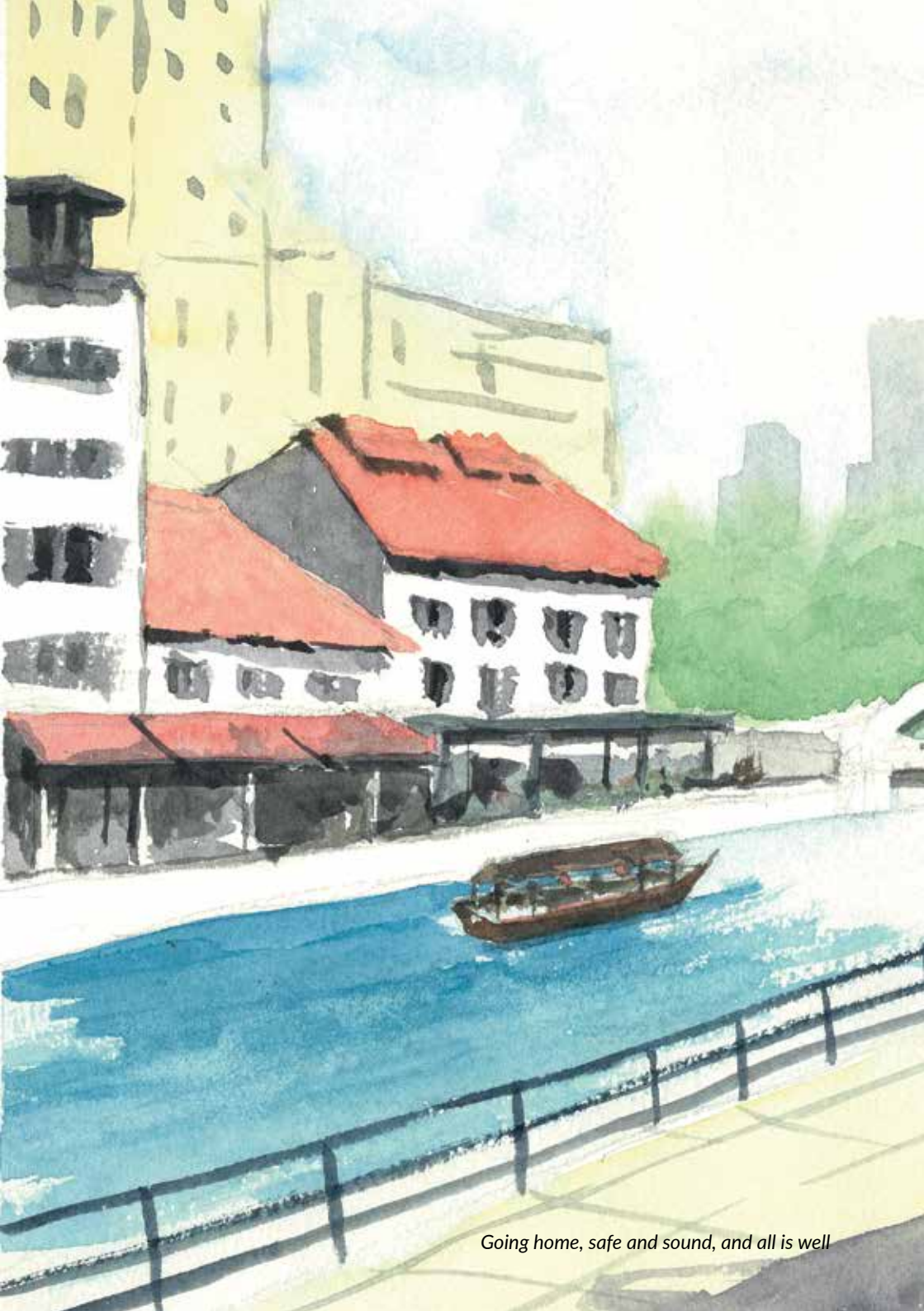
Dr Priyanka Rajendram, Preventive Medicine Residency Year 5

AN EPILOGUE

"The bug
stops here!"

May you always remember fondly the moment
you first decided to help humanity.

The S-FETP Enterprise



Going home, safe and sound, and all is well

Acknowledgements

We wish to thank all our S-FETP fellows, residents, medical practitioners, laboratory personnel, nurses, public health professionals, as well as partners from public and private healthcare institutions and other government agencies, who have, in one way or another, contributed to the information in this publication. We acknowledge their valuable contributions towards our national efforts in communicable diseases prevention and control, and look forward to their continued support and cooperation in our work.

We also gratefully acknowledge the many contributions from our colleagues in the following allied agencies: Ministry of Health Public Health Group, National Public Health Laboratory, National Public Health and Epidemiology Unit, National Environment Agency, Singapore Food Agency, Changi General Hospital, Khoo Teck Puat Hospital, National University Hospital, Ng Teng Fong General Hospital, Sengkang General Hospital, Singapore General Hospital, Tan Tock Seng Hospital, Department of STI Control, National Skin Centre, STEP Registry, TB Control Unit, National Immunisation Registry, and School Health Services, Health Promotion Board.

In addition, we appreciate all who have contributed their subject matter expertise to the various chapters of this publication and more importantly, through their untiring professional efforts, helped to maintain Singapore's high standards of communicable diseases control. Without them, the Singapore FETP enterprise would certainly not have been possible.

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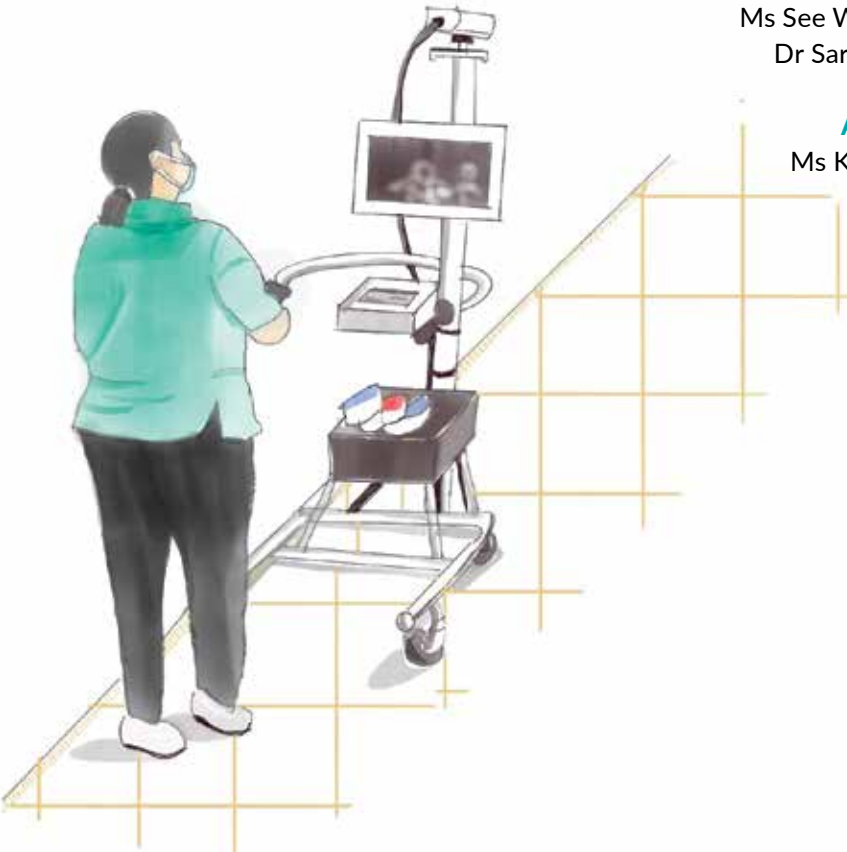
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S-FETP Tenth Anniversary Edition

“Congratulations to Singapore FETP for creating a comprehensive compendium on disease control which is rigorous and practical. We can learn a lot about the scope of the seemingly daunting challenge of communicable diseases whilst gaining some useful insights. I commend this volume to the physicians and non-physicians in our TEPHINET family who are field epidemiologists at heart.”

Dr Carl Reddy, director of TEPHINET, the global FETP network, Atlanta, USA

“This will definitely be a very useful tool and reference material for our field epidemiologists in the region. Congratulations, Singapore FETP, for promoting field epidemiology and producing a compact communicable diseases control manual. You have exemplified our spirit of sharing knowledge and experiences within the ASEAN and East Asian community to improve our common good. Thank you for this most valuable and timely enterprise.”

Dr Thilaka Chinnayah, chair of the ASEAN+3 field epidemiology training network



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