

8 December 2015

**INDEPENDENT REVIEW COMMITTEE RELEASES REPORT ON HEPATITIS C
CLUSTER IN SGH RENAL WARD**

The Independent Review Committee (IRC) chaired by Professor Leo Yee Sin has concluded its review of the Hepatitis C cluster in the Singapore General Hospital (SGH)'s Renal Ward and submitted its report to the Ministry of Health (MOH) on 5 December 2015. (The composition of the IRC is at [Annex A](#), while information on the Hepatitis C virus (HCV) is at [Annex B](#).) MOH has accepted the Report.

Findings on Extent and Causes of the Hepatitis C Virus (HCV) outbreak

2. On the extent of the outbreak, the IRC concluded that the 25 cases in the cluster were localised to the two affected wards in SGH, Ward 64A and Ward 67.

3. In investigating the cause of the outbreak, the IRC tapped on resource persons and experts, received reports and information from SGH and MOH, conducted site visits and interviewed staff involved. It narrowed its study to four possible hypotheses – (i) drug diversion; (ii) intentional harm; (iii) contaminated medical products; and (iv) breaches in infection control. The first three hypotheses were ruled out:

- a) Drug diversion was concluded to be unlikely as there were no missing narcotics and other drugs with potential for abuse in the affected wards.
- b) Extensive search and interview of staff did not yield any evidence supporting intentional harm or foul play. This was corroborated by the police investigation.
- c) Contaminated medical products were an unlikely source. 0.9% Saline solution was the only product common to all patients in the cluster. Ten randomly selected bottles of 0.9% Saline solution taken from Ward 67 tested negative for HCV.

4. The IRC noted that SGH has several commendable practices, such as consistent verification of patients' identity prior to performing procedures, and clear structure for skills development of their nursing workforce. However, the IRC observed during its investigation that there were some gaps in infection prevention and control practices in the two affected wards in SGH (i.e. Ward 64A and Ward 67). These gaps increased the transmission risk of HCV through intravenous procedures:

- a. Deviations from standard procedures in administering intravenous procedures, such as blood-taking and giving of intravenous medications;
- b. Inefficient workflow in the affected wards; and

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- c. Evidence of contamination of medical equipment (such as computerised medical carts and trolleys) and contact surfaces, as a result of inadequate cleaning and disinfection practices.

5. The IRC thus assessed that a combination of multiple overlapping factors was the most likely explanation for the HCV outbreak. Beyond the gaps observed in infection control, the IRC noted that the following characteristics of the ward and the patients contributed to the development of the cluster:

- a. The high concentration of renal transplant patients in the affected wards, who
 - i. had higher exposure risk because they required frequent intravenous procedures;
 - ii. were more susceptible to infection, because of their suppressed immune system; and
 - iii. once infected, carried extremely high quantities of the virus and served as a large virus pool; and
- b. Gaps in infection prevention and control may have been accentuated by the temporary move of the renal ward from ward 64A to ward 67, where the layout was different from ward 64A that staff were familiar with.

6. SGH tightened infection control processes from early June onwards, which was instrumental in containing the spread of infection.

Recommendations on infection control

7. The IRC's key recommendations for SGH to improve infection control are:
- a. To review existing standard operating procedures (SOPs) and practices on infection control, to further reduce risk of contamination of medical equipment and contact surfaces and to ensure adequate environmental cleaning and disinfection;
 - b. To ensure adherence to standard precautions for infection control and adopt best practices such as those laid out in US CDC guidelines with adaptation to the local context; and
 - c. To strengthen the monitoring and supervision framework for staff to ensure compliance to SOPs.

Findings on system response and communications

8. With regard to the overall system response to the outbreak, the IRC noted that the current national surveillance system works well for community outbreaks, while hospitals have robust frameworks to deal with common healthcare-associated

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infections (HAIs). The HCV cluster highlighted a gap in the current system as HCV is an unusual HAI and is not picked up easily through regular surveillance due to its unique characteristics. The IRC had the following observations:-

9. Recognition of the outbreak. The IRC noted while the SGH renal team sensed that something was amiss when four cases were detected in mid-May, it did not recognise this as an outbreak due to its unusual nature, and the fact that SGH had changed its HCV screening test in 2014 to one that is more sensitive. Thus, it did not report it to Infection Control in SGH immediately.

10. Notifications. The national surveillance system is mainly set up to pick up communicable diseases in a community setting. Some characteristics of HCV make it difficult to be detected by the current system. In addition, not all cases of HCV infections were reported by the doctors and laboratories. The notified cases were also not classified as acute HCV infections by MOH at the time based on the prevailing case definition for acute HCV.

11. Outbreak management and containment. The overall outbreak investigations performed by SGH were inadequate in some key aspects when SGH made their briefing to the Director of Medical Services (DMS) on 3 September, such as in determining the severity and extent of the outbreak. As a result, the DMS asked for additional analyses and investigations to be done and actions to be taken, within a timeline of two weeks.

12. Finally, faced with the uncommon and unfamiliar event of an HCV outbreak,
- a. Within SGH, there was a lack of clarity on the roles and responsibilities for the management of unusual HAI outbreaks.
 - b. There were delays in the escalation processes within and from SGH to MOH.
 - c. Within MOH, there was no one division with clear responsibility to oversee outbreaks of unusual HAIs.

13. The IRC found no evidence of deliberate delays by SGH or MOH staff in escalating the outbreak or in informing the Minister for Health. The IRC agreed that the decision of the DMS on 3 September to ask SGH to complete key aspects of investigation was professionally valid and appropriate.

Recommendations on processes and information flow

14. The IRC's recommendations for MOH to improve the system response to cater to unusual and unfamiliar diseases are:
- a. To improve the national notification and surveillance system for acute HCV, taking reference from international best practices and adapted to the local context. Regardless of the systems in place, healthcare professionals should always be alert to unusual events.

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- b. To designate a team within MOH to carry out surveillance, identify and investigate potential outbreaks, and ensure adequate expertise nationally for investigations. Hospitals should continue to take responsibility and develop structures, frameworks and capabilities for HAI outbreaks. Where required, the hospital's capabilities can be supplemented with additional resources from the national healthcare system.
- c. To strengthen the escalation and communication processes for HAIs, especially unusual and unfamiliar ones, within hospitals, public healthcare clusters and MOH, and between them, through clearer guidelines on the assessment of the significance and severity of an HAI, and need for escalation.

15. To read the executive summary of the report, please refer to [Annex C](#). The full report can be found on the MOH website at www.moh.gov.sg/content/dam/moh_web/PressRoom/Current_Issues/2015/ircreport.pdf.

16. Professor Leo Yee Sin, Chairperson of the Committee, extends her thanks to the members, resource persons and international advisors for their contributions to the review. The IRC would also like to thank the management and staff of MOH and SGH for their full cooperation throughout the course of investigation.

Issued by the Independent Review Committee for Hepatitis C Cluster in SGH Renal Ward

Composition of the Independent Review Committee (IRC)

Between April and September 2015, a cluster of 22 cases of Hepatitis C Virus (HCV) infection was identified amongst patients admitted to Ward 64A or Ward 67 at SGH. The IRC was convened on 28 September to provide an objective and critical review of SGH’s investigation, findings and actions. The IRC would also determine if there were gaps in the process, including the timeliness of SGH’s response, the reporting of crucial information within SGH and MOH, and whether there were areas that needed to be tightened and improved upon, such as safety protocols and escalation of information.

2. The IRC was chaired by Professor Leo Yee Sin and was appointed on 28 September 2015. The committee comprised experienced clinicians from different disciplines, including Hepatology, Renal medicine, Infection Control, Nursing, and Quality Improvement and Process Audit.

Table 1: Composition of the Independent Review Committee

Member	Designation
Prof Leo Yee Sin (Chairman)	Director (Institute of Infectious Diseases & Epidemiology) / Clinical Director (Communicable Disease Centre), Tan Tock Seng Hospital
Prof Lim Seng Gee	Senior Consultant (Division of Gastroenterology & Hepatology, Department of Medicine), National University Hospital
A/Prof Helen Oh	Head (Infectious Diseases), Changi General Hospital
Dr Titus Lau	Senior Consultant (Division of Nephrology), National University Hospital
Ms Paulin Koh	Chief Nurse, Changi General Hospital
A/Prof Quek Swee Chye	Deputy Chairman of Medical Board, National University Hospital
Dr Jeffery Cutter	Director (Communicable Disease Division), MOH

Appointment of Resource Persons and Experts

3. The Chairman of the IRC appointed resource persons to assist the committee in their investigative work and review. These resource persons, together with their areas of expertise, are listed in Table 2.

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Table 2: Resource Persons Appointed to the IRC

Resource Person	Designation	Area of Expertise
A/Prof Angela Chow	Head, Department of Clinical Epidemiology Institute of infectious Disease and Epidemiology Tan Tock Seng Hospital	Clinical Epidemiology
Asst Professor Mark Chen	Assistant Professor, Saw Swee Hock School of Public Health National University of Singapore	
Asst Prof Wong Chia Siong	Consultant, Department of Clinical Epidemiology Tan Tock Seng Hospital	
Dr Win Mar Kyaw	Senior Epidemiologist, Department of Clinical Epidemiology Tan Tock Seng Hospital	
Ms Adriana Tan	Data Analyst, Department of Clinical Epidemiology Tan Tock Seng Hospital	Data analyst supporting epidemiology investigation
Mr Joshua Wong	Biostatistician, Department of Clinical Epidemiology Tan Tock Seng Hospital	Biostatistician supporting case control study
Dr Tan Hui Ling	Assistant Chairman Medical Board, (Clinical Quality and Audit) Tan Tock Seng Hospital	Quality Assurance Audit
Ms Sharon Salmon	Assistant Director of Nursing Nursing Administration National University Hospital	Infection Control Expert to assist in Quality Assurance Audit
Dr Richard Guan	Hepatologist, Medical Clinic One Mount Elizabeth Medical Centre	To assist in clinical case reviews
A/Prof Dan Yock Young	Senior Consultant, Division of Gastroenterology & Hepatology National University Hospital	
Dr Chong Chern Hao	Senior Resident National University Hospital	
Dr Mark Muthiah	Senior Resident National University Hospital	
Prof Tan Chorh Chuan	President, National University of Singapore	To advise the committee on matters pertaining to reporting, surveillance and response workflows and structures
Prof Chee Yam Cheng	President, National Healthcare Group College	
Mr Ong Pang Thye	Deputy Managing Partner, KPMG	

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4. The IRC also appointed two teams of international experts to strengthen its capabilities and to provide additional technical and scientific input to the committee's review. The two teams were from the United States' Centers for Disease Control and Prevention and Johns Hopkins University. The international experts worked closely with the Review Committee, including attending committee meetings, as well as conducting site visits and interviews with the local team.

Table 3: International Experts

Organisation	Name	Designation
Centers for Disease Control and Prevention	Dr Scott Dewey Holmberg (Team Lead)	Chief, Epidemiology and Surveillance Branch, Division of Viral Hepatitis, National Center for HIV, Hepatitis, STD, and TB Prevention
	Dr Amanda Beaudoin	Veterinary Medical Officer, International Health Quality Team, Division of Healthcare Quality Promotion, Centers for Disease Control and Prevention
Johns Hopkins University	Prof Trish Perl (Team Lead)	Professor of Medicine and Pathology, School of Medicine, Johns Hopkins University
	Ms JoEllen Harris	Director, Epidemiology and Infection Prevention Program, Johns Hopkins Health System

Information about Hepatitis C

1. Hepatitis C is a liver disease caused by HCV. HCV is primarily a blood-borne virus and the most common modes of infection are through unsafe injection practices, inadequate sterilisation of medical equipment, and the transfusion of unscreened blood and blood products. The virus can also be transmitted sexually and can be passed from an infected mother to her baby; however, these modes of transmission are much less common. HCV is not airborne and is not spread by activities such as sneezing or coughing. It is also not spread by normal social contact like hugging, nor through food, water or the sharing of utensils.
2. The incubation period for Hepatitis C is 2 weeks to 6 months. HCV cases can be acute (i.e. recent infection, within 6 months of exposure), or chronic (i.e. beyond 6 months from infection). A person who acquires acute HCV infection usually does not manifest any symptoms. Thus, Hepatitis C infection may go undetected for a long period of time. The asymptomatic nature of the infection, coupled with variable and long incubation period, poses significant challenges on infectious disease surveillance systems.
3. About 15–45% of acutely infected persons clear the virus spontaneously within 6 months of infection without any treatment.¹ Approximately 55-85% of those infected go on to develop chronic HCV infection. Of these chronic carriers, 15-30% go on to develop liver cirrhosis, and a small proportion may develop liver cancer. HCV infection in immune suppressed patients such as post-transplant patients can cause more profound illnesses. Current antiviral medicines can cure approximately 90% of Hepatitis C infections.
4. HCV infection is diagnosed in two steps:
 - a. Screening for anti-HCV antibodies with a serological test identifies people who have been infected with the virus.
 - b. If the test is positive for anti-HCV antibodies, a nucleic acid test for HCV RNA is needed to confirm HCV infection.
5. Both the HCV antibody and RNA blood tests cannot differentiate between acute and chronic HCV infection. To do so, correlation with clinical findings and other laboratory results is required. Importance is placed on the detection of acute HCV cases so as to ensure that these newly diagnosed cases are not part of an outbreak.
6. Internationally, many HCV outbreaks have been reported both within and outside hospital settings. Furthermore, the virus is resilient and stable in the environment, and such transmission of HCV from environmental contamination has been reported in the literature. Viral infectivity on inanimate surfaces has been shown to be detectable from between 5 days to 6 weeks.

¹ WHO Fact Sheet No. 164 <http://www.who.int/mediacentre/factsheets/fs164/en/> (accessed on 18 Nov 2015)

THE INDEPENDENT REVIEW COMMITTEE REPORT
Executive Summary

This report sets out the findings and recommendations of the Independent Review Committee (IRC) appointed by the Ministry of Health (MOH) to provide an objective and critical review of Singapore General Hospital (SGH)'s investigation and actions following an outbreak of Hepatitis C Virus (HCV) infections at the hospital, and to reasonably investigate any activity within its terms of reference.

Background Information on Hepatitis C Virus

3. HCV is primarily a blood-borne virus and the most common modes of infection are through unsafe injection practices, inadequate sterilisation of medical equipment, and transfusion of unscreened blood and blood products.

4. The incubation period for HCV is 2 weeks to 6 months. Acute HCV infection can be asymptomatic, resulting in significant challenges to its surveillance. Approximately 55-85% of those infected develop chronic HCV infection, of which 15-30% of these chronic carriers develop a chronic liver illness known as cirrhosis, while a small proportion may develop liver cancer. HCV infection in immune suppressed patients such as post-transplant patients can cause more profound illnesses.

5. Internationally, many HCV outbreaks have been reported both within and outside hospital settings. Due to the challenges in surveillance of HCV as outlined above, it took some time to discover and identify these documented outbreaks. The virus is resilient and stable in the environment, and such transmission of HCV from environmental contamination has been reported in literature. Viral infectivity on inanimate surfaces has been shown to be detectable from between five days to six weeks.

SGH Hepatitis C Virus Cluster

6. Between April and September 2015, a cluster of 22 cases of acute HCV infection was identified amongst patients admitted to Ward 64A or Ward 67 at SGH. Subsequently, extensive screening of those who had been admitted to these wards from January to September 2015 identified three more cases, giving a total of 25 cases. Of these, 20 were renal transplant cases. There were eight deaths within the cluster.

7. SGH had conducted its own investigation into the cluster and taken actions to tighten infection control in the affected wards. It presented its investigation findings to the Minister for Health on 25 September 2015. On 28 September, MOH appointed an IRC to provide an independent, objective and critical review of SGH's investigation and actions. The IRC was to ascertain if all possible measures had been taken to identify the possible points where there may have been infection control breaches and to remedy any weak points in the overall workflow, particularly with regard to infection control.

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8. The IRC set out to investigate the incident via two parallel tracks. In the first, the IRC looked into probable causes of the cluster, while in the second, the IRC looked into the system response and communications between SGH, SingHealth and MOH relating to the cluster.

9. For the first track, the IRC appointed two teams of international experts from the United States' Centers for Disease Control (US CDC) and Prevention and Johns Hopkins University to strengthen its capabilities and to provide additional technical and scientific input to the committee's review.

10. For the second track, the IRC appointed three Resource Persons – Professor Tan Chorh Chuan, President of NUS, Professor Chee Yam Cheng, Senior Advisor to National Healthcare Group, and Mr Ong Pang Thye, Deputy Managing Partner, KPMG. Their role was to provide guidance and work with the IRC to evaluate the various parties' responses to the incident. As the review included reviewing MOH's role in the outbreak, IRC member Dr Jeffery Cutter (Director, Communicable Diseases Division, Ministry of Health) recused himself from this part of the IRC's work.

Investigations into the Outbreak

11. The IRC investigated the outbreak based on the principles set forth in outbreak investigations, which focus on confirming and assessing the extent of the outbreak, creating a case definition and actively searching for cases, epidemiological investigation to develop and test hypotheses and communicating findings to relevant authorities for prevention and control measures.

12. Based on SGH's investigations that were presented to MOH, SGH had by end August identified a cluster of 21 cases (later updated to 22 cases in late September) that were linked epidemiologically in time and place. From their investigations, the cluster of infections had taken place from early April to June 2015. The location at which the infection took place was the Renal Ward that was originally operating in Ward 64A, which subsequently moved to Ward 67 on 6 April 2015 when Ward 64A was under renovation, and back to Ward 64A on 28 August 2015. Laboratory analysis by SGH (and subsequently confirmed by A*STAR) noted the presence of a strain of HCV, of genotype 1b, among cases. Thus an outbreak involving a common strain of HCV was established.

13. To ascertain the extent of spread beyond Wards 64A and 67, the IRC reviewed SGH's data on HCV RNA (a genetic test for HCV) and liver function tests, new HCV cases among major dialysis centres in Singapore and the national notification system. The IRC concluded that there was no evidence that the outbreak had spread beyond the two wards in SGH.

14. Case finding began by extensive screening of patients who passed through Ward 64A and/or Ward 67. This started with the screening of 621 patients, who had been admitted in the two wards from 1 January to 30 June 2015. This period was chosen by SGH on the basis that the vast majority of infected patients would present

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with positive results within 10 to 12 weeks of infection. Of these patients screened, three additional cases of HCV infection related to the cluster were identified.

15. As the latest HCV infected case could have been infected in late July, the screening period was extended to September. This would also cover the period after migration from Ward 67 back to Ward 64A. An additional 304 patients were screened and no further cases were identified.

16. In all, the HCV cluster comprised 25 patients, 20 of whom had received a kidney transplant before and were more susceptible to infections. The IRC assessed that out of the eight deaths, HCV was a likely contributory factor to the death of seven cases.

17. The earliest infected case was one who was likely to have been admitted to Ward 64A in early March 2015. Residual blood sampling showed that the case was already infected by mid-March, although there were no earlier blood samples available to be more definite regarding the date of infection. The IRC conducted extensive screening for preceding cases, but there was no definitive evidence of other HCV cases during the earliest infected case's stay in SGH and it is uncertain as to where the case had acquired the infection from.

18. A critical review of the literature was done and taking into consideration the circumstances of this outbreak, four specific hypotheses were tested. These were drug diversion; intentional harm; product contamination; and breaches in infection control.

- a. Drug diversion was concluded to be unlikely as there were no missing narcotics and other drugs with potential for abuse in the affected wards.
- b. Extensive search and interview of staff did not yield any evidence supporting intentional harm. 319 staff including 11 of those who had since left SGH all tested negative for HCV. The findings pointed towards a low probability of foul play. This was corroborated by police investigations.
- c. Contaminated medical products were an unlikely source. 0.9% Saline solution was the only product common to all patients in the cluster. 10 randomly selected bottles of 0.9% Saline solution taken from Ward 67 tested negative for HCV.
- d. While there were established processes for the handling of procedures such as blood taking, administering of intravenous medication, environmental cleaning and waste disposal, some staff were observed to have deviated from the established standards. These practices could have led to cross-contamination of equipment (e.g. computerised medical carts and trolleys) and contamination of contact surfaces. Findings pointed towards gaps in infection prevention and control practices that likely contributed to the outbreak.

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19. The IRC concluded that a combination of multiple overlapping factors was the most likely explanation for the HCV outbreak, which was found to be contained within Wards 64A and 67 of SGH.

- a. Firstly, susceptible cases comprising mainly immunocompromised kidney transplant patients and the introduction of HCV (probably by the patient identified as the earliest infected case) led to acute infections with extremely high quantities of virus in these patients.
- b. All affected patients had many exposures to intravenous medications and/or laboratory tests that required blood taking, exacerbating the risks of HCV spread through gaps in infection control practices.
- c. There were gaps with regard to infection control practices (in particular processes involving intravenous procedures), environmental cleaning, and prevention of environmental contamination. These potentially facilitated HCV transmission in the two affected wards.
- d. Finally, these could have been accentuated by the shift to another ward where the layout was different from the ward that staff were familiar with.

20. During the course of investigations, the IRC observed several commendable practices by SGH staff. For example, consistent efforts were made to maintain patient privacy and confidentiality, as well as to minimise human errors by consistently verifying the patient's identity prior to performing procedures. SGH was also effective in upskilling their nursing workforce, with nurses trained to take on a significant share of tasks normally performed by junior doctors.

21. The IRC recommends that SGH undertake the following to minimise the risk of infection transmission:

- a. Review standard operating procedures and practices on infection control, with a view to reduce risk of environmental contamination, and to ensure adequate environmental cleaning and disinfection.
- b. Adhere to standard precautions for infection control, as laid out in US CDC guidelines².
- c. Strengthen the framework for supervision and monitoring of staff to ensure compliance with standard operating procedures.

² US Centers of Disease Control and Prevention. 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings. Accessed on 23 November 2015. Available from: [<http://www.cdc.gov/hicpac/pdf/isolation/Isolation2007.pdf>]

US Centers of Disease Control and Prevention. 2008 Guideline for disinfection and sterilisation in healthcare facilities. Accessed on 23 November 2015. Available from:

[http://www.cdc.gov/hicpac/pdf/guidelines/Disinfection_Nov_2008.pdf]

US Centers of Disease Control and Prevention. 2003 Guidelines for environmental infection control in healthcare facilities. Accessed on 23 November 2015. Available from:

[http://www.cdc.gov/hicpac/pdf/guidelines/eic_in_HCF_03.pdf]

System Response and Communications Relating to the Outbreak

22. In this track of work, the IRC interviewed the relevant parties in MOH, SingHealth and SGH involved in the outbreak, requested documentation on their key actions, and reviewed correspondences among the different parties. A thematic framework was adopted in assessing key actions and responses, according to five categories: (a) recognition of an infectious disease outbreak; (b) notifications to MOH; (c) outbreak management and containment; (d) communications and escalation and, (e) roles and responsibilities of key players during the outbreak.

23. While the current surveillance system works well for community outbreaks of known infectious diseases and hospitals have robust frameworks to handle common Healthcare-Associated Infections (HAIs), the HCV outbreak highlighted a gap. Specific findings of the system response to the outbreak were:

- a. Recognition: The SGH Renal Unit did not recognise the outbreak in a timely manner and there was a delay in reporting to SGH Infection Control for help in containment.
- b. Notifications: MOH was not notified by doctors and laboratories of all the cases in the cluster. In addition, MOH-CDD did not classify the initial communicable diseases notifications as acute HCV infections despite some cases having abnormal liver function tests, as the cases were assessed not to meet the case definition of an acute infection at the time.
- c. Outbreak management and containment: While SGH commenced investigations into the HCV cluster from mid-May 2015, and enhanced infection control measures from early-June, investigations performed by SGH were incomplete. Several elements of outbreak investigation such as assessing the severity and extent of the outbreak were done by SGH only after meeting with the Director of Medical Services (DMS) on 3 September, such as appointing an external party to chair SGH's Medical Review Committee to determine if there were related deaths due to the HCV infection and setting up a Quality Assurance Committee to do a root cause analysis.
- d. Communications and escalation: Within SGH, communication with senior management took place early. However, in the absence of an established framework for the unusual and unfamiliar event of the HCV outbreak, there was a delay in escalation from SGH to SingHealth, and SGH to MOH. In addition, within MOH, there was no single division with clear responsibility and capability to deal with the issue, resulting in a gap in ownership, until the matter was escalated to the DMS.
- e. Roles and responsibilities: Within SGH, there did not appear to be clear roles and responsibilities for the management of unusual hospital outbreaks. SingHealth did not play a part in the incident. Within MOH, the DMS assessed on 3 September 2015 that more information was needed to determine the severity and extent of the outbreak, and requested SGH to complete key pieces of work within two weeks. The Minister was

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therefore only informed of the issue on 18 September, and briefed on 25 September, after SGH submitted their investigation report on 24 September.

24. In summary, there was a delay in recognising the outbreak as HCV is not easily picked up through regular surveillance due to its unique characteristics. With HCV being an unusual HAI, SGH did not recognise the outbreak in a timely manner. While SGH commenced investigations into the HCV cluster from mid-May, and implemented enhanced infection control measures from early June 2015 onwards which were instrumental in slowing the spread of infection, the IRC is of the view that the outbreak was not investigated and managed optimally. Within MOH, unlike community outbreaks, no one division has clear responsibility to deal with outbreaks of unusual HAIs. This hindered MOH's ability to respond in a timely way to the unexpected event. In addition, the absence of an established framework for unusual and unfamiliar events resulted in delays in escalating the matter from SGH to SingHealth, from SGH to MOH, and within MOH.

25. The IRC noted that DMS was only briefed by SGH on 3 September. His key considerations then were to make his professional evaluation of the severity and extent of the outbreak, to ascertain that adequate infection control measures had indeed been instituted, and to ensure that new transplant patients were not potentially exposed to HCV infection until the issues had been adequately addressed. He therefore asked for specific additional investigations and actions to be taken in relation to each of these within two weeks, and when these were largely done, reported the matter to the Minister. The IRC is of the opinion that the additional investigations and actions required by DMS are professionally valid and appropriate. Overall, while there were gaps in identification, management and reporting of the outbreak, there was no evidence to suggest that escalation to DMS and subsequent notification of the Minister had been deliberately delayed.

26. Beyond community outbreaks, the current surveillance and outbreak response frameworks should be enhanced to cater for unusual and unfamiliar events, with regards to outbreak detection, investigation and management, communication and escalation protocols, and the appropriate roles of MOH and the hospital.

27. The IRC thus recommends that the following measures are undertaken to improve the system response to cater to unusual and unfamiliar outbreaks:

- a. Improve the national notification and surveillance system for acute HCV, taking reference from international best practices and adapting them to the local context. Regardless of the systems in place, healthcare professionals should always be alert to unusual events.
- b. Designate a single team within MOH to carry out surveillance, identify and investigate potential outbreaks, and ensure adequate expertise nationally to facilitate outbreak investigation. Hospitals should continue to take responsibility and develop structures, frameworks and capabilities for HAI outbreaks within their institutions. Capabilities can be supplemented by other public healthcare institutions and MOH where required.

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- c. Strengthen the escalation processes for HAIs, especially unusual and unfamiliar ones, within hospitals, public healthcare clusters and MOH, and between them through clearer guidelines on the assessment of the significance and severity of an HAI, and need for escalation.

Conclusion

28. The IRC concluded that this unusual outbreak of a blood-borne infection with low prevalence rates in Singapore was likely due to a combination of multiple overlapping factors concentrated during the period of April to June 2015 in the Renal Wards of SGH. In particular, the concentration of very ill patients and gaps in infection control practices provided an environment for the infection to spread.

29. While existing surveillance and response systems lend themselves well to known community outbreaks and HAIs, the system response to the incident, which is considered an unusual one, revealed some gaps in the system. The IRC thus recommends improving the notification and surveillance system for acute HCV; designating a single team within MOH to oversee surveillance, investigation and management of outbreaks and ensure adequate expertise nationally to facilitate outbreak investigation; and strengthening escalation processes for HAIs and unusual risks.