Editorial

Pandemic Preparedness: Nationally-Led Simulation to Test Hospital Systems

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Introduction

Cities that receive large numbers of international travellers are particularly vulnerable to outbreaks of emerging infectious disease with pandemic potential.[1] Secondary transmission of Ebola virus disease (EVD) occurred when travellers from West Africa infected healthcare workers in Europe and the United States in 2014.[2,3] Middle East respiratory syndrome (MERS) coronavirus has also caused secondary outbreaks due to travel by infected individuals. While most of these distant outbreaks of MERS have to date been quickly confined, South Korea experienced 185 laboratory-confirmed cases involving 5 generations of transmission over 6 weeks.[4] In Singapore, the Nipah virus in 1998 to 1999, severe acute respiratory syndrome (SARS) coronavirus in 2003 and influenza A/H1N1 in 2009[5] not only had a major impact on the health of its population and notably its healthcare workers, but also more broadly, affected the economy.

EVD outbreaks have occurred regularly in Africa. They have been invariably controlled and halted using conventional infection control practises.[6] However, the 2014 to 2015 EVD outbreak was the largest and the first to leave African shores. The risk of EVD to countries outside of Africa was a concern shared by many health administrations, including those of Singapore.

There is an expectation in Singapore that each healthcare facility will be prepared for the presentation of a traveller with a novel transmissible infectious disease. The cornerstone of providing safety against an infectious disease threat is early identification of a suspect case through robust triage mechanisms at potential sites of patient presentation followed by the institution of rigorous infection prevention and control precautions. Facility-level preparation is typically undertaken by individual healthcare facilities and their key stakeholders. Table 1 shows a generic checklist of requirements for hospital preparation, encompassing in-house evaluations using "table-top" (theoretical) exercises, quality and process improvement "walkabouts", and department-specific simulation exercises.

To mitigate the threat posed by EVD, the Ministry of Health (MOH), Singapore undertook a series of "walkabouts" to assess institutional readiness in most major public and private hospitals across the country during the latter part of 2014. To further test and facilitate enhancement of systems, MOH subsequently undertook full scale national simulation exercises collectively called Exercise Sparrowhawk.

National Simulation Exercise

Prior to the exercises, hospitals were required to submit a copy of their hospital preparedness standard operating procedures to MOH for review. MOH officials and selected external infectious diseases physicians and infection control nurses formed the planning and evaluation team. Preparation commenced 3 months prior to the actual simulations. The team created a timeline for each scenario (an example is shown in Figure 1), developed a comprehensive assessment checklist and had selected MOH staff rehearse the roles of the EVD patient and relatives in respective scenarios. The checklist (Appendix 1) assessed the following domains: Response (Box 1), Personal infection control practices (Box 2), Communications (Box 3), Surveillance and epidemiology (Box 4) and Contact tracing (Box 5). The set of checklists could be adapted to assess performance at different hospital sites based on how the scenario evolved.

A series of 3 scenario-based exercises was conducted in 3 public hospitals between December 2014 and March 2015. Hospitals were informed of the exercise 3 hours prior to commencement to ensure that measures could be instituted to minimise disruption of routine healthcare. Each hospital was tested on a different date, using a different scenario.

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Table 1. Hospital Preparation for Ebola Outbreak

Domains	Requirements
Establish outbreak preparedness taskforce	Key representatives from Infectious Diseases, Infection Control, Epidemiology, Laboratory, Hospital Operations, Corporate Communications, Emergency department, Wards, Intensive Care units, outpatient clinics, operating theatres, Radiology department, Environmental Services, Security, Porters
Personal protective equipment	Protocols for donning and doffing, training of staff, availability of stock
Infrastructure and logistics	Assess capacity for: • Isolation of suspect cases in Emergency department, critical care facilities and general wards • Safe inter-hospital transfer of a patient • Safe testing of specimens • Safe environmental cleaning and waste disposal
Establishing and practising workflows	• Rapid response team led by Infection Control for urgent advice with attendance, as required • All departments that could be exposed to suspect case: Emergency, inpatient wards, outpatient clinics, Laboratory, Environmental Services, Mortuary, Communications, Epidemiology • Consider compiling workflows into a manual containing standard operating procedures
Contact tracing and surveillance system	The Epidemiology department to oversee contacts
Communications	Establish information sharing protocols prior to and after any case, involving the patient/next-of-kin, internally amongst hospital staff and externally with Ministry of Health
Human resource	Contingency plans to sustain routine healthcare
Table-top exercise	Multidisciplinary meeting to discuss and finalise workflows
Unannounced simulation exercise	• Aims to test the system and workflows, and to identify gaps • Planning of case scenarios • Assessment checklist, evaluators and exercise controllers

The first simulation exercise involved a case identified in the emergency department that required transfer to the isolation ward (Fig. 1). A second scenario involved a patient identified late in an open general ward after surgery. A third scenario involved a vomiting child who required interhospital transfer. A total of 5 exercise controllers, 3 actors and 10 evaluators facilitated each exercise. Tasks were divided between the team to ensure that an evaluator was witness to each assessment criteria.

An exercise debrief was conducted immediately at the conclusion of the scenario. This facilitated discussion that covered all aspects of the exercise performance and included the hospital staff, senior management and the evaluation team. This also included an interview and feedback from staff
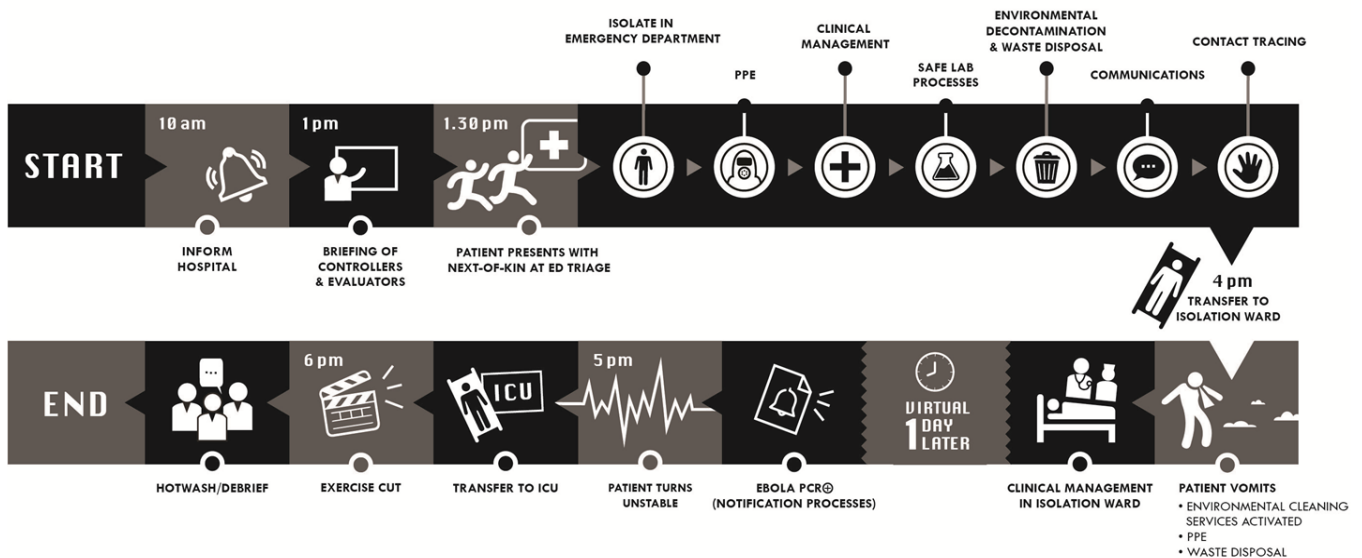

Fig. 1. An exercise timeline.

involved in the prolonged care of an EVD patient, focusing particularly on their physical and emotional well-being. The evaluation team later produced a detailed presentation on the findings and recommendations by way of feedback to hospital management as well as a written evaluation report. Hospitals were required to provide plans for rectification a month after receipt of the report.

In general, all hospitals were assessed as having robust preparedness systems to respond to a potential EVD patient. Some typical key recommendations following the exercise included:

- Scheduled ongoing training on personal protective equipment (PPE) and environmental decontamination;
- Clearer communication with the patient, next-of-kin and other healthcare workers;
- Further details for contact tracing information;
- Limiting the number of healthcare workers in contact with the suspect patient; and
- Provision of staff time limit when wearing full PPE to avoid staff exhaustion and overheating.

Conclusion

Nosocomial transmission of Ebola in Europe and the United States[2,3] highlighted the risk for secondary spread within hospitals distant from Africa even with single imported cases whose diagnosis was already known to hospital staff. Having systems and workflows in place is not sufficient. These need to be tested with gaps identified and rectified. Instituting preparedness activities such as simulation exercises is an ideal tool for this purpose.[7] Each hospital simulation required approximately 250 man-hours from the evaluation team in preparation for and undertaking of the event plus to generate the post-exercise report. Although this was moderately time-consuming and labour intensive, this increased familiarity with workflows, tested the coordination of workflows between different disciplines and allowed the identification of gaps.

It is inevitable that healthcare facilities particularly in countries well-connected globally will remain vulnerable to pandemic threats. Looking beyond the EVD outbreak, Singapore is equipped with an improved infrastructure and workflows that can be adapted for future pandemic threats. Roles and responsibilities within hospitals are clearer. The need to be prepared has facilitated a more generic awareness and state of readiness in Singapore, crystallised by a series of large scale simulation exercises.

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Appendix 1
Assessment Checklist

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Box 1: Response

1. Clinical Management
a. Clear command and control line for the clinical management of the suspect case
b. System to carry out temperature screening of patients.
c. System to identify febrile patients and suspect case. (TRIAGE)
d. System to achieve immediate and effective local isolation by physically isolating the suspect case from other patients by at least 1 metre.
e. System to activate the Infection Control Response Team (team competent and trained to handle the patient).
f. System to transfer and hand over clinical management to ICRT (if applicable)
g. System to reduce exposure to staff (minimum number required to attend to patient)

2. Infection Control Response Team (ICRT)
a. System to pre-determine composition of the ICRT. (EMD is adequately staffed with personnel trained in PPE per shift)
b. Name list with contact particulars of identified ICRT personnel. (System to handover to isolation ward/ ID team after office hours)
c. ICRT staff are adequately protected.
d. System to reduce exposure to ICRT staff (eg minimum number required to attend to patient)
e. System for ICRT to assess infection control risk and initiate appropriate infection controls for the ward and hospital.
f. System to manage and minimise movement of patients in and out of the ward.
g. System to restrict entry of visitors to ward.
h. Demarcation of area to restrict patients/visitors movement (e.g. signages present, perimeter drawn)
i. Appropriate PPE donned to handle suspect patient
j. Alcohol hand-rubs and sanitisers present to staff
k. System to obtain clinical sample from suspect case.
l. System to ensure clinical sample is handled according to appropriate risk group of pathogen.
m. System to transport clinical sample to internal or external laboratory for confirmatory analysis.
n. System to receive result of confirmatory analysis
o. System to communicate to the Hospital Ops Centre and management, information on the detection of the suspect case.
p. System to manage the normal operations together with the detection of the suspect case.
q. System to do contact tracing.
r. System to manage patients and staff (eg, fever monitoring and further management).
s. System to gather exposure history, relevant contact details and check health status of Next-of-Kin
t. System to communicate with Next-of-Kin to inform them of the patient's/case's condition
u. System to ensure cases requiring radiology studies and other procedures are transferred with proper infection control precautions.

3. Intra-hospital transfers
a. Flow of cases out of ward via controlled disposition point.
b. System to notify Isolation Ward or Intensive Care Unit of the transfer prior to actual disposition from the ward.
c. System to assign trolley and management team prior to actual disposition from the ward.
d. Transfer routes are pre-planned.
e. System to minimise contamination of environment and other persons during transfer.
f. Supply of PPE for paramedical staff
g. System to track movement of case e.g. radiology department or operating theatre

4. Inter-hospital Transfers
a. System to notify receiving hospital of transfer prior to actual disposition from the hospital.
b. System to transfer suspect/confirmed case to receiving hospital.
c. Case is accompanied by the required medical staff during the transfer
d. Staff carrying out the transfer are adequately protected.

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Box 1: Response (Con't)

e.   Transfer routes are pre-planned.
f.   System to ensure the transfer and hand-over of clinical management documentation together with the case.
g.   System to document transfer.
h.   System to minimise contamination of environment and other persons during transfer.
i.   System to disinfect equipment (including vehicle), and persons involved in the transfer.

   5.   Disposal and Decontamination
a.   System to carry out decontamination of the environment.
b.   System to dispose biohazardous wastes.
c.   System to protect cleaning staff.
d.   System to store reusable equipment prior to being sent for cleaning.
e.   System to transport, clean, and disinfect reusable equipment.
f.   System to manage dead bodies
g.   System to ensure bodily wastes are treated appropriately

Box 2: Personal Infection Control Practice

   1.   PPE
a.   System to ensure proper donning and doffing of PPE.
b.   Adequate supply of PPE.
c.   Mechanism to request for appropriate additional PPE (for example gloves, gowns) to provide adequate protection.
d.   Proper disposal of PPE after use.
e.   System to manage spills on PPE/breach of PPE

   2.   Hand Hygiene
a.   Standard for hand hygiene clearly defined.
b.   Hand hygiene meets standard for infection control.
c.   Hand washing and drying facilities for staff are within easy access.

Box 3: Communications

a.   Pre-planned communication lines between the Ward, Isolation Ward, Intensive Care Units, Hospital Operations Centre, and with other departments within the hospital.
b.   Telephone lists of ICRT, Isolation Ward, Hospital Operations Centre, and other departments.
c.   Adequate communication means (for example cordless phones, fax machines, walkie-talkies/mobitalk sets, email) to ensure command, control and communication.
d.   System to manage public reaction to knowledge of a suspect case
e.   System to manage Visitor policy if there are changes
f.   System to communicate to the patients/family members on the situation in the ward.
g.   System to gather exposure history, relevant contact details and check health status of Next-of-Kin
h.   System to communicate with Next-of-Kin to inform them of the patient's/case's condition
i.   System to escalate for decision-making
j.   System to ensure adequate covering of key appointment holders during their absence
k.   System to manage the media / press
l.   System to disseminate information for awareness

Box 4: Surveillance and Epidemiology

a. System to report to Ministry of Health unusual health events especially in cases with travel history to EVD affected countries.
b. System to ensure timely notification and update on progress of cases.
c. System to pre-determine composition of epidemiology team.
d. Name list with contact number of epidemiology team staff which the hospital has pre-identified for deployment.
e. System to rotate the staff in the event of a prolonged incident.

Box 5: Contact Tracing

1. Team Setup
a. System to pre-determine composition of Hospital Contact Tracing (HCT) Team.
b. Point of Contact (POC) has been identified.
c. Name list with contact number of HCT Team personnel which the hospital has pre-identified for deployment.
d. Well-defined tasks and responsibilities for HCT Team staff.
e. System to rotate the POC and HCT Team staff in the event of a prolonged incident.

2. Activity Mapping
a. System to trigger activity mapping.
b. System to ensure correct template is used and filled in appropriately.
c. System to ensure that activity map is submitted to Ministry of Health on time and is complete.

3. Hospital Contact Tracing Template
a. System to trigger hospital contact tracing.
b. System to ensure correct template is used and filled in appropriately.
c. System to capture HCW contacts.
d. System to capture patient contacts.
e. System to capture visitor contacts.
f. System to ensure contact tracing information is submitted to MOH on time and is complete.
g. System to monitor health status of HCW contacts
h. System to minimise risk of cross contamination by HCW contacts