ANTIMICROBIAL RESISTANCE & INFECTION CONTROL

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Preparedness of institutions around the world for managing patients with Ebola virus disease: an infection control readiness checklist

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Abstract

Background: In response to global concerns about the largest Ebola virus disease (EVD), outbreak to-date in West Africa documented healthcare associated transmission and the risk of global spread, the International Society of Chemotherapy (ISC) Infection Control Working Group created an Ebola Infection Control Readiness Checklist to assess the preparedness of institutions around the globe. We report data from the electronic checklist that was disseminated to medical professionals from October to December 2014 and identify action needed towards better preparedness levels.

Findings: Data from 192 medical professionals (one third from Africa) representing 125 hospitals in 45 countries around the globe were obtained through a specifically developed electronic survey. The survey contained 76 specific questions in 7 major sections: Administrative/operational support; Communications; Education and audit; Human resources, Supplies, Infection Prevention and Control practices and Clinical management of patients. The majority of respondents were infectious disease specialists/infection control consultants/clinical microbiologists (75; 39 %), followed by infection control professionals (59; 31 %) and medical doctors of other specialties (17; 9 %). Nearly all (149; 92 %) were directly involved in Ebola preparedness activities. Whilst, 54 % indicated that their hospital would need to handle suspected and proven Ebola cases, the others would subsequently transfer suspected cases to a specialized centre.

Conclusion: The results from our survey reveal that the general preparedness levels for management of potentially suspected cases of Ebola virus disease is only partially adequate in hospitals. Hospitals designated for admitting EVD suspected and proven patients had more frequently implemented Infection Control preparedness activities than hospitals that would subsequently transfer potential EVD cases to other centres. Results from this first international survey provide a framework for future efforts to improve hospital preparedness worldwide.

Keywords: Ebola virus disease, EVD outbreak, EVD preparedness, Personal protective equipment

Introduction

On 8th August, 2014 the World Health Organization (WHO) declared the Ebola epidemic to be a Public Health Emergency of International Concern (PHEIC) [1, 2]. The Ebola virus disease outbreak had an unprecedented rate of increase with 22,500 reported cases and nearly 9000 deaths as of 4 February 2015 [1]. Furthermore, cases exported to other countries made this a global concern and both a medical and public health crisis [3]. WHO recommended all nations to implement public health measures to respond to the suspected and confirmed EVD cases and for the international community to strengthen their support towards the affected countries [4, 5]. As pointed out in the Lancet [5], however, there are no incentives or sanctions in place for failing to build capacity to implement such measures. Whilst, infections related to cross-transmission, similar to the ones seen in Dallas, USA and Spain, will probably remain sporadic in the more developed regions around the globe, the widespread transmission in

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healthcare facilities in the three countries most badly affected emphasizes the need for hospitals to be prepared. It is imperative to understand the current situation in the diverse healthcare facilities globally, in order to be better prepared for Ebola and any future emerging infectious diseases.

This survey is an initiative of the International Society of Chemotherapy (ISC) - Infection Control Working Group, to better understand the infection control needs and preparedness levels of various ISC members found globally.

Methods

The ISC infection control working group is represented from officers coming from around 40 different countries around the globe. An Infection Control readiness checklist, based on a draft checklist from the Infection Control Association (Singapore), was compiled by members of the ISC Infection Control Working Group. Following this, an electronic version of the survey was created. Members were asked to further disseminate the survey to other colleagues/healthcare workers in their countries or networks. Copies of this survey were made available to participants at the Infection Control African Network conference organized in Zimbabwe (November 2014). Whilst, there is an optimal representation of ISC infection control working group officers from Singapore, Australia and Switzerland amongst other countries conversely, there is no group representative from Spain or West African countries.

In addition, the link to the questionnaire was circulated via email and printed copies of the questionnaire were also made available for those without access to a computer/internet. Demographic data included: hospital name, city and country. In addition, the questionnaire determined whether hospitals would need to handle suspected and proven EVD cases as compared to only "suspected" cases which would then be subsequently transferred to a specialized centre. The section addressing administrative/operational support specifically assessed alert notification systems in the case of Ebola/emerging viruses and surveillance reports on unexpected deaths or unexplained illnesses. The questionnaire also assessed whether communication mechanisms and visual tools are in place, to provide regular updates to healthcare workers. In addition, respondents were asked whether training and competency assessments on the use and removal of personal protective equipment (PPE) sequence take place at regular intervals. Additional questions assessed infection prevention measures and availability of supplies (e.g. evidence based guidelines, isolation rooms, negative pressure, ventilation, PPE, spill kits, handling of laboratory specimens, waste management). Questions pertaining to the clinical management of patients addressed laboratory diagnostics for the detection of EVD, intensive care supportive facilities, renal replacement therapy and a process for fast tracking accessibility to any new therapeutics for the treatment of EVD. Respondents were asked to select the most appropriate answer from the options provided in each question: 'in place'; 'in progress'; and 'action needed'. At the end of the survey an open-ended question was dedicated to comments from participants. The survey completion period was active between October and December 2014. For those interested in checking their own institution, a complete version of the questionnaire is available in the Additional file 1 of this manuscript.

Analysis

The analysis was performed using descriptive statistics for the survey data. SPSS version 19.0 (IBM Corp, Armonk, NY) was used for data analysis and significant differences between the groups were analyzed by using the Chi-squared test of association. Subsequently, a p-value of less than 0.05 was considered as significant. Comparisons were made between hospitals that would need to admit and manage patients with suspected EVD and those that would provide immediate care and subsequently transfer suspected EVD cases to another specialised centre.

Results

Participants characteristics

The 192 respondents represented 125 hospitals in 45 countries around the globe, with the largest proportion originating from Europe (63; 33 %) and Africa (60; 31 %). Among the remaining respondents were professionals from Australia (19; 10 %), South America (17; 9 %), Asia (16; 8 %) and North America (3; 2 %) as presented in Fig. 1. More than half of the respondents' (83; 54 %), were from hospitals that would admit and manage EVD cases. The remaining 75 respondents (46 %) were from hospitals that would provide immediate care only for suspected cases and then transfer these patients to other specialized centers. In the remainder (30) the role of their hospital was not clear. Out of 192 healthcare workers responding to the questionnaire, 18 did not provide information regarding their medical profession. The majority of the remaining 174 respondents were infectious disease specialists/infection control consultants/clinical microbiologists (75; 39 %), followed by infection control professionals (59; 31 %) and medical doctors of other specialties (17; 9 %). The remaining respondents were nurses (12; 6 %), institutional safety officers (3; 2 %), pharmacists (3; 2 %) and other professions (5; 3 %) (Fig. 2). The majority of respondents from the African continent originated from the southern region ($n = 49$); there were 4 from central Africa, 3 from north Africa, 3 from west Africa and only 1 respondent from east Africa.

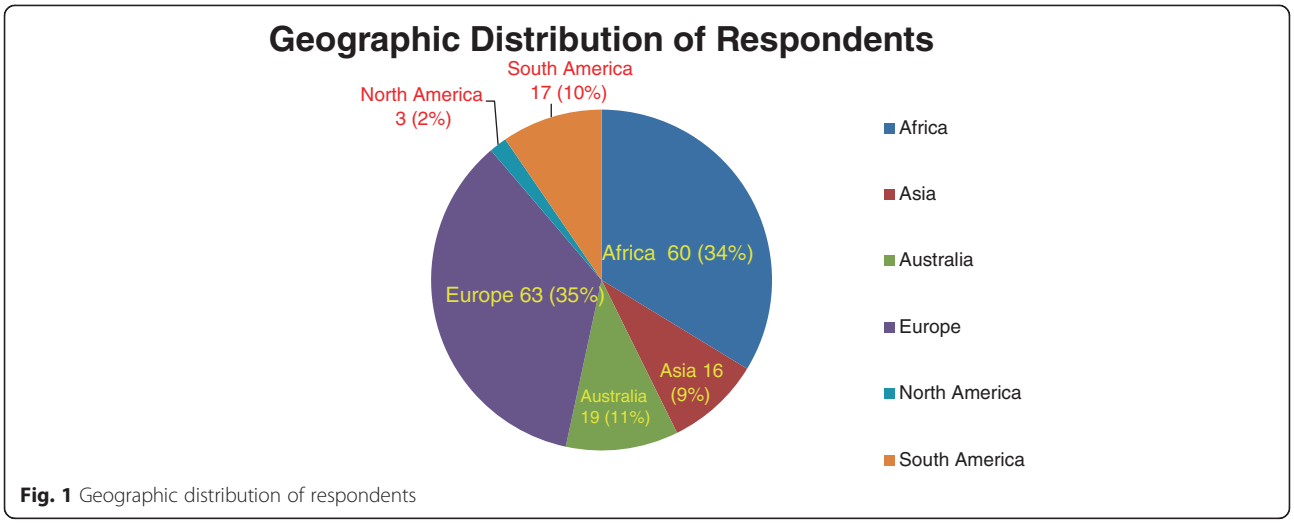

Fig. 1 Geographic distribution of respondents

Administrative and operational support

More than half of the hospitals that would admit and manage suspected EVD patients, have established Infection Prevention and Control (IPC) programs and personnel, represented in the hospitals' operations team preparing for Ebola/other emerging viruses (57; 70 %). Less than half had daily surveillance reports circulated through hospital operations on unexpected deaths in hospitals (30; 36 %). A good number of respondents from hospitals that would treat EVD patients (30; 37 %) as well as the other hospitals that would transfer suspected cases to specialized centers (29; 41 %) stated that action is needed to have a system in place which monitors clusters of patients and staff with unexplained fever. Most "Frontline" healthcare workers were aware (56; 68 %) of the surveillance systems and the notification process upon identification of a suspected EVD case, while others felt that this was still a work in progress (15; 18 %) or something for which action is needed (11; 13 %). The majority of hospitals (57; 70 %) had guidelines in place for implementation of appropriate measures upon the notification of a suspected case of EVD (Table 1).

Communication

Communication and provision of information on Frequently Asked Questions (FAQ's) in response to the EVD outbreak have been implemented for the majority of the hospitals that would admit EVD suspected cases (45; 59 %). Visual tools such as PPE teaching posters, videos in respective languages are available and were disseminated in 29 hospitals (38 %), whilst 28 (36 %) are in progress and 17 (22 %) need action to be taken. Internal communication mechanisms are in place in 42 (55 %) hospitals, providing regular updates to healthcare workers whilst, for 18 (24 %) action is still required (Table 2).

Education and audit

Preparedness activities in response to the EVD outbreak incorporated education and training. When EVD admitting

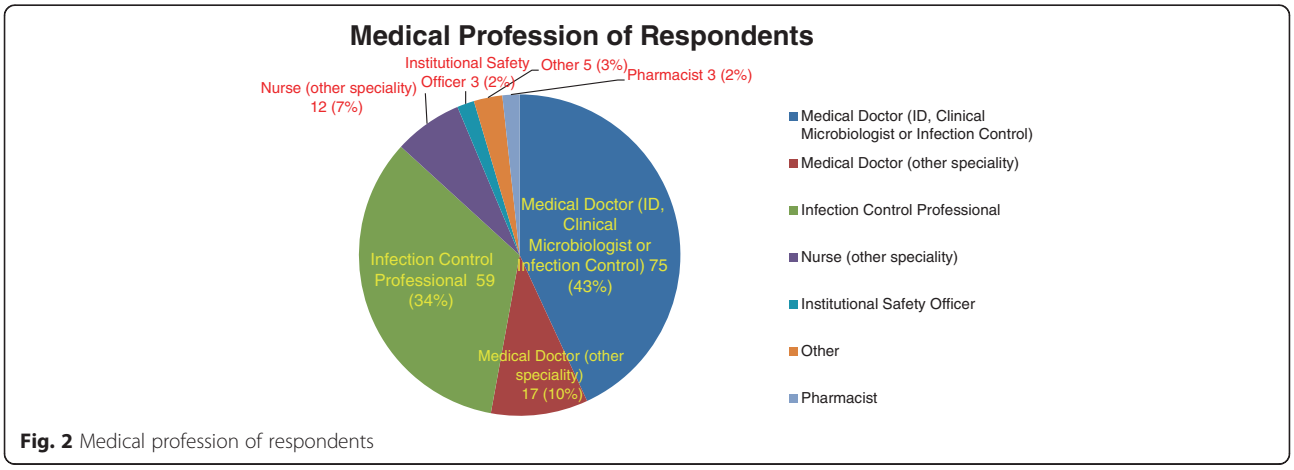

Fig. 2 Medical profession of respondents

Table 1 Administrative operational support

	Hospitals that (would) take care of EDV patients		Other hospitals		Significance
Administrative/Operational support	In place	Action needed	In place	Action needed	
IPC is represented in the Hospital Operations Team preparing for EVD	57 (69.5)	4 (4.9)	46 (63.9)	3 (4.2)	0.7
There is a notification system to alert the hospital Operations and Infection Control of suspect cases of EVD	61 (73.5)	7 (8.4)	51 (70.8)	3 (4.2)	0.4
Daily surveillance reports are circulated on unexpected deaths in hospital	20 (24.1)	30 (36.1)	15 (20.8)	23 (31.9)	0.62
Daily surveillance reports are circulated on unexplained illness in travelers	30 (36.6)	26 (31.7)	19 (26.4)	25 (34.7)	0.5
"Frontline" staff are aware of the surveillance systems and know how to notify suspect cases of EVD	56 (68.3)	11 (13.4)	43 (60.6)	6 (8.5)	0.1
There are plans in place to conduct regular in-house exercises to test systems put in place	41 (49.4)	18 (21.7)	20 (27.8)	14 (19.4)	< 0.01
A policy is in place to implement appropriate measures upon the notification of the first suspect case in the institution	57 (70.4)	12 (14.8)	48 (66.7)	11 (15.3)	0.9
A system is in place to monitor clusters of patients and staff with unexplained fever	27 (33.3)	30 (37.0)	19 (26.8)	29 (40.8)	0.67

hospitals were compared to those transferring suspect patients, almost half (41; 49 %) of the hospitals that would manage EVD patients had plans in place to conduct regular in-house training, to test that the necessary systems are put in place whilst, in 18 (22 %) hospitals this had not been implemented and 20 (24 %) hospitals were working on it ($p < 0.01$). In more than half of admitting hospitals (41; 57 %), training was conducted periodically to ensure healthcare workers' competency and safety in donning/doffing PPE procedures whereas 13 hospitals (18 %) lacked such procedures and in addition, 16 (22 %) hospitals were currently working on it ($p < 0.01$).

Evidence of training activities to ensure healthcare workers are informed about standard precautions was in place in the majority (52 (71 %)) of hospitals that would admit EVD patients; 37 hospitals (56 %) would not admit patients. Data pertaining to visitors and their awareness of cough etiquette and hand hygiene revealed comparable results between hospitals that would admit EVD patients (24; 33 % action needed, 26; 35 % in progress) and hospitals indicating not to admit patients (19; 29 % action needed, 20; 30 % in progress). The details are to be found in Table 3.

Human resource

There are clearly gaps in human resource policy and infrastructure. A sick leave policy for healthcare workers who have sick family members is in place in 21 (30 %) hospitals and action is needed in 34 (49 %) and the remaining is work in progress (6 (9 %)). Subsequently, a plan is in place to support healthcare workers with temporary accommodation for purpose of quarantine during an outbreak in only 14 hospitals (20 %) and action is needed in this matter in 33 hospitals (48 %). Provision of psychological support to medical professionals who were exposed to or were potential suspected cases of EVD

Table 2 Communication

	Hospitals that (would) take care of EDV patients		Other hospitals		Significance
Communication	In place	Action needed	In place	Action needed	
FAQs on infectious diseases of interest e.g. Ebola virus disease (EVD) are disseminated to all staff in the healthcare facility in particular to frontline staff	45 (59.2)	14 (18.4)	33 (46.5)	19 (26.8)	0.28
PPE teaching posters, slides and/or video are available in appropriate languages and disseminated	29 (38.2)	17 (22.4)	28 (39.4)	22 (30.9)	0.45
Drafts on public messaging with respect to screening, ward shutdown, etc. are in readiness	28 (36.8)	25 (32.9)	9 (12.7)	30 (42.3)	< 0.01
A draft press release for the first case of EVD identified in the hospital is prepared	19 (25.3)	27 (36.0)	10 (14.1)	40 (56.3)	0.03
Internal communication mechanism is in place to provide regular updates to staff	42 (55.3)	18 (23.7)	37 (52.8)	17 (24.3)	1

Table 3 Education & Audit

	Hospitals that (would) take care of EDV patients		Other hospitals		Significance
Education and Audit	In place	Action needed	In place	Action needed	
There is evidence of training to ensure all healthcare workers (HCWs) know about standard precautions and isolation precautions	52 (71.2)	4 (5.4)	37 (56.1)	6 (9.1)	0.07
HCWs are aware of cough etiquette and hand hygiene	61 (83.5)	3 (4.1)	53 (80.3)	3 (4.5)	0.88
Patients are aware of cough etiquette and hand hygiene	30 (41.1)	21 (28.8)	28 (42.4)	19 (28.8)	0.97
Visitors are aware of cough etiquette and hand hygiene	20 (27.4)	24 (33.0)	24 (36.4)	19 (28.8)	0.52
There are training teams in place who can rapidly train all staff in hospital on infection control	46 (63.0)	10 (13.7)	35 (53.0)	9 (13.6)	0.4
There are audit teams who can audit infection control independent of the IPC teams	24 (33.8)	28 (39.4)	16 (25.0)	35 (54.7)	0.22
Training and competency assessment are done for the designated teams at the high risk areas on use of PPE and its removal sequence	36 (50.0)	12 (16.7)	27 (41.5)	15 (28.1)	0.38
Training and exercises are conducted periodically to ensure staff competency and safety in use of PPE	41 (56.9)	13 (18.1)	22 (33.8)	13 (20.0)	< 0.01
Where applicable, training and competency assessment is planned for staff handling human waste management e.g. the use of the autoclave machine	26 (36.1)	22 (30.6)	20 (30.8)	15 (23.1)	0.74

was in place in 16 hospitals (23 %) and 40 hospitals needed to take action on this issue (58 %). In hospitals indicating that they would admit EVD patients, the fit test for the N95 respirator was in place in only 21 (30 %) hospitals, whilst 23 (33 %) needed action and others 21 (30 %) were still in progress (Table 4).

Supplies

The majority of the respondents from hospitals that would admit EVD patients stated that, PPE (i.e. masks, gloves, gowns, eye protection) was easily accessible to healthcare workers particularly in frontline areas (55, 89 %). However, only 37 respondents (54 %) indicated that a process is in place for regular checks (i.e. expiry date) on PPE items to ensure their appropriate usage. The majority of participants, identified that for scarce supplies of PPE, a system is in place (49; 72 %) to prioritize healthcare workers caring for affected cases (Table 5).

Essential support services

Essential support activities in response to the EVD outbreak were in place for methods of cleaning and disinfecting healthcare facilities. In 51 (75) of the respondents, disposal of medical and non-medical solid waste are in accordance with national standards, cleaning and disinfection is done for reusable equipment between patient use

Table 4 Human resource

	Hospitals that (would) take care of EDV patients		Other hospitals		Significance
Human resource	In place	Action needed	In place	Action needed	
All frontline healthcare workers with contact with patients have completed the mask fit test with a N95 respirator	21 (30.0)	23 (32.9)	11 (17.7)	30 (48.4)	0.13
Policy is in place for HCWs who are not well or exposed to infectious agents to be given sick leave without penalty	34 (47.9)	24 (33.8)	32 (51.6)	20 (32.3)	0.84
A sickleave policy for staff who have sick family members/dependents is in place	21 (30.0)	34 (48.6)	19 (31.7)	28 (46.7)	0.96
Designated teams are appointed to high demand/ risk services (e.g. infectious disease wards, emergency & ICUs) to ensure that all the necessary clinical services are covered in the event of restriction of some HCWs from clinical service due to isolation, treatment and/or quarantine	27 (38.6)	22 (31.4)	11 (17.7)	26 (41.9)	0.05
A plan is in place to meet needs of staff for temporary accommodation for purpose of quarantine during an outbreak	14 (20.3)	33 (47.8)	11 (17.7)	37 (59.7)	0.1
A plan is in place to provide postexposure prophylaxis or vaccination if this is available for the emerging infectious disease	25 (35.7)	27 (38.6)	22 (35.5)	25 (40.3)	0.94
A plan is in place for providing psychological support (professional counseling) to staff who were exposed, who were suspects or have loved ones who were EVD patients	16 (23.2)	40 (57.9)	12 (19.3)	35 (56.4)	0.5

Table 5 Supplies

	Hospitals that (would) take care of EDV patients		Other hospitals		Significance
Supplies	In place	Action needed	In place	Action needed	
Personal protective equipment (PPE) (i.e. medical/surgical masks, gloves, gowns, eye protection) is easily accessible to staff especially in frontline areas	55 (80.9)	7 (10.3)	42 (68.9)	6 (9.8)	0.13
Where the supply of PPE is limited, prioritization is done for staff caring for cases	49 (72.1)	8 (11.8)	33 (54.1)	12 (19.7)	0.13
Stockpiling is done for essential supplies and chemoprophylaxis agents according to national guidelines	36 (52.2)	15 (21.7)	22 (36.7)	22 (36.7)	0.12
A process is in place for checks on PPE and other stockpile items to keep items current i.e. not expired by date	37 (53.6)	11 (15.9)	33 (54.1)	16 (26.2)	0.36

in 52 hospitals (76 %) and plans exist for safe disposal of human body waste in 44 hospitals (66 %) (Table 6).

Infection prevention and control practices

Preparedness for infection prevention and control activities in response to the EVD outbreak included availability of isolation rooms which were in place in 46 hospitals (69 %), isolation rooms with ≥12 air changes per hour were in place in only 38 hospitals (56 %) and required action in 22 hospitals (33 %). Additionally, when isolation rooms from hospitals in Africa were compared to those in all other countries participating in this survey a significant statistical difference was identified ($p < 0.01$) where more than half of the isolation rooms 26 (55 %) in African countries were not in line with isolation room standards. Auditing of compliance to IPC guidelines related to handling laboratory specimens is in place in 30 hospitals (45 %) and requires action for implementation in 16 hospitals (24 %). Similar numbers are seen in food preparation as well as cleaning and laundry. Availability of alcohol hand rub agents at point of care areas for use by healthcare workers was assessed and compared between Africa and other continents and a significant statistical difference was identified, with considerable action needed, particularly in Africa (48 % and 2.8 % respectively). A policy is in place for the safe management of the patient following death; including use of body bag, cleaning of the corpse in 32 hospitals (48 %) whilst, it required action in 19 hospitals (29 %) (Table 7). This is a concern as EVD is well documented to be transmitted during burials and funerals.

Clinical management of patients

Clinicians' preparedness in recognizing the characteristics of patients suffering from EVD, especially in EVD admitting hospitals were compared to non-admitting hospitals. In 37 hospitals (56 %), laboratories had protocols in place for the diagnosis of fever in travelers returning from West Africa so as to promptly rule out malaria and typhoid. Intensive care facilities are available and in place for patients with suspected and probable EVD, providing supportive care in 31 (48 %) in hospitals that would admit patients. Renal replacement therapy is in place for patients with

Table 6 Essential support services

	Hospitals that (would) take care of EDV patients		Other hospitals		Significance
Essential support services	In place	Action needed	In place	Action needed	
Estimation is done for additional medical and other supplies and plan is in place to introduce a mechanism to ensure the continuous availability of these supplies	33 (48.5)	18 (26.5)	17 (29.3)	22 (37.9)	0.09
Methods of cleaning and disinfecting the respective areas in the healthcare facilities are in accordance with the national guidelines and standards	51 (75.0)	5 (7.3)	44 (77.2)	3 (5.3)	0.94
Methods for the disposal of medical and nonmedical solid waste are in accordance with the national guidelines and standards.	51 (77.3)	6 (9.1)	37 (63.8)	5 (8.6)	0.22
Cleaning and disinfection is done for reusable equipment between patient use in accordance with current national IPC guidelines	52 (76.5)	7 (10.3)	46 (79.3)	2 (3.4)	0.26
Trained cleaning personnel are appointed for the high risk areas e.g. Emergency department and isolation ward	33 (48.5)	17 (25.0)	24 (42.1)	15 (26.3)	0.46
Plans exist for safe disposal of human body waste (urine and faeces) into public system–disinfection with appropriate concentration of disinfectants OR autoclaving onsite before normal disposal process	44 (65.7)	13 (19.4)	27 (47.4)	14 (24.6)	0.13

Table 7 Infection prevention and control practices

	Hospitals that (would) take care of EDV patients		Other hospitals		Significance
Infection prevention and control practices	In place	Action needed	In place	Action needed	
The IPC Department or Unit is responsible for development of evidencebased and practical IPC guidelines for the institution or publication and dissemination of the current national guidelines or international guidelines if local guidelines are not available	43 (65.2)	11 (16.7)	40 (68.9)	7 (12.1)	0.84
Isolation areas/rooms for examination of suspect cases are identified in clinical areas (inpatient and outpatient)	46 (68.7)	12 (17.9)	40 (68.9)	7 (12.1)	0.66
Staff are aware of the process for safe movement of suspect patient from point of identification to examination area/room for review	47 (70.1)	7 (10.4)	32 (56.1)	9 (15.8)	0.34
Isolation rooms/ward is available for use at all times in case of a suspect or probable case	50 (74.6)	11 (16.4)	34 (58.6)	8 (13.8)	0.13
Isolation rooms should ideally be adequately ventilated single rooms (optimally ≥12 air changes per hour) and negative pressure for aerosol generating procedures, with anteroom	38 (56.7)	22 (32.8)	20 (34.5)	23 (39.7)	0.07
Process is in place for regular monitoring of the pressure and ventilation of the isolation rooms to ensure good maintenance ready for use	33 (49.2)	25 (37.3)	21 (36.8)	24 (42.1)	0.58
There is clear identification of and restriction to the rooms, routes and buildings used in connection with patient care of patients with suspected and probable EVD	37 (55.2)	21 (31.3)	25 (43.1)	18 (31.0)	0.42
Number of visitors is limited to those essential for patient support and they take the same IPC precautions as the healthcare workers	50 (74.6)	10 (14.9)	33 (56.9)	13 (22.4)	0.12
Medical/surgical masks are provided to all suspected and confirmed cases during transport	53 (80.3)	6 (9.1)	39 (67.2)	9 (15.5)	0.04
A particulate respirator is used during aerosolgenerating procedures (e.g. aspiration of respiratory tract, intubation, resuscitation, collection of nasopharyngeal swab/aspirate, bronchoscopy, autopsy).	37 (55.2)	16 (23.8)	24 (41.3)	20 (34.5)	0.26
PAPR is available when needed (as alternative to N95 mask for healthcare workers who fail to fit) and who have been adequately trained in their use, and decontamination	25 (37.9)	29 (43.9)	9 (15.5)	32 (55.2)	0.01
Compliance to IPC guidelines related to handling laboratory specimens is audited regularly with timely feedback to stakeholders for prompt correction actions to be taken	30 (44.8)	16 (23.9)	22 (39.9)	16 (27.6)	0.65
Compliance to IPC guidelines related to food preparation is audited regularly with timely feedback to stakeholders for prompt correction actions to be taken	24 (36.9)	22 (33.8)	28 (49.1)	18 (31.6)	0.33
Compliance to IPC guidelines related to laundry and cleaning services is audited regularly with timely feedback to stakeholders for prompt correction actions to be taken	36 (56.2)	15 (23.4)	29 (50.9)	13 (22.8)	0.85
Compliance to IPC guidelines related to waste management is audited regularly with timely feedback to stakeholders for prompt correction actions to be taken	43 (66.2)	10 (15.4)	32 (56.1)	10 (17.5)	0.48
The sequence in putting on and removal of PPE is developed	44 (67.7)	8 (12.3)	32 (56.1)	6 (10.5)	0.2
Adequate alcohol hand rub agents are provided at point of care areas for use of healthcare workers	44 (68.7)	16 (25.0)	44 (77.2)	9 (15.8)	0.48
Hand moisturizer is freely accessible for use of healthcare workers to help maintain skin integrity on hands	29 (45.3)	28 (43.7)	32 (56.1)	20 (35.1)	0.52
Spill kits complete with absorbent pads and disinfectants are freely accessible in the isolation rooms for timely and prompt use by healthcare workers when required	26 (39.4)	29 (43.9)	17 (30.4)	23 (41.1)	0.18
Healthcare workers are familiar with steps for management of spills and competent in safe execution of these steps	39 (59.1)	9 (13.6)	28 (49.1)	8 (14.0)	0.41
Staff working in high risk areas (Emergency Department, Isolation Wards) work as a team in looking out for each other on integrity of PPE during use, safe removal and compliance to IPC guidelines	38 (58.5)	11 (16.9)	29 (50.9)	12 (21.0)	0.73

Table 7 Infection prevention and control practices *(Continued)*

Where applicable, for patients discharged home following recovery from an infectious disease, family members are instructed on the appropriate IPC measures to be taken at home	30 (45.4)	21 (31.8)	24 (42.1)	14 (24.5)	0.55
Contact tracing teams are trained and competent in contact tracing methodology	39 (59.1)	14 (21.2)	33 (57.9)	14 (24.6)	0.39
Policy is in place for exposure management of staff and this includes investigations, quarantine/sick leave	31 (46.9)	19 (28.8)	26 (45.6)	16 (28.1)	0.94
Healthcare workers are familiar with steps in reporting of exposures	51 (77.3)	7 (10.6)	40 (70.2)	4 (7.0)	0.27
Policy is in place for safe after death management such as use of body bag, cleaning of corpse at clinical area	32 (48.5)	19 (28.8)	21 (36.8)	19 (33.3)	0.36

renal failure due to EVD in only 15 (23 %). In only 18 hospitals (27 %), is a process is in place for fast tracking access to any new therapeutics which might become available for the treatment or chemo-prophylaxis of EVD (Table 8). This is a concern given the limitations of current clinical trials on EVD vaccines and therapeutics in West Africa.

Discussion

After WHO's Public Health Emergency of International Concern (PHEIC) declaration on 8th August 2014, plans and strategies for the early recognition and management of EVD patients were activated in several countries around the globe. Our group's EVD Infection Control preparedness questionnaire was compiled so as to assess the level of preparedness of hospitals in Africa, Asia, Europe, Australia, North and South America at that time. The level of preparedness was assessed on a hospital level rather than on a nationwide scale to better understand what was needed at a more micro level in different hospitals. This survey explored the hospitals' preparedness levels from the medical professionals perspectives, in several countries. No responses were obtained from the three affected countries with widespread and intense EVD transmission.

Moreover, 6 countries (Mali, Nigeria, Senegal, Spain, United Kingdom and USA) have previously reported a case or cases imported from a country with intense EVD transmission. Our survey reported on participating hospitals from Nigeria ($n = 3$), United Kingdom ($n = 9$) and USA ($n = 3$) only, with no respondents from other countries. As the number of respondents differed substantially with low numbers in Nigeria and USA, results should be interpreted with caution. Nonetheless, whilst UK and USA have many of the preparedness activities implemented, responses from Nigeria indicate lack of essential PPE and lack of periodical training to ensure staff competency and safety in use of PPE.

The EVD transmission cases in healthcare workers in Spain and US have demonstrated the absolute need for adequate training of healthcare workers in correct PPE donning and doffing sequences as well as in developed countries. Of note, in a recent survey of preparedness for admission of EVD patients in European hospitals, the authors identified a high proportion of hospitals (27 %) not

Table 8 Clinical management of patients

	Hospitals that (would) take care of EDV patients		Other hospitals		
Clinical management of patients	In place	Action needed	In place	Action needed	Significance
Clinicians especially frontline clinicians in the ICU and EMDs are trained in recognizing the characteristics of patients with EVD	41 (62.1)	6 (9.1)	29 (52.7)	9 (16.4)	0.38
Clinicians are aware of the basic principles of supportive clinical care for patients with EVD	48 (72.7)	4 (6.1)	29 (51.8)	14 (25.0)	< 0.01
Laboratories have protocols in place for the detection of EVD	40 (61.5)	12 (18.5)	25 (44.6)	15 (26.8)	0.31
Laboratories have protocols for the diagnosis of fever in travelers returning from West Africa in particular ruling out malaria and typhoid promptly	37 (56.1)	16 (24.2)	34 (60.7)	8 (14.3)	0.43
ICU facilities are available for patients with suspected and probable EVD to receive the best supportive care	31 (47.7)	23 (35.4)	14 (25.0)	20 (35.7)	0.21
Renal replacement therapy is available for patients with renal failure due to EVD	15 (22.7)	29 (43.9)	9 (16.1)	22 (39.3)	0.77
A process is in place for fast tracking access to any new therapeutics which might become available for treatment or chemoprophylaxis of EVD	18 (27.3)	30 (45.5)	1 (1.8)	31 (56.4)	< 0.01

having performed training for healthcare workers' putting on and removal of PPE through safe methods [6]. Comparable to the findings based on European hospitals (46 %), from de Jong and colleagues [6], our survey demonstrated that 49 % of admitting hospitals had plans in place for regular in-house drills, testing the systems put in place. On the other hand, only 28 % of non-admitting hospitals would perform such exercises. Even though, EVD suspected cases would subsequently be transferred to a specialized centre, the initial examination would be performed in the hospital where the patient has presented. Therefore, even in non-admitting general hospitals, drills may prove to be a useful tool in making healthcare workers aware of such management protocols.

The isolation rooms with recommended standards of negative pressure ventilation and the presence of anteroom were lower both for admitting and non-admitting EVD patients (57 % and 34 %) when compared to the survey of 48 highly infectious diseases units in 16 European countries (100 and 90 %) and also the recent survey in 14 European countries (87 and 69 % respectively). This indicates some of the global inequalities with regards to healthcare resources between North and South [6, 7].

At the time of the survey, a substantial proportion of EVD admitting hospitals lacked high-care settings such as ICU and renal facilities (action needed: 35 and 44 % versus 11 and 18 % still in progress, respectively). Patients with Ebola require intensive care and renal replacement therapy, and clinical reports have indicated that improved supportive care ameliorates patient's chances of survival, therefore they are essential [3]. While the questionnaire did not assess the reason for the absence of certain measures, some hospitals might have intentionally chosen not to offer this treatment to EVD patients, due to the increased risk of exposure to blood and body fluids for the healthcare workers. We hope that this is not the case.

With regards to laboratory preparedness our survey did not assess the bio containment levels for processing blood specimens for EVD diagnostics. Nevertheless, it looked at having protocols in place for the detection of EVD or other emerging viruses from travelers returning from West African countries. It should be noted that 24 % did not have protocols for diagnosis of fever in travelers returning from West Africa and 18 % of admitting hospitals did not have protocols in place for the detection of EVD. This is clearly a cause for concern as prompt and accurate recognition of cases is critical for EVD and other emerging infectious diseases.

Soon after the emergence of SARS outbreak in 2003, the Centre for Disease Prevention and Control and the World Health Organization, issued strong recommendations for health-care facilities on the use of respiratory hygiene and cough etiquette as part of the standard precautions [8–10]. This survey identified that the awareness of patients and visitors of cough etiquette and hand hygiene was low in both admitting and non-admitting hospitals. Such basic general Infection Control measures aimed at reducing or preventing the dissemination of infectious agents from the original source should always be in place irrespective of the threat of emerging viral diseases including pandemic influenza or novel coronavirus infections [10].

The unfortunate secondary EVD transmissions that occurred in the US and in Spain, have stressed the importance of repeated training and demonstration of competency of healthcare workers in Infection Control practices, particularly in PPE procedures [11, 12]. The finding that 12 % of hospitals needed action in developing the correct donning/doffing PPE and another 18 % are still work in progress shows that there is a lot of room for improvement as well as an opportunity for international organizations to provide this training, either by webinars or regional seminars in these countries and regions.

The WHO guidelines stress on safeguarding the well-being of healthcare workers by making optimal provisions for hand hygiene, PPE availability and ease of access. One of the primary responsibilities of the employer is allowing all the necessary equipment provisions so as to protect the health and safety of the employees [13]. Scientific evidence indicates alcohol hand rub is more effective, it saves time and provides better hand hygiene compliance when compared with hand washing with soap and water [14, 15]. Nevertheless, in our survey, alcohol-based hand rub availability at point of care was lacking in 25 % of EVD admitting hospitals and 16 % of hospitals who would transfer EVD suspected cases to a specialized centre. Moreover, at the time of this survey both admitting and non-admitting hospitals lacked spill kits in considerable amounts (44 and 41 % respectively). This is a concern given the global efforts to disseminate the WHO hand hygiene formulation to even very low resource settings.

The ease of accessibility to PPE in hospitals only providing immediate care to suspected EVD cases which are then transferred to other centers was lacking in 10 % of these hospitals, whilst in 21 % this was still in progress. PPE must be available and accessible to all healthcare workers at all times. The US CDC recommends healthcare facilities use a powered air-purifying respirator (PAPR) or an N95 respirator in the event of an unexpected aerosol-generating procedure [16]. Notwithstanding this recommendation, the availability of PAPR as an alternative to N-95 for healthcare workers failing the fit test was only available in 38 % of EVD admitting hospitals.

The need for ameliorated global preparedness for emerging infectious diseases outbreaks has been identified here. In order to save lives and protect healthcare workers, it is vital for healthcare facilities to make available essential equipment in some countries and ensure that standardized

training with regular competency assessments on use of PPE and the removal sequence is implemented on an international level.

A major limitation of our survey is that even though we had respondents from the majority of continents and countries, the survey results may not be fully representative of medical professionals and hospitals across the globe for a number of reasons. The geographical distribution of survey participants might not have contributed equally and may not be fully representative of global hospitals due to limited or unavailable participants from some areas, such as the three countries heavily affected by the Ebola outbreak (Liberia, Guinea and Sierra Leone). Whilst, there were high numbers of responses from Zimbabwe, Singapore, Australia, Croatia and Switzerland suggesting overrepresentation of findings from these countries, there were only 3 respondents from West African country of Nigeria. The number of respondents from each different country was small, affecting generalizability of results from this survey. Since, respondents were not limited to one per hospital there could have been over-representation from some hospitals or countries. It would have been ideal to have a fair distribution of respondents for the various regions of the continents since the majority of respondents from Africa were from Southern Africa which is not representative of the whole African population. In addition, the authors recommend that a follow-up of this survey is made by addressing the Ebola outbreak affected countries explicitly. Findings from such survey would add substantial contributions to current knowledge.

Another limitation in this article is the time gap between data collection and publication hence; during the period elapsed facilities might have made other implementation changes in their preparedness. Despite these limitations and the resulting uncertainties, the results presented here help us to understand the importance for infection prevention. Our survey depicts issues which have not been previously reported in the literature such as lack of guidelines for healthcare workers exposed to infectious agents, accommodation of healthcare workers during an outbreak and psychological support for suspected healthcare workers exposed to EVD.

In conclusion, data provided as well as the checklist itself, may support various hospitals around the globe to assess their preparedness level whilst taking the necessary actions to address gaps in their preparedness. This survey is one of the first surveys to represent a global snapshot of infection prevention practices that have been put in place in the preparedness of healthcare facilities for a potential EVD case. It offers an important tool for assessing hospitals' preparedness to EVD or other new emerging pathogens in a comprehensive manner. In order to save lives and protect healthcare workers in hazardous environments, the international community needs to strengthen its support to affected countries by continuing to share experiences, provide training, perform competency assessments and provide basic necessary supplies. This survey revealed that, despite most of the facilities having EVD plans for implementation in place, shortcomings in preparedness have been identified. Basic Infection prevention recommendations are often lacking but most importantly the actual application of recommended guidelines sometimes falls short. These observations point to immediate priorities for control, training and equipping in particular for low resourced countries around the globe. The general preparedness levels, for the management of potentially suspected cases of Ebola virus disease is only partially adequate in some hospitals. In addition, the findings from this article emphasize the need for global preparedness plan/ protocol implementation order to control EVD and other emerging diseases as well as preventing diseases transmission to HCWs.

Additional file

Additional file 1: Infection Control Readiness Checklist - Ebola.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Substantial contribution was made from the core team in creating this checklist with members from the Infection Control Association (Singapore): ML, PA, BA, LL, LCL. In addition, SM, BA, JH and AV gave comments and suggestions towards the development of the final checklist. All participating members gave the final approval of the survey version to be published; ET, BA, BA, NC, PC,JH, LL, LC, ML, SM, PT, AW, AV. ET and AV drafted the manuscript. Statistical analysis was performed by NC. All authors read and approved the final manuscript.

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