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Abstract

Background: The first case of Ebola diagnosed in the United States and subsequent cases among two healthcare workers caring for that patient highlighted the importance of hospital preparedness in caring for Ebola patients.

Methods: Infectious disease physicians who are part of the Emerging Infections Network (EIN) were surveyed about current Ebola preparedness at their institutions from October 21-November 11, 2014.

Results: Of 1566 EIN physician members, 869 (55.5%) responded to this survey. Almost all institutions represented in this survey showed a substantial degree of preparation for the management of patients with suspected and confirmed Ebola virus disease. Despite concerns regarding shortages of personal protective equipment, approximately two-thirds of respondents reported that their facilities had sufficient and ready availability of hoods, full body coveralls and fluid-resistant or impermeable aprons. The majority of respondents indicated preference for transfer of Ebola patients to specialized treatment centers rather than caring for them locally. In general, we found that larger hospitals and teaching hospitals reported higher levels of preparedness.

Conclusion: Prior to the CDC's plan for a tiered approach identifying specific roles for frontline, assessment, and designated treatment facilities, our query of infectious disease physicians suggested that healthcare facilities across the United States were making preparations for screening, diagnosis and treatment of Ebola patients. Nevertheless, respondents from some hospitals indicated that they were relatively unprepared.

The 2014 Ebola outbreak that first began in Guinea in December 2013 [1] is the largest and most geographically dispersed Ebola outbreak ever reported, affecting multiple countries in West Africa. Unlike previous Ebola outbreaks, which have occurred in rural areas, the majority of transmission has occurred in more populated and urban areas [2]. Indeed, higher population densities have helped spread the disease [3]. Clusters of Ebola transmission have been noted in clinics and hospitals in affected countries [4]. Transmission to healthcare providers has occurred in West Africa [5,6] and, rarely, in the United States (U.S.) [7] and Spain [8]. These cases highlight the importance of hospital preparedness in countries outside West Africa. Hospital preparedness includes a wide range of activities including infection-control planning, monitoring healthcare staff, environmental cleaning, waste handling, diagnostics, systematic screening for exposures, and ensuring the availability, training and appropriate use of personal protective equipment (PPE). We queried the Infectious Disease Society of America's (IDSA) Emerging Infections Network (EIN) to gain a better understanding of hospital preparedness for Ebola in the United States. In this paper, we provide a cross-section of Ebola preparedness in October-November 2014.

Methods

The IDSA EIN is a provider-based network of practicing infectious disease physicians from all 50 states, the District of Columbia, and Canada [9]. An eighteen-question survey (http://www.int-med.uiowa.edu/Research/EIN/Ebola2014_query.pdf) was conceived, developed and conducted by EIN staff with technical assistance from CDC. EIN sent the electronic query to all network physicians on October 21 and it remained open until November 11, 2014. We sent 2 reminders to non-responders at 1-week intervals. Data about region of practice, years of experience, and employer were taken from the EIN database.

Respondents were asked to indicate their facility type (community, non-university teaching, university, VA/DOD hospital, city/county hospital) and its inpatient bed size (<200, 200-350, 351-450, 451-600, >600 beds). The survey included questions regarding Ebola and patient care, screening protocols, personnel, PPE and laboratory testing. Finally, to address the issue of multiple responses from the same institution, we performed a sensitivity analysis to determine if our results changed when we only considered a single respondent from each institution, specifically the member with the longest duration of EIN membership. We analyzed the data using SAS software, version 9.3 (SAS Institute, Cary, NC). Fisher's exact and $\chi 2$ tests were used when appropriate.

Results

We distributed the query to 1,566 enrolled EIN members and received 869 (55.5%) responses. Respondents from 47 states and the District of Columbia represented a broad geographic distribution (see Table 1). Sixteen percent of respondents to the survey (n=143) were excluded from the remainder of these results because they indicated that they either did not see inpatients or were not aware of their hospital's Ebola planning process.

Ebola Testing and Patient Care

Most respondents (494/726, 68%) reported that they would prefer transferring Ebola patients to a regional facility rather than treating them within their own facility. These preferences differed substantially by hospital type and size (see Table 2).

Of 726 infectious disease physicians involved in inpatient care or aware of their hospital's Ebola planning, only 94 (13%) respondents reported that a patient in their hospital had been tested for Ebola in the previous 3 months. Respondents at smaller hospitals were significantly less likely to report patient testing for Ebola (see Figure 1, p=0.0003), and testing a patient for Ebola also varied by type of hospital

(p<.0001). For the 94 (13%) respondents reporting at least one patient being tested, we received 68 open-text-field responses for alternative clinical diagnoses that explained their symptoms, and these represented a wide range of conditions. Alternative reported diagnoses included malaria (n=40), upper respiratory infection (n=10), gastroenteritis / traveler's diarrhea (5), undifferentiated febrile illness (n=4), psychiatric illness or erroneous history (n=3), typhoid (n=2), and other (n=4).

Protocol and Screening

Most respondents (650/726, 89%) reported that their hospital had a written protocol for managing and testing suspected Ebola patients (see Table 3). Of these 650 respondents, 616 (95%) reported that this protocol included instructions for screening patients for Ebola, and 515 (79%) reported that there were arrangements for disposal of contaminated items.

Most respondents (646/690, 94%) reported that screening would take place at initial intake, rather than during provision of patient care (26/690, 4%). To trigger a screening, 254 (37%) reported that only a history of travel to endemic areas would be required, 30 (4%) reported that only signs and symptoms (e.g., fever) would be required, and 391 (57%) reported that both positive travel history and signs/symptoms would be required.

Healthcare Personnel

When asked whether their hospital had a specific team of healthcare personnel to care for Ebola patients, 505/690 (73%) of respondents answered yes. Most respondents (517/690, 75%) also had policies that limit the number of healthcare providers who have direct patient contact. Finally, 59% (411/690) said their hospital limited the number of trainees who have direct patient contact (19% responded that they did not have trainees in their hospital).

CDC's Interim U.S. Guidance for Monitoring and Movement of Persons with Potential Ebola Virus Exposure was released on October 27, 2014 [10]. An excerpt is shown in the Box (insert Box here). Briefly, healthcare workers who provide care to Ebola patients in U.S. facilities while wearing appropriate PPE and with no known breaches in infection control are considered to have low (but not zero) risk of exposure. Healthcare workers taking care of Ebola patients in a U.S. facility where another healthcare worker has been diagnosed with confirmed Ebola without an identified infection control breach are considered to have a higher level of potential exposure (exposure level: high risk). Such individuals would be subject to restrictions, including controlled movement.

Because the query was conducted from October 21-November 11, 2014 (CDC *Interim U.S. Guidance* was released on October 27, in the middle of the reporting period), respondents understandably reported varying views about the monitoring and movement of healthcare workers with potential Ebola virus exposure at their institutions. Some respondents (252/690, 36%) reported that they would have these individuals self-monitor and report symptoms if they occur, 182 (26%) of respondents were unsure, 129 (19%) reported that there would be daily active contact and institutional monitoring, 82 (12%) reported that both self-monitoring and institutional monitoring would be required, and 45 (7%) chose 'other'. In open text field comments, numerous respondents indicated confusion regarding what the 21 day restrictions for healthcare providers, considered to have a higher level of potential exposure (exposure level: high risk), entailed. Some respondents also reported concern that nursing staff might not be available due to the potential risk of being required to take off work for 21 days in the unlikely event they were found to be in a high risk category.

When asked if technology (e.g., video link/telemedicine) would be used for consultative care to avoid direct patient contact, most respondents (416/690, 60%) reported yes, but 138 (20%) were unsure. Finally, most respondents believed that they had adequate staff to treat Ebola patients: 512/690

(74%) were not concerned that there would be too few healthcare providers who were willing to care for Ebola patients if the need arose.

Personal Protective Equipment (PPE)

Respondents were queried about the specific types of PPE available in their hospital and their protocols for training staff for PPE use. Sixty-three percent (435/690) of facilities had PPE that covers the head and neck currently available and in sufficient supply (as determined by the respondents), 20% (139) did not, and 17% (116) were unsure. Sixty-four percent (442/690) of respondents worked in facilities with sufficient full-body protective suits (19% did not, and 17% were unsure). Sixty-six percent (457/690) reported that their facilities had sufficient disposable, fluid-resistant or impermeable aprons (13% do not, and 21% were unsure).

Most respondents reported that their institutions had implemented specific PPE protocols including in-person training and practice for donning PPE before a case appears (604/690, 88%), use of a buddy system for PPE removal (558, 81%), use of a trained observer to manage PPE removal (481, 70%), and full-scale drills with simulated patients (298, 43%). However, 9% of respondents report that their hospital had implemented none of the above protocols.

Laboratory Testing and Other Issues

A variety of plans for clinical laboratory testing (other than Ebola diagnostic testing) were reported by respondents, including point-of-care testing at the patient's bedside (iSTAT, etc., 451/690, 65%), additional testing in a BSL3 hood or special laboratory (153, 22%), testing in the hospital's main laboratory with additional safeguards (162, 24%), and testing offsite including arrangements for transit/shipping (262, 38%), while 85 (12%) were unsure.

Finally, respondents were asked about communications between their hospital and public health officials. Eighty-one percent (560/690) of respondents reported that their hospital had a designated individual who was responsible for communicating with public health officials; 8% (54) answered that they did not have such an individual identified, and 11% (76) were unsure. Among those who answered yes to this question, 78% (437/560) reported that they could identify the designated person at the hospital.

Sensitivity Analysis

On review of our data, we concluded that 767 of the 869 respondents were from unique facilities, while 102 respondents represented at least the second responder from a single institution. We repeated all analyses, ignoring 102 "duplicate responses", and found that all statistical results remained unchanged (at the $p<.05$ level). In addition, all response results based on the smaller data set remained within two percentage points of the complete data set. Finally, the frequency distribution and relative frequencies for all results were also unchanged.

Discussion

Since the time this query was conducted, CDC has adopted a tiered approach to U.S. Hospital Preparedness that identifies specific roles for frontline healthcare facilities, assessment hospitals, and designated Ebola treatment centers. Frontline healthcare facilities should be able to rapidly identify, triage, and isolate any patient with exposure history and signs or symptoms compatible with Ebola. Ebola assessment hospitals should be prepared to receive, isolate and care for patients under investigation until a diagnosis of Ebola can be confirmed or ruled out, and transfer to a designated Ebola treatment center, if indicated, is completed. [11]. In October-November 2014, almost all institutions represented in this survey showed a substantial degree of preparation for the screening,

diagnosis and management of patients with suspected and confirmed Ebola. The focus on preparation appeared to parallel the public concern regarding this disease and state and local efforts to improve preparedness for Ebola. In general, the larger the hospital, the higher the level of reported preparedness. Although the majority of respondents indicated that they would prefer to transfer Ebola patients to specialized treatment centers rather than care for them locally, the reported preparation efforts indicated recognition of the importance of their ability to effectively screen, diagnose, and initially manage patients locally. Further, in the event of a confirmed case, only a minority of respondents (26%) thought that they would have difficulty finding healthcare providers to take care of Ebola patients. Reasons for healthcare workers' unwillingness to care for Ebola patients included financial issues, e.g., payment/compensation during furlough or 21 days of isolation post exposure. Other concerns focused on travel restrictions and being afraid to go home to family after caring for Ebola patients.

Measuring preparedness using a one-time query is difficult as hospitals' reactions to guidelines were evolving throughout October. Ideally, we would have answers for the same questions from the same respondents repeatedly at sequential time intervals. However, this query was not designed as a longitudinal study and statistical inferences comparing responses from the first week to the third week should not be made. Interestingly, in the comments section, a few respondents volunteered that had they answered the survey earlier, their answers would have reflected a lower degree of preparedness. Our survey was initially distributed on October 20, 2014, the day after the clarified healthcare PPE recommendations, which followed the EVD transmission that occurred among healthcare providers caring for the index patient in Dallas [12]. Our questions were designed to address this revised CDC guidance [13]. Thus, it is not surprising that more people indicated better preparedness over time, especially regarding new and more extensive PPE recommendations. Responses from different

responders over the three week period of response suggest that preparedness may have increased over time.

Despite concerns regarding potential shortages, approximately two-thirds of respondents reported sufficient availability of hoods, full body coveralls and fluid-resistant or impermeable aprons. We did not specifically ask how many days' worth of supplies institutions have on-site or the anticipated rate of use. It should be noted that early reports on the care of patients with Ebola have indicated a prodigious rate of supply usage [14,15]. When asked in an open-text field to describe any issue that needed to be addressed in order to enable their facility to safely care for suspected Ebola patients, the most frequently mentioned topic was concern about PPE. A number of respondents reported that their facilities had sufficient supplies for a short period of time, but concern was expressed over availability of ongoing supplies should a suspected patient be admitted. Concern was also expressed regarding the need for additional training of staff regarding PPE and, in particular, donning and doffing protective equipment. Ambulatory care settings were identified as a particular area of concern given needs for training staff in these settings.

In general, larger hospitals and teaching hospitals were significantly more prepared than other types of hospitals, which may be related to more resources including infection prevention physician and nurse staffing, dedicated isolation units and other resources [16, 17]. Interestingly, our respondents at military/Veterans' Affairs hospitals reported the lowest availability of an Ebola patient management protocol.

While responses to this query indicated substantial preparedness, challenges remain. For example, although some physicians reported their hospital had a detailed plan in place, only 43% had practiced full-scale drills including simulated patients. Nine percent had not practiced donning PPE, used a buddy system/trained observer for PPE donning and doffing, or had a site manager oversee PPE use, or full-scale drills In addition, our results indicated that communication and messaging could be

improved in hospitals. For example, although 81% were aware that their institution had an individual responsible for communicating with public health officials, 22% of these respondents did not know who this person was. Finally, a number of respondents indicated a desire for more detailed communications from public health officials at all levels. In the comments section of our query, respondents focused on the lack of clear guidance about a variety of issues including where monitoring of exposed healthcare workers should occur and whether exposed healthcare workers could enter patient rooms while still asymptomatic. More specific guidance was also requested on ambulatory care, and ethical guidelines for cardiopulmonary resuscitation.

There are several limitations to our study. First, as noted above, our query was not specifically designed to address time related changes as we did not ask the same respondents the same questions in a serial fashion. Thus, the later respondents may have reported greater levels of preparedness for a variety of reasons. Second, we did not specifically ask what role the respondents played in Ebola planning at their institution. We did ask if members were unsure of the level of preparedness at their institutions, but only 10-20% of members indicated that they were unsure about PPE supplies, and these respondents were significantly more likely to answer “unsure” to the healthcare, personnel plans and training questions. Thus, the majority of respondents seem well prepared to answer questions about Ebola preparedness. Third, there was potential for bias in our sample. EIN is not a random sample of providers, and clinicians who participate in the EIN may not necessarily represent the opinions of clinicians who do not participate. Also, EIN physicians involved in Ebola preparation might have been more likely to respond to this survey than others, leading to upwardly biased results. However, the response rate for this survey was high relative to previous EIN queries (56%), and respondents from all sizes and types of hospitals as well as all U.S. Census Bureau divisions were represented. Because some of the questions were focused at the institutional level, an additional potential limitation is the issue of

multiple responders from a single institution. However, our sensitivity analysis showed that ignoring multiple responses did not change our results.

In general, infectious disease physicians practice at larger hospitals that can support subspecialists; it follows that our results may not reflect the smallest frontline hospitals, and this is another limitation for our study. However, our respondents are employed by a wide range of hospitals including university hospitals, non-university teaching hospitals, community hospitals, veterans' hospitals, and city/county public hospitals, and our respondents represented a wide range of hospital bed sizes from less than 200 to greater than 600 beds. Of concern, we found that respondents from smaller hospitals (less than 200 beds) reported that these facilities were, in general, less prepared. To address issues about preparedness in smaller hospitals, states are developing Ebola response plans that include specific roles for frontline small hospitals to rapidly identify and isolate persons with a travel or exposure history and signs and symptoms of Ebola, and identifying other hospitals in their jurisdiction that can receive transferred patients with suspected or confirmed Ebola [18]. In addition, persons currently in the United States with potential Ebola exposure are actively monitored by public health officials on a daily basis during the 21 days after their last exposure [19]. Our results provide a cross-section of Ebola preparedness in October-November 2014, prior to the CDC's plan for a tiered a tiered approach identifying specific roles for frontline, assessment, and designated treatment [20] facilities. Our query of infectious disease physicians suggested that healthcare facilities across the United States were making preparations for screening, diagnosis and treatment of Ebola patients. Nevertheless, respondents from some small hospitals indicated that they were relatively unprepared.

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Box: Excerpt from CDC's Interim U.S. Guidance for Monitoring and Movement of Persons with Potential Ebola Virus Exposure
Healthcare workers who provide care to Ebola patients in U.S. facilities while wearing appropriate PPE and with no known breaches in infection control are considered to have low (but not zero) risk of exposure because of the possibility of unrecognized breaches in infection control and should have direct active monitoring. As long as these healthcare workers have direct active monitoring and are asymptomatic, there is no reason for them not to continue to work in hospitals and other patient care settings. There is also no reason for them to have restrictions on travel or other activities. Review and approval of work, travel, use of public conveyances, and attendance at congregate events are not indicated or recommended for such healthcare workers, except to ensure that direct active monitoring continues uninterrupted. Healthcare workers taking care of Ebola patients in a U.S. facility where another healthcare worker has been diagnosed with confirmed Ebola without an identified breach in infection control are considered to have a higher level of potential exposure (exposure level: high risk). A similar determination would be made if an infection control breach is identified retrospectively during investigation of a confirmed case of Ebola in a healthcare worker. These individuals would be subject to restrictions, including controlled movement and the potential use of public health orders, until 21 days after the last potential unprotected exposure.

Table 1. Practice characteristics of EIN respondents versus non-respondents.

	Respondents (N=869)	Non-respondents (N=697)
Practice: Adult ID	646 (74%)	547 (78%)
Pediatric ID	198* (23%)	122 (18%)
Both adult and pediatric ID	25 (3%)	28 (4%)
Region: New England	66 (8%)	40 (6%)
Mid Atlantic	128 (15%)	89 (13%)
East North Central	124 (14%)	103 (15%)
West North Central	76 (9%)	74 (11%)
South Atlantic	148 (17%)	133 (19%)
East South Central	50 (6%)	31 (4%)
West South Central	58 (7%)	39 (6%)
Mountain	50 (6%)	47 (7%)
Pacific	156 (18%)	130 (19%)
Puerto Rico	1 (0.1%)	1 (0.1%)
Canada	12 (1%)	10 (1%)
Years experience since ID fellowship		
<5 years	183 (21%)	230 (33%)
5-14 years	246 (28%)	237 (34%)
15-24 years	225** (26%)	109 (16%)
≥25 years	214 (25%)	121 (17%)
Employer: Hospital/clinic	251 (29%)	202 (29%)

Private/group practice	222 (26%)	179 (26%)
University/medical school	343 (40%)	279 (40%)
VA and military	45 (5%)	34 (5%)
State government	8 (1%)	3 (0.4%)

*p=0.02

**p<0.0001

Table 2. Preferences for continued care for Ebola patients in their own facilities versus transfer to a regional Ebola care facility, shown by facility type and inpatient bed size.

By facility type*	Continued care in your facility	Transfer to a regional Ebola facility
Community (n=220)	28 (13%)	192 (87%)
Non-university teaching (n=177)	42 (24%)	135 (76%)
University (n=260)	143 (55%)	117 (45%)
VA or DOD hospital (n=39)	8 (21%)	31 (79%)
City/county (n=30)	11 (37%)	19 (63%)
By inpatient bed size*		
<200 (n=106)	18 (17%)	88 (83%)
200-350 (n=207)	58 (28%)	149 (72%)
351-450 (n=113)	32 (28%)	81 (72%)
451-600 (n=122)	44 (36%)	78 (64%)
>600 (n=178)	80 (45%)	98 (55%)
TOTAL	232 (32%)	494 (68%)

*$p<0.0001$

Table 3. Written protocol available to healthcare providers for dealing with suspected Ebola patients, shown by facility type, inpatient bed size and week of response.

By facility type*	Yes	No	Unsure
Community (n=220)	194 (88%)	16 (7%)	10 (5%)
Non-university teaching (n=177)	161 (91%)	9 (5%)	7 (4%)
University (n=260)	241 (93%)	7 (3%)	12 (5%)
VA or DOD hospital (n=39)	27 (69%)	8 (21%)	4 (10%)
City/county (n=30)	27 (90%)	2 (7%)	1 (3%)
By inpatient bed size**			
<200 (n=106)	91 (86%)	9 (8%)	6 (6%)
200-350 (n=207)	179 (86%)	19 (9%)	9 (4%)
351-450 (n=113)	102 (90%)	4 (4%)	7 (6%)
451-600 (n=122)	113 (93%)	3 (2%)	6 (5%)
>600 (n=178)	165 (93%)	7 (4%)	6 (3%)
By week of response***			
Week 1 (n=380)	332 (87%)	28 (8%)	20 (5%)
Week 2 (n=218)	197 (90%)	11 (5%)	10 (5%)
Week 3 (n=128)	121 (95%)	3 (2%)	4 (3%)
TOTAL	650 (90%)	42 (6%)	34 (5%)

* p=0.0015

** p=0.15

***p=0.20

Figure 1. Percent of Facilities that had Tested a Patient for Ebola by a) Number of Beds and b) Type of Hospital, October 21-November 11, 2014