World Health Organization

A PRELIMINARY REPORT
21 May 2015

Health worker Ebola infections in Guinea, Liberia and Sierra Leone

SUMMARY

This special WHO report is the first to summarize the impact of the Ebola epidemic on the health workforce of Guinea, Liberia and Sierra Leone. It investigates the determinants of infection and describes safe practices put in place to protect health workers during the epidemic. The report covers the period from 1 January 2014 to 31 March 2015.

In this report, the term ”health worker” includes not only clinical staff, but all those who work in health services, including drivers, cleaners, burial teams, and community -based workers amongst others.

This preliminary report describes and characterizes health worker infection and infection outcomes, and quantifies the health worker infection risk. It summarizes the findings based on the 815 confirmed and probable cases for whom individual case reports (as opposed to aggregate data) were available through the Viral Haemorrhagic Fever (VHF) database. However, it should be noted that those were preliminary data, since the national VHF database is currently being revised and updated in Liberia and Sierra Leone. For this reason, our data might differ from those available within the countries.

Preliminary analysis shows that, depending on their occupation in the health service, health workers are between 21 and 32 times more likely to be infected with Ebola than people in the general adult population.

A large number of nurses and nurse aides have been affected, accounting for more than 50% of all health worker infections with occupation reported (n= 373/718). Other categories of health workers affected include medical workers (doctors and medical students, 12%), laboratory workers and trade and elementary workers (janitors, maintenance staff, etc.) with 7% each.

Preliminary findings of a systematic review of the published literature on health-care workers’ filovirus infections (both Marburg and Ebola viruses), including those in the current outbreak, show that identifying the precise risk factors and the situations in which health workers were exposed is very difficult. However, serious gaps in implementing infection prevention and control (IPC) standards were reported in the settings where transmission likely took place or where infected health workers were employed. Among these, the most frequently reported were deficiencies in administrative, engineering and environmental controls, inappropriate use or lack of personal protective equipment (PPE), defective IPC practice and behaviour, and poor employment conditions and social determinants.

It was also difficult to establish the setting where health workers acquired the infection. Exposure may have occurred in health facilities where triage may not have been effective and where health workers unknowingly provided care to Ebola-infected patients. It is also possible that the infection was acquired in the community with or without linkage to care provision. In addition to their official employment in governmental facilities, many health workers work in private clinics or outpatient offices or in their community.

WHO/EVD/SDS/REPORT/2015.1

This is another possible setting where exposure can happen. Finally, exposure risks exist for health workers working in Ebola treatment facilities.

The range of possible circumstances of health worker infections flags the importance of going beyond the supply of personal protective equipment to ensure better working conditions and practices.

Health worker infections can be prevented. WHO and partners have worked with ministries of health, partner managers and health workers to put in place IPC and Occupational Health and Safety (OHS) strategies and supplies to prevent health worker infections and improve patient safety. The reduction in the infection of health workers as a proportion of all cases from 12% in July 2014 to a low of 1% in February 2015 may be attributable to these preventive interventions. This Situation Report does not seek to establish causality, but highlights examples of key strategies implemented to prevent health worker infections.

The Ebola epidemic has taken a heavy toll on the already scarce health workforce in the three most affected countries. Among the health workers for whom final outcome is known, two-thirds of those infected have died (61% among hospitalised vs 74% for those not hospitalised). With higher risks of exposure in caring for others, health workers were disproportionately impacted and traumatized by Ebola. This has exacerbated the pre-existing shortage of health workers, high rates of attrition, uneven distribution, poor employment conditions and gaps in OHS in the three countries. Guinea, Liberia and Sierra Leone have developed investment plans to build health system resilience, including strategies to cultivate a needs-based health workforce. Health workers played a critical yet high risk role in responding to the Ebola epidemic and in working to meet the health needs of their communities during the epidemic. Many paid for this with their lives. Protection from Ebola infection and provision of psychosocial support is a critical priority to safeguard and support the health workforce, protect patients and preserve public trust in the response and in the reactivation of safe essential health services. There is no health care without a health workforce that is fit for purpose, protected and capable of meeting the needs of the population.

One lesson learnt from the Ebola epidemic is that health worker protection is key to the capability of health systems to respond to health emergencies and meet routine healthcare needs. Health worker protection and support must be at the core of emergency response, preparedness and efforts to build a resilient health system. Cementing this lesson learnt into practice can be a lasting tribute to all those who lost their lives and all those who fought in the epidemic.

EPIDEMIOLOGICAL SITUATION

INTRODUCTION

Since the first reported outbreaks of Ebola virus disease (EVD) in humans in 1976, infections acquired in health-carefacilities have been recognised as an important cause of morbidity and mortality, particularly in health workers. Two large hospital-based outbreaks reported in the Democratic Republic of the Congo in 1995 and Uganda in 2000 resulted in 80 and 29 health worker infections, respectively (1-3).

The current EVD outbreak in West Africa is unprecedented in many ways, including the high number of doctors, nurses, and other health workers who have been infected. This has had a devastating impact on the already fragile health workforces of Guinea, Liberia and Sierra Leone.

Although there have been a few country-specific publications on Ebola infections in health workers, none have yet provided an overview of findings in the three countries with widespread and intense transmission (4-6).

This special Situation Report focuses on the three countries with widespread and intense transmission. Its aim is:

- to describe and characterize health worker infections and infection outcomes; and
- to quantify the risk of infection in health workers.

METHODS

EVD cases are defined as either confirmed, probable, or suspected (Box 1). The analyses in this study only include confirmed and probable cases.

The Viral Haemorrhagic Fever (VHF) database, which was made available for these analyses by WHO headquarters, is comprised of the national VHF databases from Guinea, Liberia and Sierra Leone. It is important to note that the VHF database is different from the aggregate data presented in the weekly, public WHO Ebola Situation Report, which draws from MOH Situation Reports. The database contains information on each individual case of EVD and is regularly updated to include new cases and outcomes of previously reported cases. Obtaining completed case reports for every case was particularly challenging in the early phases and at the peak of the epidemic. Ongoing efforts are underway to update and triangulate case information about cases from multiple sources. For these reasons, the number of health workers in this report is preliminary and may differ from the MOH Situation Reports.

All information on individual patients is anonymized. Standard case-investigation forms are used to gather demographic, clinical, exposure, hospitalization and outcome data. In addition, information on selected occupa-

tional categories are recorded. If a case identifies him or herself as a "health-care worker", additional data on his or her position and workplace are collected.

For the purpose of these analyses, age was assigned as missing for those health workers whose age was reported as less than 15 (n=9 confirmed and probable). Eight cases were included in the analyses who were not recorded in the database as health workers but who held health worker positions. The final status of 14 cases was corrected. To take into account not only hospitalization at the time of reporting, but also previous hospitalizations, a new variable termed "ever hospitalized" was created. And finally, 12 duplicate cases were excluded from the analysis.

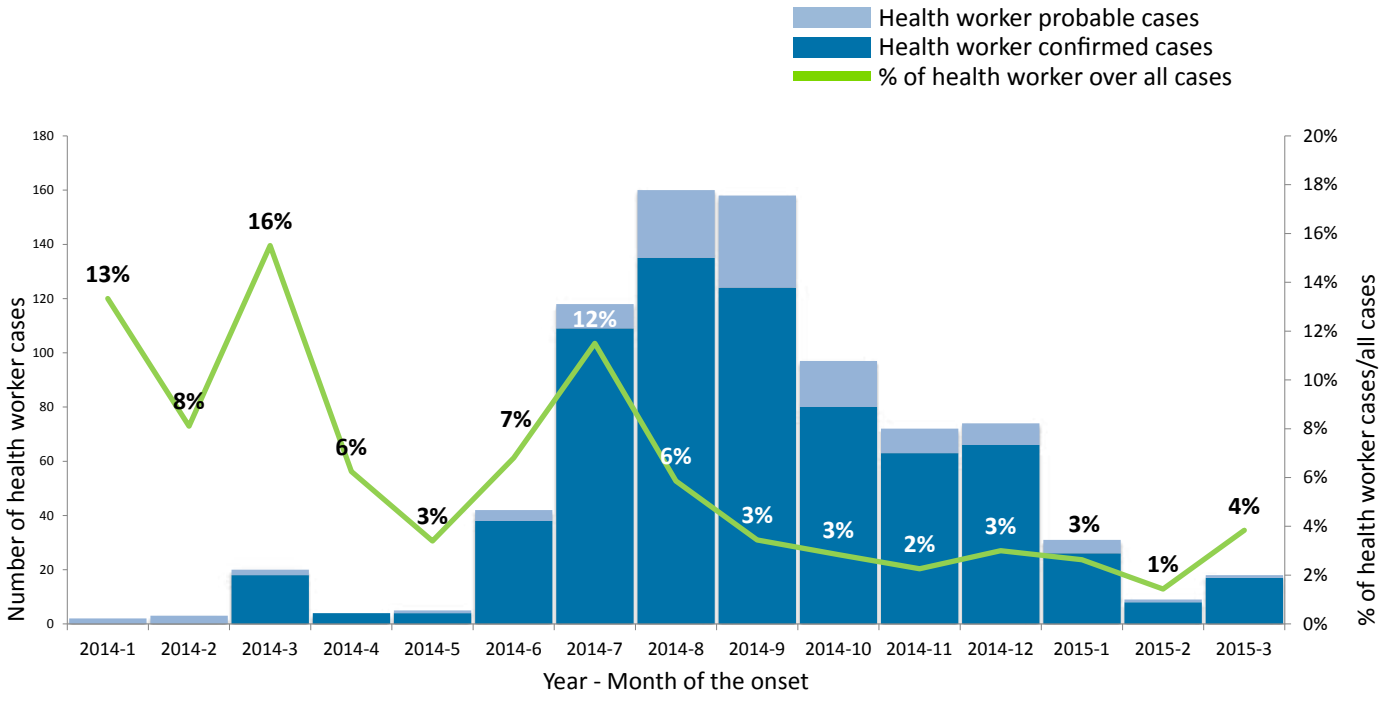
The denominator data used to calculate the cumulative incidence rate is based on the most recent health workforce data obtained from the three countries (Guinea: 2014[1], Sierra Leone: 2014[2], Liberia: 2015[3]). Workforce data from Liberia and Guinea were disaggregated by sex and age. Population figures for the cumulative incidence among the non-health worker population ≥ 15 years of age are based on estimates from the United Nations Department of Economic and Social Affairs, Population Division[4].

Descriptive analyses were performed using STATA version 13 and EXCEL 2010. Demographic characteristics and outcomes of health workers versus non-health workers were compared using chi-square tests. P-values < 0.01 were considered significant.

Characteristics and case-fatality ratios were compared between health workers and non-health workers ≥ 15 years of age. Cumulative incidence was calculated using confirmed and probable cases from the beginning of the outbreak to 31 March 2015. Since the Human Resource databases of the countries are in the process of being updated, cumulative incidence rates were calculated for selected professions only, where data were more complete.

1 Guinea: Recensement biométrique des personnels de santé du Ministère de la Santé, République de Guinée, December 2014
2 Sierra Leone: MOHS Human Resources for Health database, November 2014 (public sector only)
3 Liberia: MOH Personnel Unit and MOH Office of Financial Management, February 2015 (public sector only)
4 United Nations Department of Economic and Social Affairs, Population Division

Figure 1. Number of confirmed and probable health worker EVD cases over time (and proportion of health worker cases among all cases* reported) in the three countries combined (Guinea, Liberia and Sierra Leone), 1 January 2014 - 31 March 2015



All cases include health worker and non-health worker confirmed and probable cases.

KEY FINDINGS

From 1 January 2014 to 31 March 2015, 815 confirmed and probable health worker EVD cases were recorded in the VHF database, with 328 in Sierra Leone, 288 in Liberia and 199 in Guinea. An additional 225 suspected cases were reported, with 117 from Liberia, 108 from Sierra Leone and none from Guinea. Suspected cases are not included in these analyses.

From January 2014 to 31 March 2015, health workers accounted for 3.9% (815/20 955) of all confirmed and probable cases reported (all ages). However, this proportion fluctuated over time in each country. Except for the first few months, during which there were only a few reported cases, health worker infections as a proportion of all monthly number of cases peaked in July 2014 and decreased thereafter (Figure 1). The decrease from 12% in July 2014 to a low of 1% in February 2015 may reflect the implementation of preventive interventions.

61% of health worker infections were in males, representing a male: female ratio among affected health workers of 1.6:1. Among the four categories of health workers most affected, males represented 95% of the medical workers, 88% of the laboratory workers, 77% of the trade and elementary workers and 45% of the nurse workers. Based on the health workforce databases of Liberia and Guinea, it appears that males may have been disproportionally affected. This warrants further investigation. (Table 1).

Nearly 50% of all EVD infections in health workers occurred in those aged between 30 and 44 years old, 22% of all health workers infected were aged between 15-29 years old.

Nurses, nurse assistants and nurse aides accounted for over 50% of all health worker infections with occupation reported (n= 373/718). They were followed by medical workers (12%), laboratory workers (7%) and trade and elementary workers (janitors, maintenance staff, etc) (7%). (Table 1) (See Appendix 1 for detailed description of positions included in each category)

When comparing affected health workers to non-health workers ≥ 15 years, health workers were more likely to be males and slightly older with a higher proportion of them aged between 30-44 (47% vs 35%) and conversely, a lower proportion in the 15-29 age-group (22% vs 36%). 77% of health workers were hospitalized compared to 62% of non-health workers ≥ 15 years of age (p <0.01). This may be a reflection of greater EVD awareness and access to care among health workers or simply a reflection of a higher proportion of missing data among non-health worker cases. And although the case-fatality ratio was slightly lower in health workers, the difference was not statistically significant (p= 0.02). (Table 1)

Figure 2. EVD confirmed and probable health worker infections by country and by week of onset, 1 Jan 2014 to 31 March 2015

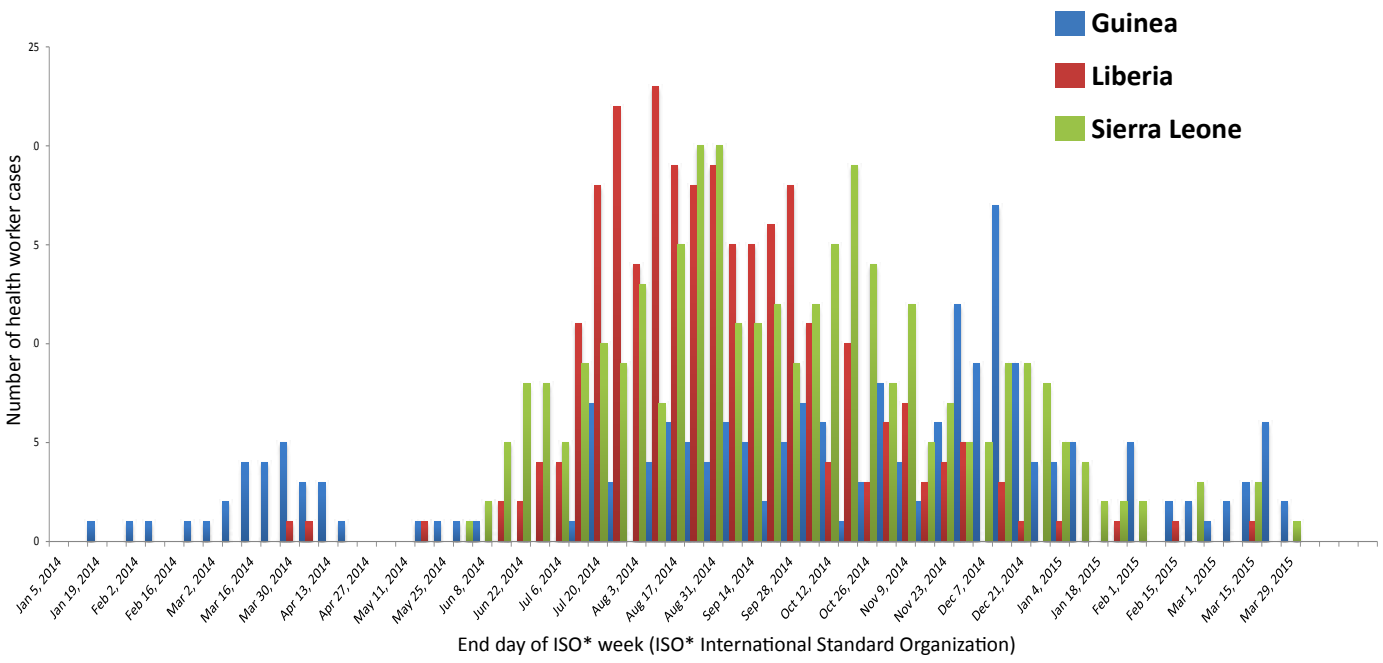


Table 1. Comparison of demographic, health and occupational characteristics of EVD confirmed and probable cases by health worker status (HW vs non-HW) and by country, 1 January 2014 - 31 March 2015

	GUINEA, LIBERIA AND SIERRA LEONE			HEALTH WORKERS		
	NON-HEALTH WORKERS ≥15 [1] % [95% CI] (n)	HEALTH WORKERS % [95% CI] (n)		GUINEA % [95% CI] (n)	LIBERIA % [95% CI] (n)	SIERRA LEONE % [95% CI] (n)
Sex	N=15976 Missing=256	N= 814 Missing= 1	p-value	N=199 Missing=0	N=287 Missing=1	N=328 Missing=0
Female	52% [51.1-52.7] (8296)	39% [35.2-42.0] (314)	<0.01	23% [17.0-29.1] (45)	42% [36.0-47.8] (120)	45% [39.9-51.0] (149)
Male	48% [47.3-48.8] (7680)	61% [58.0-64.8] (500)		77% [70.9-83.0] (154)	58% [52.2-64.0] (167)	55% [49.0-60.1] (179)
Age-group	N=15265 Missing=967	N=792 Missing=23	p-value	N=199 Missing=0	N=276 Missing=12	N=317 Missing=11
15-29	36% [35.5-37.1] (5541)	22% [18.8-24.6] (171)	<0.01	29% [22.5-35.5] (57)	15% [10.6-19.2] (40)	23% [18.8-28.4] (74)
30-44	35% [34.1-35.6] (5323)	47% [43.8-50.9] (375)		46% [39.2-53.4] (92)	51% [45.0-57.1] (141)	45% [39.2-50.5] (142)
45+	29% [28.1-29.6] (4401)	31% [27.9-34.4] (246)		25% [19.3-31.7] (50)	34% [28.8-40.4] (95)	32% [26.8-37.3] (101)
Hospitalization	N= 10946 Missing=5286	N=749 Missing=66	p-value	N=189 Missing=10	N=263 Missing=25	N=297 Missing=31
Yes	62% [60.8-62.6] (6754)	77% [73.4-79.6] (574)	<0.01	96% [92.5-98.5] (182)	71% [64.8-76.2] (186)	69% [63.8-74.6] (206)
No	38% [37.4-39.2] (4192)	23% [20.4-26.6] (175)		4% [1.5-7.5] (7)	29% [23.8-35.2] (77)	31% [25.4-36.2] (91)
Final outcome[2]	N=8474 Missing=7758	N=635 Missing=180	p-value	N=196 Missing=3	N=220 Missing=68	N=219 Missing=109
Alive	30% [28.8-30.8] (2523)	34% [30.5-38.0] (217)	0.02	44% [37.3-51.6] (87)	29% [22.8-35.1] (63)	31% [24.6-37.2] (67)
Dead	70% [69.2-71.2] (5951)	66% [62.0-69.5] (418)		56%[48.4-62.7] (109)	71% [64.9-77.2] (157)	69%[62.8-75.4] (152)
Health worker position category[3,4]	Not applicable	N=718* Missing=97	Not applicable	N=191 Missing=8	N=228 Missing=60	N=292 Missing=29
Medical workers		12% [9.3-14.1] (83)		30% [23.5-36.9] (57)	7% [4.1-11.1] (16)	3% [1.7-6.2] (10)
Nursing workers[5]		52% [48.2-55.7] (373)		45% [37.8-52.4] (86)	53% [45.9-59.3] (120)	57% [51.3-62.9] (167)
Midwifery workers		3% [2.0-4.8] (23)		4% [1.5-7.4] (7)	2% [0.7-5.0] (5)	4% [1.9-6.6] (11)
Ambulance workers		3% [1.9-4.6] (22)		6% [2.9-10.1] (11)	1 % [0.1-3.1] (2)	3% [1.4-5.8] (9)
Laboratory workers		7% [5.0-8.8] (48)		5% [2.2-8.8] (9)	7% [3.7-10.6] (15)	8% [5.3-12.0] (24)
Pharmacy workers		3% [1.8-4.4] (21)		1% [0.0-3.7] (2)	5% [2.7-9.0] (12)	2% [0.6-4.2] (7)
Community health workers		3% [2.2-4.9] (24)		1% [0.0-2.9] (1)	1% [0.3-3.8] (3)	7% [4.2-10.4] (20)
Trade and elementary workers		7% [4.8-8.6] (47)		5% [2.2-8.8] (9)	8% [4.7-12.2] (18)	7% [4.2-10.4] (20)
All others		11% [8.6-13.2] (77)		5% [2.2-8.8] (9)	16% [11.7-21.7] (37)	11% [7.33-14.7] (31)

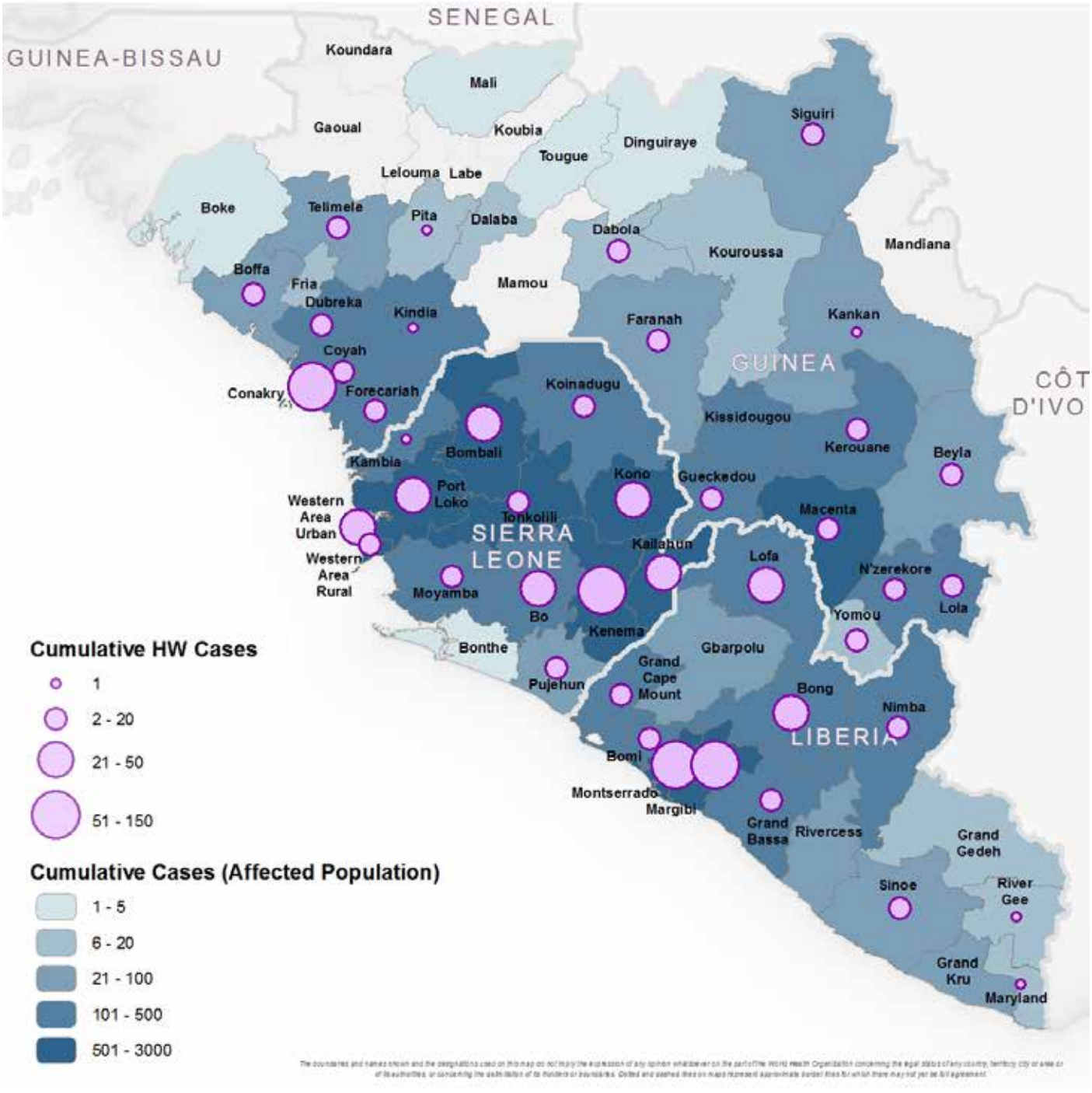
*1. Non-health worker population ≥ 15 years of age. 2. Final outcome only among those for whom final status was available. 3. For the purpose of this analysis, the numerous descriptive types of health worker positions were recoded into 14 groupings based on the International Classification of Occupations, 2008 revision. See Annex 1 for detailed descriptions of positions included in each category. However, all categories with fewer than 20 persons for the three countries were combined into a category entitled "All others". 4. Since the number of health workers by occupation by country is often small, the results should be interpreted with caution. 5. It should be noted that Nursing workers include the "Agents techniques de santé (ATS)" in Guinea. "Missing" refers to all the cases for which the data for this particular variable was missing or unknown. * Total equals to 101% due to rounding up.*

While the first health worker infected by Ebola in this epidemic was from Gueckedou, Guinea in January 2014, the first one in Liberia occurred in March 2014 in Lofa and in June 2014 in Port Loko and Kailahun (1 day apart), Sierra Leone. The number of health worker cases peaked in August 2014 in Liberia and in Sierra Leone. In Guinea, the largest number of health worker infections occurred in December 2014, although this country experienced several smaller waves as opposed to one large peak. (Figure 2)

Health worker infections peaked 3 to 4 weeks before the reported peak for all cases (health workers and non-health workers combined) in Liberia and Sierra Leone. This pattern, though, was not observed in Guinea.

Health worker infections occurred in all but 12 of 56 districts/counties/"prefectures" affected by the Ebola epidemic (see Map 1). The highest number of health worker cases occurred, in decreasing order, in Montserrado (n=136), Kenema (n=80), Conakry (n=78) and Margibi (n= 53). On the other hand, they respectively represented 14.9% (80/537) of all cases in Kenema, 13.8% (78/566) i n Conakry, 6.3% (53/839) in Margibi and 4.8% (136/2829) in Montserrado. Kenema was among the first districts affected and its relatively high number and proportion of health workers affected may reflect the lack of awareness and limited IPC measures early on in the epidemic.

Map 1. Geographic distribution of all health worker EVD infections, Guinea, Liberia and Sierra Leone, 1 January 2014 – 31 March 2015.



EBOLA INFECTION OUTCOMES

Table 2. Case-fatality ratio (CFR)[1] by demographic, health and occupational characteristics of confirmed and probable health worker EVD cases by country, 1 January 2014 - 31 March 2015

HEALTH WORKERS CHARACTERISITICS	ALL HEALTH WORKERS % [95% CI] (n)	GUINEA % [95% CI] (n)	LIBERIA % [95% CI] (n)	SIERRA LEONE % [95% CI] (n)
Sex (n, %)	**N=634 Missing=181**	**N=196 Missing=3**	**N=219 Missing=69**	**N=219 Missing=109**
Female	**68% [61.1-73.5]** (N=158/234)	**56% [39.9-70.9]** (N=24/43)	**73%[63.3-82.0]** (N=63/94)	**67% [56.7-76.2]** (N=65/97)
Male	**65% [59.8-69.4]** (N=259/400)	**56% [47.3-63.6]** (N=85/153)	**70% [60.7-77.5]** (N=87/125)	**71% [62.4-79.1]** (N=87/122)
Age-group	**N=621 Missing=194**	**N=196 Missing=3**	**N=213 Missing=75**	**N=212 Missing=116**
15-29	**56% [46.8-64.2]** (N=74/133)	**40% [27.6-54.2]** (N=23/57)	**62% [42.3-79.3]** (N=18/29)	**70% [55.1-82.7]** (N=33/47)
30-44	**63% [57.3-68.8]** (N=182/288)	**55% [44.2-65.4]** (N=50/91)	**67% [54.7-75.9]** (N=74/110)	**67% [55.7-76.4]** (N=58/87)
45+	**76% [69.5-81.7]** (N=152/200)	**75% [60.4-86.4]** (N=36/48)	**81% [70.3-89.3]** (N=60/74)	**72% [60.5-81.4]** (N=56/78)
Hospitalization	**N=583 Missing=232**	**N=186 Missing=13**	**N=203 Missing=85**	**N=194 Missing=134**
Yes	**61% [56.3-65.4]** (N=281/461)	**51% [43.8-58.9]** (N=92/179)	**68% [60.0-75.3]** (N=104/153)	**66% [57.0-74.0]** (N=85/129)
No	**74% [65.0-81.3]** (N=90/122)	**100% [59.0-100]** (N=7/7)	**76% [61.8-86.9]** (N=38/50)	**69% [56.6-80.1]** (N=45/65)
Health worker position category[2,3]	**N=562 Missing=253**	**N=188 Missing=11**	**N=173 Missing=115**	**N=201 Missing=127**
Medical workers	**47% [35.6-59.3]** (N=35/74)	**42% [28.7-55.9]** (N=23/55)	**46% [16.7-76.6]** (N=5/11)	**88% [47.3-99.7]** (N=7/8)
Nursing workers[4]	**68% [62.0-73.1]** (N=193/285)	**59% [47.6-69.4]** (N=50/85)	**82% [72.1-88.9]** (N=75/92)	**64% [53.7-72.6]** (N=68/107)
Midwifery workers	**67% [41.0-86.7]** (N=12/18)	**71% [29.0-96.3]** (N=5/7)	**100% [29.2-100]** (N=3/3)	**50% [15.7-84.3]** (N=4/8)
Ambulance workers	**78% [52.4-93.6]** (N=14/18)	**73% [39.0-94.0]** (N=8/11)	**100% [15.8-100]** (N=2/2)	**80% [28.4-99.5]** (N=4/5)
Laboratory workers	**71% [54.4-83.9]** (N=29/41)	**44% [13.7-78.8]** (N=4/9)	**69% [38.6-90.9]** (N=9/13)	**84% [60.4-96.6]** (N=16/19)
Pharmacy workers	**88% [61.7-98.4]** (N=14/16)	**100% [15.8-100]** (N=2/2)	**75% [34.9-96.8]** (N=6/8)	**100% [54.1-100]** (N=6/6)
Community health care workers	**52% [29.8-74.3]** (N=11/21)	**100% [0-100]** (N=1/1)	**33% [0.8-90.6]** (N=1/3)	**53% [27.8-77.0]** (N=9/17)
Trade and elementary workers	**65% [46.5-80.3]** (N=22/34)	**11% [0.3-48.2]** (N=1/9)	**85% [54.6-98.1]** (N=11/13)	**83% [51.6-97.9]** (N=10/12)
All others	**76% [63.0-86.8]** (N=42/55)	**78% [40-97.2]** (N=7/9)	**71% [51.3-86.8]** (N=20/28)	**74% [48.8-90.9]** (N=14/19)

*1. Case-fatality ratio (CFR) was calculated only among those for whom final outcome was available. **"Missing"** refers to all the cases for whom the data for this particular variable was missing or unknown. 2. For the purpose of this analysis, we recoded the numerous descriptive types of* health workers *positions into 14 groupings based on the International Classification of Occupations, 2008 revision. See **Annex 1** for detailed description of positions included in each category. However, all categories with less than 20 persons for the 3 countries were combined into a category entitled "All others". 3. Since the CFR by occupation is often based on small numbers, the results should be interpreted with caution. 4. It should be noted that Nursing workers include "Agent technique de santé (ATS)" in Guinea.*

Case-fatality ratio (CFR) was calculated among infected health workers for whom the final outcome was available (n=635). Among those, two-thirds (418/635) died from the disease. While the CFR was slightly lower in health workers compared to non-health workers, it varied considerably from one country to another, and was significantly lower in Guinea than in the other two countries which has the most complete data for this variable (Table 2). Health workers who died from EVD may be more likely to have the final outcome of their case recorded in their files over health workers who survived. As a result, it is possible that the CFR may be overestimated where the final outcome was not routinely recorded in the case report.

Among health workers, the CFR was slightly higher for females (68%) than for males (65%), but the difference was not statistically significant (p=0.5). As in the general population, increased age was associated with higher CFR (p <0.01). The CFR was lower in hospitalized cases (61%) compared with non-hospitalized health workers (74%) (p <0.01). (Table 2)

When comparing the CFR of the affected health workers to non-health workers, there were no statistically significant differences except for CFR in males. Since the final outcome variable is needed for the calculation of CFR, it should be noted this information was missing in more than 48% of the non-health worker cases. Therefore, the results for non-health workers should be interpreted with caution. (Table 3)

Table 3. Comparison of CFR[1] by demographic and health characteristics of confirmed and probable Ebola cases, by health worker status (HW vs non-HW) and country, 1 January 2014 - 31 March 2015.

	HEALTH WORKERS CFR [95% CI] (N)	NON-HEALTH WORKERS ≥ 15[2] CFR [95% CI] (N)	RR [95% CI] (HW vs non-HW)	p-value
Sex (n, %)	**N=634 Missing=181**	**N=8401 Missing=7831**		
Female	**68% [61.1-73.5]** (N=158/234)	**68% [66.6-69.4]** (N=2967/4360)	0.99 [0.91-1.09]	0.87
Male	**65% [59.8-69.4]** (N=259/400)	**73% [71.1-73.8]** (N=2928/4041)	0.89 [0.83-0.96]	<0.01
Age-group	**N=621 Missing=194**	**N=8220 Missing=8012**		
15-29	**56% [46.8-64.2]** (N=74/133)	**60% [58.2-61.9]** (N=1683/2801)	0.93 [0.79-1.08]	0.33
30-44	**63% [57.3-68.8]** (N=182/288)	**70% [68.7-72.0]** (N=2040/2899)	0.90[0.82-0.98]	0.02
45+	**76% [69.5-81.7]** (N=152/200)	**80% [78.8-81.9]** (N=2025/2520)	0.95 [0.87-1.02]	0.17
Hospitalization	**N=583 Missing=232**	**N=6486 Missing=9746**		
Yes	**61% [56.3-65.4]** (N=281/461)	**57% [55.0-58.0]** (N=2419/4280)	1.08 [1.00-1.17]	0.06
No	**74% [65.0-81.3]** (N=90/122)	**84% [82.7-85.8]** (N=1859/2206)	0.88 [0.79-0.97]	0.015

*1. Case-fatality rate (CFR) was calculated only among those for whom final outcome was available. 2. Non-health worker population over the age of 15 years. "**Missing**" refers to all the cases for whom the data for this particular variable was missing or unknown.*

Table 4. Cumulative EVD incidence rate for <u>selected</u> health worker types for the three countries combined, 1 January 2014 to 31 March 2015

	CUMULATIVE INCIDENCE RATE PER 1000 (95% CI)	RATE RATIO (95% CI)	p-value
Non-health workers ≥ 15 years	1.4 (1.4-1.4)	Reference	
Medical doctors	29.5 (22.6-36.4)	21.4 (17.0-27.1)	<0.01
Registered nurses	43.7 (37.5-49.9)	31.7 (27.5-36.6)	<0.01
Laboratory technicians	40.4 (26.2-54.6)	29.3 (20.7-41.7)	<0.01

Sources of health worker denominator data:
Guinea: Recensement biométrique des personnels de santé du Ministère de la Santé, République de Guinée, 2014
Sierra Leone: MOH Human Resources for Health database, November 2014 (public sector only)
Liberia: MOH Personnel Unit and MOH Office of Financial Management, February 2015 (public sector only)
General population over 15 years of age are based on estimates from the Population Division, United Nations Department of Economic and Social Affairs.

HEALTH WORKER INFECTION RISK

The cumulative incidence was analyzed for "selected" health professions (medical doctors, registered nurses and laboratory technicians) for which the Human Resource databases may be more accurate and complete in the three countries. Depending on the health profession, the risk was between 21 to 32 times higher in health workers compared with non-health workers ≥ 15 years of age. While the risk of infection among those selected health workers is very high, it is however, much lower than the risk previously reported (4). (Table 4)

LIMITATIONS

These analyses are based on the VHF database, which combines the national databases made available to WHO by the three countries which suffered widespread and intense transmission. It includes epidemiological and limited clinical data. However, the data must be interpreted with caution due to a number of limitations.

First, under-reporting of health worker cases and conversely case duplications have been observed through special health worker studies. Therefore, it should be noted that these are preliminary data since the VHF databases in Liberia and Sierra Leone are currently being revised and updated. For this reason, these data might differ from those available in the countries themselves. In addition, some health worker categories, particularly non-clinical health staff, such as hospital cleaners, ambulance drivers, burial team members, might not have been recorded as health workers. Finally, there is a significant number of suspected health worker infections for whom the final infection status remains unknown.

Second, data were incomplete for some important variables in this analysis, such as health worker position. Final outcome was also missing in more than 20% of the health worker cases. It is possible that the likelihood of having completed "final outcome" was higher for health workers who died than for those who survived. This was evidenced in Guinea which has the most complete dataset and has a significantly lower CFR. With the possibility of underreported final outcomes amongst survivors in Liberia and Sierra Leone, the CFR for health workers may well be overestimated. At last, since two-thirds of the data on potential exposures were missing, these were not able to be used for analysis.

Finally, it should be noted that data for non-health worker were much more incomplete.

Third, the risk calculation is based on health workforce denominators which had its own limitations. Cumulative incidence rates were determined for selected health worker types where denominator data were likely to be most complete. Health worker denominators did not include the private sector and efforts are underway to improve the completeness and reliability of the Human Resource Information Systems. Future risk calculations will be able to mae use of updated health worker denominator information for an expanded number of health worker types.

DETERMINANTS OF HEALTH WORKER INFECTIONS: PRELIMINARY FINDINGS FROM A LITERATURE REVIEW

A systematic review of the published literature about health worker filovirus infections (both Marburg and Ebola viruses) including the current outbreak, is being finalized by the WHO IPC team in collaboration with the Global Occupational Health Programme. This section presents a brief qualitative summary of the possible determinants or exposure situations leading to health worker infections as reported in case series or retrospective cohort studies.

As with previous epidemics, it has been difficult to identify, for the current outbreak in West Africa, the risk factors and situations of health workers' exposure to Ebola. While some literature addressing this topic was available, causal relationships between exposure and infection have rarely been documented through case investigations. Preliminary findings provide some information about the possible determinants of health worker infections (Table 5).

Our literature review suggests that infection includes non-clinical staff within a health-care setting. Therefore, the focus and language should shift from "health-care workers" to "health workers", thus encompassing drivers, cleaners, security guards, burial teams, community-based volunteers and workers, and others who are also at risk while performing health services.

Given the unprecedented scale of the Ebola epidemic in all three countries and the limited absorptive capacity at the height of the epidemic to conduct in depth investigations, it is difficult to establish the setting where health workers acquired the infection. They may have occurred in health facilities where triage may have not been effective and health workers unknowingly provided care to Ebola infected patients. It is also possible that the infection was acquired in the community with or without linkage to care provision. In addition to their official employment in governmental facilities, many health workers work in private clinics or outpatient offices or in their community. Finally, exposure risks exist for health workers working in Ebola treatment facilities. In conclusion, the fact that health workers may have multiple potential exposure possibilities, makes it difficult to ascertain whether they acquired infections in the community or the workplace.

Other occupational health risks should also be recognized, such as heat and psycho-social stress, as well social and employment determinants like staff shortages, long working hours, unpredictable and delayed remuneration, stigma, poor social protection. These may all undermine the power of interventions to address occupationally acquired Ebola infections.

Table 5. Determinants of health workers infections identified in the filovirus outbreak literature*

POSSIBLE DETERMINANT	DESCRIPTION
DEFICIENCIES IN ADMINISTRATIVE CONTROLS	Lack of or inappropriate point of care risk assessment • Cadaver exposure • Standard and transmission-based (from blood and bodily fluid exposure) precautions not universally followed • No reassessment of admitted patients to identify new symptoms of Ebola (especially <5 years) • Delayed lab diagnosis of Ebola cases
	Problems with patient flows and zoning • Lack of triage or incorrect performance of triage for Ebola patients • Inadequate control of Ebola patient or health worker movement within health facilities
	Lack of IPC policies and staff • Lack of standard operating procedures and clearly assigned responsibilities for IPC • Lack of IPC specialists
	Lack of supplies and training • Lack of or inadequate equipment, materials, training, monitoring of decontamination • Limited capacity or inadequate training on safe management of contaminated waste • Limited capacity or inadequate training on the safe management and burial of the deceased
LACK OF ENGINEERING AND ENVIRONMENTAL CONTROLS	Inadequate isolation and barriers • Inappropriate or inadequate isolation areas or setup • Lack of delineation between high-risk and low-risk Ebola zones • Inappropriate, inadequate or absent barrier nursing • Infrastructure limitations with lack of barriers separating general wards from Ebola patients • Limited availability of safe transport vehicles for patients and the deceased
	Lack of environmental controls • Poor hygiene and contaminated equipment and surfaces • Lack of or insufficient hand hygiene stations, soap, running water, alcohol-based hand rubs, chlorine/bleach/cleaning supplies, electricity, working waste disposal system
PROBLEMS WITH PPE	Insufficient/inadequate PPE and inappropriate use of it • Inconsistent PPE use • Multiple use of disposable PPE • Health workers in hospital refusing to wear PPE while taking care of a relative
DEFECTIVE PRACTICES/ EXPOSURE AT THE POINT OF CARE	• Inadequacies or inconsistencies in hand hygiene practices • Inadequacies or inconsistencies in biological specimen sampling • Needle stick injuries • Touching mucous membranes while wearing PPE (e.g. rubbing eyes with contaminated glove) • Smoking while wearing PPE • Mobile phone use while wearing PPE • Health worker providing nursing care at home • Health worker embracing an ill colleague
POOR EMPLOYMENT CONDITIONS AND SOCIAL DETERMINANTS	• Delayed and unpredictable remuneration • Staff shortages • Lack of social protection for illness

IPC: infection prevention and control; PPE= personal protective equipment

**Preliminary WHO analysis of the literature review, full publication in process*

STRATEGIES TO PREVENT HEALTH WORKER INFECTIONS DURING THE EVD EPIDEMIC

In the early phase of the epidemic there was a lack of IPC standards, poor working conditions, and inadequate IPC and OHS expertise, training, capacity and practice in the countries with widespread and intense transmission. Triage and isolation practices were sub-optimally implemented and basic IPC supplies and PPE were urgently needed were insufficient and inadequate. There was also a lack of information on how health workers were getting infected.

Health worker infections are preventable. WHO, CDC and partners are supporting MOHs to undertake in depth health workers infection investigations that provide real time information to prevent further infections. WHO and partners are working actively with MOHs, managers and health workers to put IPC and occupational health and safety (OHS) strategies and supplies in place to prevent health worker infections and improve patient safety.

This section illustrates key strategies applied by WHO and partners durimg the epidemic, to prevent health worker infections. These strategies are not only essential to getting to and staying at zero Ebola cases, they are also critical to ensure vigilance and standard precautions in early recovery, as well as the reactivation of essential services. An analysis of health worker prevention strategies and their relationship to the epidemiological trends is warranted.

WHO is working with MOHs and partners to establish strong IPC and OHS expertise and capacity at the national and county-level and to ensure coordinated and decentralized IPC efforts to establish strong national and county IPC systems. In the meantime, efforts in the field aim to implement optimal triage and isolation practices and minimum IPC standards in all health-care facilities, communicate targeted messaging to health workers and communities to raise awareness and change behaviours, and ensure continuous and timely provision of IPC supplies including PPE.

To support these efforts, WHO has deployed IPC and occupational health expertise and built the necessary IPC capacity to establish and sustain IPC practices in Ebola care facilities and routine health facilities.

In all three countries with widespread and intense transmission, WHO has worked with MOHs to establish systems for the continuous monitoring, supportive supervision and improvement of IPC standards in Ebola facilities in order to ensure health-care workers' safety and prevent cross-transmission between patients. Following each assessment, WHO IPC specialists have worked closely with facility managers, local health authorities and implementing partners to develop priority action plans and put immediate actions in place to mitigate risks and improve supplies, infrastructures and practices, as needed.

WHO has developed guidance on IPC standards for care of Ebola patients including recommendations for selecting and using PPE in patient care and for hand hygiene in the context of Filovirus disease outbreak response. Accordingly, WHO coordinated the procurement and distribution of PPE and IPC supplies in the affected countries.

WHO also organized courses for environmental health officers and safety officers on the measures for basic occupational health and workplace improvement in health-care facilities.

WHO has also carried out workplace assessments for the prevention of occupational health and safety risks, and is working to support the development of policies, procedures, protocols and training for the protection of occupational health and safety of health workers. Working with partners, WHO is supporting the expansion of access of health workers to healthcare and psychosocial support.

Pre-existing challenges of the health workforce such as shortages, attrition, poor distribution, hazardous working conditions and lack of occupational health and safety were further exacerbated by the Ebola epidemic. All three countries have developed investment plans to build health system resilience, including strategies towards a productive health workforce that is fit for purpose to meet health needs. Health worker protection and support to ensure safe and conducive employment and working conditions are critical for the safe reactivation of health services and have been embedded into early recovery strategies.

Abeer Riad, IPC specialist in Sierra Leone's WHO Country Office trains health workers in Kenema district. More than 2 500 health workers were trained in IPC by WHO in Sierra Leone. In addition, WHO supported partners to train over 6 000 health workers nationwide using a standardized training package.

Photo: WHO/Sierra Leone

Daniel Bulwadda, IPC specialist of WHO Sierra Leone conducts one of 170 independent assessments of Ebola care facilities at Maforki Ebola treatment facility in Port Loko as part of an IPC improvement project. These efforts supported the development and implementation of tailored action plans to improve IPC practices in Ebola care facilities in Sierra Leone. To ensure adherence to IPC standards in every Ebola care facility, WHO has deployed international IPC specialists at the national level and in each district in Sierra Leone. In addition, WHO has supported advanced IPC training of 70 local health workers and the deployment of 37 of them as district focal points.

Photo: WHO Sierra Leone

Urmila Sharma, IPC specialist of WHO Liberia, supports health workers at St Joseph's Catholic Hospital, Montserrado County to ensure effective triage and isolation as a first line defense in the early detection and management of suspected Ebola cases. WHO has provided technical support and supervision to health facilities to reactivate safe essential health services by developing and implementing triage and isolation protocols in routine health facilities.

Photo:
WHO LIberia/Rhonda DeMarco

Dr Kim Son Il (third from left), Epidemiologist of WHO Liberia works with colleagues from the Ministry of Health in Liberia (from left) Dr Nelson Dunbar, Director, Research Development Division; Ms Faith Tina Kamara, Health Worker Infection Management Focal Point; and Mr Mohammed Dunbar, Research Fellow, Research Development Division to analyse interviews of health worker survivors to identify exposure risks. WHO has been working with the MOH to develop investigative tools and interview health worker survivors in four counties since March 2015, as part of an in-depth retrospective investigation into health worker infections.

Photo:
Ministry of Health Liberia/
Mr Dikena Jackson

Dr Toru Yoshikawa, Occupational Health and Safety Officer, WHO Liberia worked with the Department of Environmental and Occupational Health, Ministry of Health to train district environmental health technicians to assess and improve workplace safety using the WHO/ILO HealthWISE training package in health facilities.

Photo: WHO Liberia

Dr Abdoulaye Ouegraogo, from Ratoma Hospital Guinea, is one of four master mentors working in 21 high-risk hospitals supported by WHO to establish and institutionalise triage. Triage is a first line of a health facility's defence against not only Ebola but also other reportable diseases with epidemic potential. Triage had been absent in routine health facilities in Guinea until a new package of interventions were implemented by WHO and partners. WHO is working with partners to oversee the construction of permanent infrastructure for effective triage including waiting, screening, registration, triage and isolation areas; coordinate and lead the development with the IPC committee to develop harmonised SOPs for triage; training and deploying triage mentors to establish and institutionalise triage protocols in each high-risk health facility WHO is coordinating partners to ensure full scale up to the 44 high-risk health facilities identified by the national coordination in the fight against Ebola.

Photo: WHO Guinea/P. Haugton

ACKNOWLEDGEMENTS

This special report is dedicated to the health workers who lost their lives, survived and those who are continuing to serve their communities in reactivating safe essential health services and core health systems functions.

This report would not have been possible without the leadership and contribution of the concerned Ministries of Health. We acknowledge the CDC for its support and collaboration with WHO in countries in the investigation, analysis and prevention of health worker infections.

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ANNEX 1

Table 6. Health worker categorization

HEALTH WORKERS CATEGORIES	ISCO CODES*	EXAMPLES OF HEALTH WORKER POSITIONS ENTERED IN VHF DATA-BASE (ENGLISH AND FRENCH)
Medical workers	2211, 2212,	Doctor, MD, physician assistant, medical student, médecin, stagi-aire en médicine
Nursing workers	2221, 3221	Nurse, nurse aide, nurse assistant, Maternal and Child Health (MCH) Aide, vaccinator, infirmier/infirmière, Assistant Technique en santé (ATS, equivalent to nurse aide)
Midwifery workers	2222, 3222	Midwife, traditional birth attendant (TBA) , matronne, sage-femme
Ambulance workers	3258	Ambulance worker, ambulancier, brancardier Note> ambulance drivers were included in this category but not the other drivers.
Laboratory workers	2312, 3141	Laboratory technician, laboratory aide
Pharmacy workers	2262, 3213	Pharmacist, dispenser, pharmacy technician, pharmacien,
Community health-care workers	3253	Community health worker, community health volunteer, communi-ty health assistant, agent communautaire
Social work and counselling professionals	2635	Social worker, mental health worker, HIV counsellor
Radiology workers	3211	Radiologist, X-ray technician, radiologue
Hygiene workers	No code	Burial team, sprayer, hygienist, hygiéniste, morgue worker
Trade and elementary workers	No code	Maintenance, cleaner, janitor, housekeeper, laundry attendant, driver, garçon de salle, agent d'entretien
Surveillance workers	No code	Surveillance officer, public health worker, contact tracer,
Health service manage-ment and administration	1342	Manager, hospital matron, County Health Officer (CHO), Public health officer(PHO), administrator, accountant, registrar, data clerk
Other	----	Security, volunteer, gardien, volontaire, etc

**Codes from the International Standard Classification of Occupations (ISCO, 2008 revision)*

Box 1. Ebola case-definition criteria

CLASSIFICATION	CRITERIA
Suspected	Any person, alive or dead, who has (or had) sudden onset of high fever and had contact with a suspected, probable or confirmed Ebola case, or a dead or sick animal OR any person with sudden onset of high fever and at least three of the following symptoms: headache, vomiting, anorexia/ loss of appetite, diarrhoea, lethargy, stomach pain, aching muscles or joints, difficulty swallowing, breathing difficulties, or hiccup; or any person with unexplained bleeding OR any sudden, unexplained death.
Probable	Any suspected case evaluated by a clinician OR any person who died from 'suspected' Ebola and had an epidemiological link to a confirmed case but was not tested and did not have laboratory confirmation of the disease.
Confirmed	A probable or suspected case is classified as confirmed when a sample from that person tests positive for Ebola virus in the laboratory.

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http://www.who.int/csr/disease/ebola/en/