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Projected Treatment Capacity Needs in Sierra Leone

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Contribution Estimates

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Related article: Projected Treatment Capacity Needs in Liberia, Lisa Lee, and Jerry Jerome Rodriguez

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Keywords ebola

Background

Background: The ongoing outbreak of Ebola Virus Disease in West Africa requires immediate and sustained input from the international community in order to curb transmission. The CDC has produced a model that indicates that to end the outbreak by pushing the reproductive number below 1, 70% of infections must be treated in Ebola Treatment Units (ETUs). This study aims to provide a parsimonious estimate of the number of treatment capacity needs in Sierra Leone that are required to achieve this goal, based on the international response in Sierra Leone, to estimate the national and international personnel and treatment capacity that may be required to support the national response, and to provide a comparison between Sierra Leone and Liberia. Methods: The CDC model provides a quantitative method to compute the number of treatment units that are required in Sierra Leone. The model is adapted for Sierra Leone. We used the previously estimated 21st century Ebola Virus Disease epidemiology by the CDC to correct for underreporting. Number of personnel required to provide treatment capacity is estimated based on the number of personnel per ETU observed in the Liberian response. Results: Approximately 1,000 treatment units are required in Sierra Leone. Approximately 2,000 international staff and health workers are required to staff the ETUs and to assist in transition, and an additional 5701 (95% CI:3276 to 6723) ETU case management and outreach. To reach the CDC targets today, we need 11,000 ETU beds, 2,000 international staff, and 6,000 national staff. Conclusions: Sierra Leone requires a substantial increase in the number of treatment units and personnel. Although these approximations are based on the CDC model, which is based on the experience of the epidemic in Liberia, the ETU data in Liberia and Sierra Leone are comparable. If the current transmission rate is not reduced, up to 7,000 personnel in total will be required to staff treatment units in Sierra Leone. Although the number of treatment units required in Sierra Leone is comparable to Liberia, the number of personnel required is significantly greater because of the lower transmission rate in Sierra Leone. Reducing the transmission rate will reduce the number of transmissions in Sierra Leone. If sufficient treatment facilities, healthcare workers and support personnel are not rapidly deployed, the epidemic will continue to grow, and the number of treatment units, healthcare workers and treatment motivation, other vector control measures, such as the development of an effective vaccine, should be supported.

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The international response to this crisis has been widely criticized as slow and insufficient[1,2,3]. As early as June 2014, Medecins Sans Frontieres (MSF), an organization that has been working in the affected countries since the beginning of the epidemic, was reporting large scale and sustained support from the international community. Despite these requests, the response has been slow to materialize. On August 8, 2014, the World Health Organization (WHO) declared the outbreak a public health emergency of international concern (PHEIC). On 18 September the UN Security Council determined that the outbreak was "a threat to international peace and security" and announced the creation of the United Nations Mission for Ebola Emergency Response (UNMEER).[4] This was the first time in history that the UN Security Council convened to address a public health issue. This action reflects the continued severity of the epidemic and the potential for destabilizing consequences.

Several studies have been developed to forecast the progression of the outbreak, with and without intervention options. A model developed by the WHO-Ebola Response Team has been used to estimate the number of treatment units and beds required in each country and the number of treatments for the coming weeks[5]. Based in part upon this model, presented to the WHO from Liberia, Liberia, and Sierra Leone and 14 September 2014, the CDC has developed a model that indicates that to end the outbreak, 70% of infections must be treated in Ebola Treatment Units (ETUs) and safe burials must be performed.[6] Data from the Liberia and Sierra Leone ETUs suggest that this goal is achievable with substantial international intervention by demonstrating the large long-term costs of delay and giving estimates of the size of the control intervention needed to end the outbreak. The CDC model has been used to estimate the number of treatment units, beds, and staff required in each country, and to estimate the number of treatments required to end the outbreak. Although the model is based on the experience in Liberia, it is adaptable to other settings if sufficient epidemiological data are available. The CDC model established that the cost of delay is devastating - the number of cases doubles every 20 days, taking 100,000 cases from today.

Since the creation of UNMEER, the international community has committed extensive resources to controlling the outbreak, including commitments of personnel, treatment units, and other resources. Although the number of treatment units in Liberia has risen, it is difficult to provide an accurate estimate of the number of treatment units, personnel, and other resources that have been deployed. The United States Government has committed 3,000 military personnel, 1,000 civilian personnel, and 4,000 beds in treatment units, which will be operated by the United States Government (USG) and staffed by other countries' personnel.[7] The United Kingdom has committed 800 personnel and 700 treatment beds, which will be operated by the United Kingdom Government (UKG) and staffed by other countries' personnel.[8] The Cuban government has committed 165 personnel, which will be operated by the Cuban Government (CG) and staffed by other countries' personnel.[9] Not all of these personnel are expected to be involved in treatment units, but some are. Although these commitments are significant, they are not sufficient to stop the epidemic. Although these approximations are based on the CDC model, which is based on the experience of the epidemic in Liberia, the ETU data in Liberia and Sierra Leone are comparable. If the current transmission rate is not reduced, up to 7,000 personnel in total will be required to staff treatment units in Sierra Leone. Although the number of treatment units required in Sierra Leone is comparable to Liberia, the number of personnel required is significantly greater because of the lower transmission rate in Sierra Leone. Reducing the transmission rate will reduce the number of transmissions in Sierra Leone. If sufficient treatment facilities, healthcare workers and support personnel are not rapidly deployed, the epidemic will continue to grow, and the number of treatment units, healthcare workers and treatment motivation, other vector control measures, such as the development of an effective vaccine, should be supported.

Methods

Outbreak data

To fit our model, we used the public data released by the World Health Organization[5] from 2014-03-22 and 2014-08-17, after which the WHO-Ebola Response Team stopped publishing country-level data. We used the data from Liberia and Sierra Leone from 2014-07-29 to 2014-11-29 to fit the parameters of our model, we considered a continued, unprotected, epidemic in each country prior to the ETU cases.

Model

We developed a compartmental model to describe the outbreaks in Sierra Leone (Figure 1). Briefly, the population is divided into six compartments: non-infectious susceptible individuals, exposed, infectious, hospitalized, dead, and recovered.

Susceptible individuals (S) may become Exposed (E) after contact with infectious material. After an average of 11.4 days (T_E), Exposed individuals become infectious and may be hospitalized in an Ebola Treatment Unit (ETU) or become Dead (D) or Recovered (R). Infectious (I) individuals may also be hospitalized in an ETU and become non-infectious, or they may Recover (R) after an average of 15.3 days (T_I), or die (D) after an average of 7+4.5 days (T_D). Treated (T) patients may either Recover (R) after an average of 15.3 days (T_T), or they may succumb to the disease and die (D) after an average of 7+4.5 days (T_D). We assume that the ETU is a safe environment that prevents transmission to the surrounding population and no ETU deaths are considered to be transmissions. We assumed that approximately 40% of the population have been exposed, and their treated or some fraction (either infectious or in ETU or isolated in a community setting) of the infectious population in the initial conditions of the model. We assumed that $\frac{1}{T_E}$ of the Exposed (E) and $\frac{1}{T_I}$ of the infectious (I) population, and $\frac{1}{T_T}$ of the treated (T) population, will become infectious. We assumed that a fraction of the infectious population will be treated in ETU, and the remaining fraction will recover or die. We assumed that a fraction of the treated population will recover or die. We assumed that a fraction of the dead (D) population will be buried safely, and the remaining fraction will remain infectious. We assumed that no fraction of the recovered (R) population will become infectious. We assumed that the population is closed, with no immigration or emigration. We assumed that the population is homogeneous, with no spatial or other structure. We assumed that the population is homogeneous, with no spatial or other structure. We assumed that the population is homogeneous, with no spatial or other structure

Table 3. Rates used in the SEIR model

Total estimates of cumulative cases (per 2014-12-04)

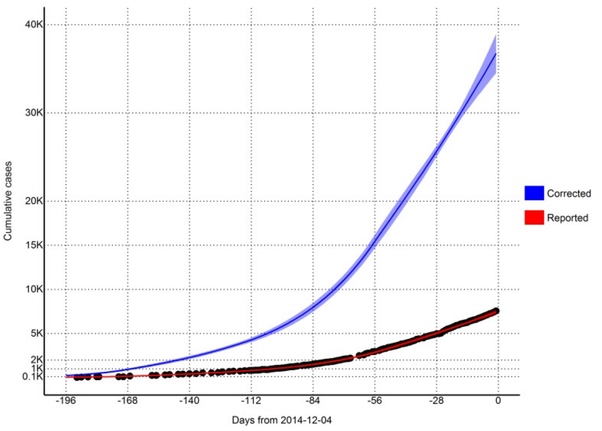
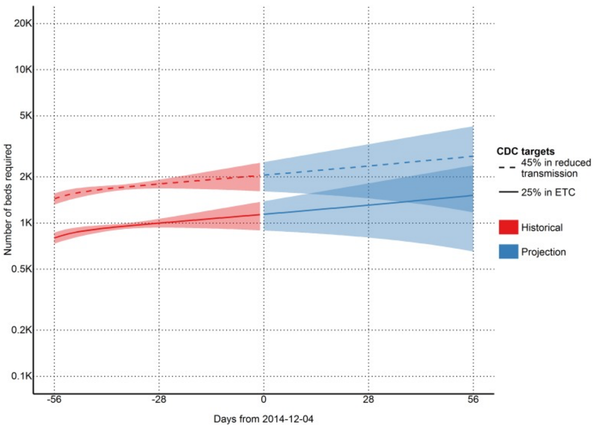
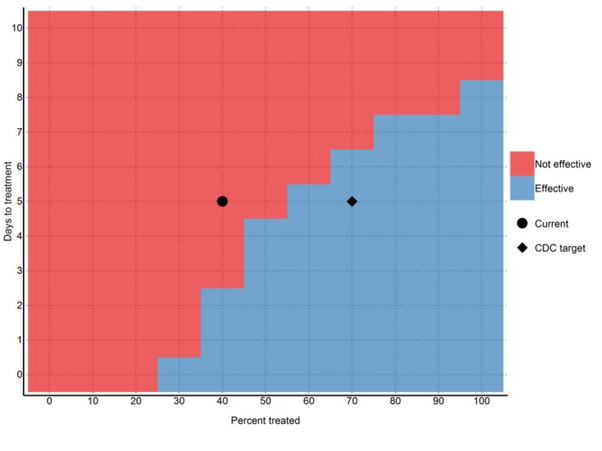


Table 4. Model estimates

Variable	2014-12-04	2015-01-01	2015-01-29
Days from today	0	28	56
Cases (reported)	7528	10378	13665
	(7206, 7850)	(9053, 11703)	(10472, 16857)
New daily cases (reported)	95	109	126
	(70, 119)	(59, 159)	(41, 211)
Cases (corrected for underreporting)	37191	50415	65701
	(34838, 39543)	(42551, 58278)	(48134, 83267)
New daily cases (corrected for underreporting)	439	505	586
	(301, 577)	(242, 769)	(150, 1023)
Incubation period	5017	5776	6702
	(3418, 6615)	(2743, 8809)	(1682, 11722)
Infectious and unreported	3751	4308	4987
	(2778, 4723)	(2321, 6295)	(1597, 8378)
Undergoing treatment	810	928	1072
	(646, 973)	(558, 1298)	(416, 1728)
Beds for CDC target of 25% cases in ETC	1140	1309	1515
	(894, 1387)	(804, 1814)	(651, 2378)
Beds for CDC target of 45% cases in reduced transmission	2052	2356	2727
	(1608, 2496)	(1447, 3266)	(1173, 4281)
Reporting (treatment) quotient	40%	40%	40%

Estimates of needed capacity corresponding to the CDC goals of 25% of cases in ETCs and 45% of cases in reduced transmission settings (per 2014-12-04)



Estimates of personnel needed to operate ETCs with CDC goal of 25% of cases in ETCs (per 2014-12-04)

Ability of different intervention scenarios to achieve a reproductive number below one (per 2014-12-04)