Paediatric care in relation to the 2014–2015 Ebola outbreak and general reporting of deaths in Sierra Leone

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In August 2014, the World Health Organization (WHO) declared the 2014 West African Ebola virus disease outbreak an international public health emergency. This was the most devastating Ebola outbreak in history.1–3 Sierra Leone was one of the hardest hit countries, with 14,122 reported cases and 3,955 deaths.4 The outbreak, which affected all 13 districts in the country, was officially declared over on 7 November 2015.5

Prior to the Ebola outbreak, Sierra Leone already had a weak health infrastructure, with serious health care worker shortages.6,7 This situation was aggravated by the sustained Ebola outbreak, as some health facilities closed temporarily due to health care worker deaths and fear of Ebola.8

Few studies from West Africa have highlighted the detrimental effect of Ebola on the health system. One study from Sierra Leone showed a drop in surgical interventions associated with the Ebola outbreak,9 while others have shown declines in out-patient consultations for malaria,10 reduced attendance of reproductive health services11 and deterioration in the quality of chronic care.12 In Sierra Leone, malaria and respiratory infections are the most common morbidities among children aged < 5 years.13 As both of these conditions present with fever, which overlaps with the symptoms of Ebola virus disease, anecdotal evidence shows that parents might have avoided bringing their children to health facilities due to fears of being labelled as an Ebola case. This may have adversely influenced the utilisation of health facilities and reported morbidity patterns. The quality of in-patient care may also have been influenced by shortages of health care workers and inadequacies in the health system.

In terms of mortality reporting, during the Ebola outbreak the Port Loko District health management team (DHMT) established a Safe and Dignified Burials (SDB) database in October 2014 in which all community and hospital deaths were captured. Records from 2008 to 2014 were then compared with the Safe and Dignified Burials (SDB) database in October 2014 in Port Loko.

The Ebola disease outbreak was associated with reduced utilisation of health services, and appears to have triggered a measles epidemic. Almost 70% of deaths were missed by the HMIS during the Ebola outbreak period. These findings could guide health system responses in future outbreaks.
The Health Management Information System and the Safe and Dignified Burials database

The HMIS is a comprehensive information system used to store all health-related information on morbidity and mortality in Sierra Leone. At the district level, it is known as the District Health Information System (DHIS). Data are recorded in eight different forms representing the different morbidities and services at the peripheral health unit (PHU) level. Copies are then sent to the district level, where they are entered into the DHIS database. The DHIS data are then sent to the national level for collation of the data for the entire country.

During the Ebola period, and as a result of outbreaks that originated from unsafe burials, the Ministry of Health and Sanitation (MoHS) and the National Ebola Response Centre (NERC) introduced measures before and during the outbreak and before the Ebola outbreak (1 June 2014–30 April 2015) and a 6-month period after the outbreak (1 November 2015–30 April 2016).

Specific setting

Port Loko District, one of five districts in the northern province of Sierra Leone, has a population of 537,000, approximately 96,000 of whom are under-fives. The district capital, Port Loko, is 124 km from Freetown. There are 107 public health facilities: 2 district public hospitals, 15 community health centres, 19 community health posts and 71 maternal and child health posts.

The first case of Ebola disease in Port Loko District was reported on 10 June 2014. By January 2016, a total of 1484 cases and 469 deaths had been reported. Among healthcare workers, there were 32 infected cases and 24 deaths.

Study population and period

The study population included all 1185 PHU-level records on all children aged <5 years reported in the HMIS system countrywide. For hospital exit outcomes, we included all under-fives admitted to the two district hospitals in Port Loko District. All community and health-facility deaths in Port Loko District were also included. The study included an 11-month period before the Ebola outbreak (1 June 2013–30 April 2014), an 11-month period during the outbreak (1 June 2014–30 April 2015) and a 6-month period after the Ebola outbreak (1 November 2015–30 April 2016).

Data collection, sources and analyses

The data variables related to the study objectives were sourced from the HMIS, the district hospital registers and the SDB database. Hospital exit outcomes were stratified into favourable (discharged, transferred out), unfavourable (died or abandoned), and uneventualised. Three common morbidities—malaria, acute respiratory infection (ARI) and watery diarrhoea—and one vaccine-preventable disease, measles, were selected to assess the morbidity patterns.

We used EpiData software for data entry (v. 3.1) and analyses (v. 2.2.2.182, EpiData Association, Odense, Denmark). The data from the HMIS were double-entered and validated. The principal investigator supervised the process to ensure the quality of the data.

Descriptive statistics were used to present the results. Differences between groups were assessed using Pearson's χ² test. For morbidity, we compared the periods before and during the Ebola outbreak and before

TABLE 1 The tiered structure and function of health facilities in Sierra Leone, 2015

<table>
<thead>
<tr>
<th>Health care level</th>
<th>Health facility category</th>
<th>Services provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MCHP</td>
<td>Antenatal care services, basic community health interventions, uncomplicated deliveries and postnatal follow-up</td>
</tr>
<tr>
<td>2</td>
<td>CHP</td>
<td>Basic medical, obstetric and neonatal care</td>
</tr>
<tr>
<td>3</td>
<td>CHC</td>
<td>Emergency obstetric and neonatal care and general medical care with 5–10 bed capacity for admission</td>
</tr>
<tr>
<td>4</td>
<td>District (secondary) hospital</td>
<td>Highest level of care at district level, including medical, surgical, obstetric and paediatric care</td>
</tr>
<tr>
<td>5</td>
<td>Tertiary hospital</td>
<td>Most advanced level of care (at least one per region)</td>
</tr>
</tbody>
</table>

MCHP = maternal and child health post; CHP = community health post; CHC = community health centre.
and after the outbreak. The comparison periods were comprised of the same calendar months to address any potential effects of seasonality. The pre- vs. post-outbreak comparisons were therefore restricted to the months inclusive of November to April in each time period. The level of significance was set at $P \leq 0.05$.

**Ethics approval**
Ethics approval was obtained from the Sierra Leone Ethics Review Board (MoHS, Freetown) and the Ethics Advisory Group of the International Union Against Tuberculosis and Lung Disease (Paris, France). As the study used anonymised data, informed consent was not needed.

**RESULTS**

**Countrywide trend in out-patient consultations for selected under-five morbidities**
All 1185 PHUs located in the 14 districts of Sierra Leone were included in the analysis. Table 2 shows the trend in outpatient consultations for selected morbidities. Average monthly consultations for malaria, ARI and watery diarrhoea declined significantly during the Ebola outbreak period compared to the pre-Ebola period ($P < 0.001$), and did not recover to similar levels post-Ebola ($P < 0.001$). The declines during the Ebola period were 27% for malaria and 38% for watery diarrhoea. In the post-Ebola period, the consultations remained respectively 16% (malaria), 24% (ARI) and 20% (watery diarrhoea) lower than pre-Ebola levels.

For measles, the opposite was observed, with an 80% increase in reported cases in the Ebola period, and a 6.5-fold increase from pre-Ebola levels in the post-Ebola period. The monthly trends show an increase in cases of measles toward the end of the Ebola outbreak that became steeper in the post-Ebola period (Figure 1).

**Standardised hospital exit outcomes in under-five children**
Of the two district hospitals included in the analysis, the admission registers could not be found for one (the Port Loko hospital), as they were destroyed by decontamination teams. For Lungi hospital, where the data were available, the rate of unfavourable outcomes (died or absconded) was 9% in the pre-Ebola period, rose to 13% during the Ebola outbreak (relative risk [RR] 1.4, $P = 0.04$), and was 10% in the post-Ebola period (Table 3).

Unrecorded hospital exit outcome, observed during all three study periods, was 19% in the pre-Ebola period, decreasing to 6% during Ebola and then rising again to 13% post-Ebola.

**Discrepancies in reported deaths in the Ebola database and the HMIS (Ebola period)**
Of 6565 deaths reported in the Port Loko SDB database during the Ebola outbreak, only 2219 (34%) appeared in the HMIS, a reporting deficit of 66% (Figure 2).

**DISCUSSION**
This study shows that, at country level, consultations for malaria, ARI and watery diarrhoea declined significantly during the Ebola outbreak and did not recover thereafter to pre-Ebola levels. Conversely, measles consultations increased dramatically. We also found that the HMIS system missed almost 70% of recorded deaths during the Ebola period at district level. This could be attributed to the common practice of not reporting community deaths to the health facilities during the Ebola period.

This study is important, as it shows that the sustained Ebola outbreak negatively influenced the utilisation of health services in under-five children, and the effects seem to be lingering. Although the under-utilisation of health services may currently be contributing to child mortality, this is difficult to ascertain practically, as most deaths are being missed by the HMIS. The almost six-fold increase in measles cases observed late in the post-Ebola period indicates a measles epidemic, most likely related to the cessation of vaccination activities, and highlights the need for the MoHS to consider options to continue such activities during future Ebola outbreaks or other humanitarian crises.

The study strengths are that we included both countrywide and district-level data from before, during and after the Ebola virus disease outbreak, allowing a trend analysis through to the post-Ebola period. The data were also double-entered and validated. Furthermore, the study responds to an identified operational research priority for Sierra Leone, and is thus timely.

The main study limitations are that hospital exit outcomes may therefore be subject to ascertainment bias. In
the pre-Ebola period, almost half of unfavourable outcomes were ‘absconded’, and we do not know the reason for this finding. These shortcomings highlight the overall need for the MoHS to improve hospital data management, including monitoring and supervision.

This study has some important operational implications. First, the decline in consultations for malaria, ARI and watery diarrhoea during the Ebola period is understandable, as these morbidities have symptoms that overlap with those for Ebola. Community members may therefore have had fears about visiting health facilities and being labelled an Ebola case. This notwithstanding, the finding that consultation levels did not recover post-Ebola is of concern. A possible reason may be a loss of confidence in the public health services, but there may be other reasons, and this merits further research.

Second, it is likely that the cessation of measles vaccination activities during the Ebola outbreak is directly responsible for the dramatic increase in measles cases seen both during and after the Ebola outbreak. During the Ebola outbreak, the general recommendation was to avoid all invasive procedures as a way of minimizing Ebola-related occupational risks. Many children would therefore have missed their measles vaccination and herd immunity would have dropped. Maintaining a high level of herd immunity is essential to avoid measles epidemics. This scenario may also apply to the pentavalent vaccine (covering diphtheria, pertussis, tetanus, hepatitis B and Haemophilus influenza type B) and other injectable vaccines. Increased surveillance is thus necessary to prevent further epidemics of vaccine-preventable diseases. The recently introduced Integrated Disease Surveillance and Response (IDSR) system may be a useful framework. Mass catch-up vaccination campaigns from the Expanded Programme on Immunisation of the MoHS may also be justified, but may need further evaluation through vaccination coverage surveys.

The essential lesson from our study is that infection prevention and control (IPC) training as well as the provision of IPC supplies for health workers should have been addressed pre-emptively. This would have boosted health worker confidence and readiness for future outbreaks. The Table and Figures below provide a summary of the findings:


**FIGURE 2** Reporting of deaths in the SDB database that were captured in the HMIS in Port Loko District during the Ebola virus disease outbreak, June 2014–April 2015. SDB = Safe and Dignified Burial; HMIS = Health Management Information System.

**TABLE 3** Admissions and exit outcomes for under-fives admitted before, during and after the Ebola virus disease outbreak* at Lungi Hospital, Port Loko District, Sierra Leone.

<table>
<thead>
<tr>
<th></th>
<th>Pre-Ebola n (%)</th>
<th>Ebola n (%)</th>
<th>Post-Ebola n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total admissions</td>
<td>609</td>
<td>422</td>
<td>685</td>
</tr>
<tr>
<td>Average monthly admissions</td>
<td>55</td>
<td>38</td>
<td>114</td>
</tr>
<tr>
<td>Hospital exit outcomes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not evaluated</td>
<td>113 (19)</td>
<td>25 (6)</td>
<td>87 (13)</td>
</tr>
<tr>
<td>Evaluated</td>
<td>496 (81)</td>
<td>397 (90)</td>
<td>598</td>
</tr>
<tr>
<td>Favourable outcomes</td>
<td>449 (91)</td>
<td>345 (87)</td>
<td>536 (90)</td>
</tr>
<tr>
<td>Discharged</td>
<td>449</td>
<td>337</td>
<td>532</td>
</tr>
<tr>
<td>Transferred out</td>
<td>0</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Unfavourable outcomes</td>
<td>47 (9)</td>
<td>52 (13)</td>
<td>62 (10)</td>
</tr>
<tr>
<td>Deaths</td>
<td>25</td>
<td>48</td>
<td>53</td>
</tr>
<tr>
<td>Absconded†</td>
<td>22</td>
<td>4</td>
<td>9</td>
</tr>
</tbody>
</table>

† Left the hospital against or without medical consent of the attending clinician.
motivation to sustain routine vaccination. A recent study from Guinea showed that such pre-emptive measures bear fruit and should be emulated.18,19

Third, unfavourable hospital exit outcomes were 44% higher during than before the Ebola period. This may be a reflection of reduced clinical attention attributed to the repurposing of medical staff to Ebola control activities and/or of the ‘no touch’ policy, which in particular could have prevented severely ill children from receiving parenteral treatment. The unfavourable hospital exit outcomes seen during the Ebola period in our study were much higher than the 6.2% reported in a paediatric hospital in conflict-affected Somalia20 or the 8% reported in a hospital in Kenya.21

We observed a three-fold improvement in the reporting of hospital exit outcomes during the Ebola period compared to before Ebola. We do not know the exact reasons for this finding, but it may be attributed to the closer monitoring and supervision of hospital admissions during the outbreak period as an active part of Ebola surveillance. The finding that reporting of exit outcomes deteriorated in the post-Ebola period suggests a need for the district health team to maintain monitoring and supervision.

Finally, that almost 70% of deaths in Port Loko District were missed by the HMIS is of serious concern. Ideally, all deaths should be captured as part of vital registration, as the event of death could serve as an early warning sign for potential epidemics. A possible solution for improving vital registration is to introduce village-level vital registers. Early encouraging experiences from countries such as Malawi could be built upon in Sierra Leone.22 Working out the details of how to achieve this at the MoHS in the Sierra Leone context would need further reflection.

In conclusion, we have highlighted the fact that in a humanitarian crisis such as a massive infectious disease outbreak, reduced attendance of under-fives in health facilities could lead to the emergence of other infectious diseases, particularly vaccine-preventable illnesses. The MoHS may therefore need to deploy innovative strategies to keep important services such as immunisation services going. We have also demonstrated the need for the MoHS to improve on death reporting in the HMIS, as death monitoring could be an early warning system for the detection of disease outbreaks.

References

Contexte : Toutes les unités périphériques de santé dans le pays et un hôpital à Port Loko, Sierra Leone.
Objectifs : La Sierra Leone a été gravement affectée par l’épidémie d’Ebola de 2014–2015. Son influence sur les soins pédiatriques et les rapports de décès mérite une évaluation. Cette étude compare, avant, pendant et après l’épidémie d’Ebola, la tendance de la morbidité des enfants âgés de <5 ans dans tout le pays et, dans un hôpital de district (Port Loko), les résultats à la sortie. Pendant Ebola, les lacunes des rapports de décès du district au sein du système d’information de la gestion de la santé de routine (HMIS) ont été comparées à la base de données SDB (enterrement en sécurité et digne) de Port Loko.
Schéma : Une analyse rétrospective de dossiers.
Résultats : Le nombre moyen de consultations par mois pendant Ebola a diminué de 27% pour le paludisme et les infections respiratoires aiguës et de 38% pour la diarrhée aqueuse, et ce nombre n’est pas remonté aux niveaux d’avant Ebola. Pour la rougeole, il y a eu une augmentation de 80% pendant Ebola qui a été multipliée par 6,5 après Ebola. Sur 397 sorties d’hôpital, 52 ont eu un résultat défavorable (13%) pendant Ebola, ce qui a été plus élevé qu’avant Ebola (47/496, 9% ; P = 0,04). Sur 6565 décès rapportés dans la base de données SDB de Port Loko, seulement 2219 (34%) sont apparus dans le HMIS (déficit de rapportage = 66%).
Conclusion : L’épidémie d’Ebola a été associée à une réduction de l’utilisation des services de santé, et semble avoir déclenché une épidémie de rougeole. Près de sept décès sur dix ont été manqués par le HMIS pendant Ebola. Ces résultats pourraient guider les ripostes du système de santé lors de futures épidémies.

Marco de referencia: Todas las unidades periféricas de salud en el territorio nacional de Sierra Leona y un hospital de Port Loko.
Objetivos: El brote epidémico de fiebre hemorrágica del Ébola afectó de manera considerable a Sierra Leona durante el 2014 y el 2015. La evaluación de la repercusión de la epidemia sobre la atención pediátrica y la notificación de las defunciones es digna de interés. Se comparó la evolución de la morbilidad de los niños < 5 años de edad en todo el país y los desenlaces del alta hospitalaria en un hospital distrital (Port Loko), antes de la epidemia del Ébola, durante el brote y después del mismo. Durante la epidemia se compararon las deficiencias de notificación de defunciones del distrito en el sistema corriente de información sobre gestión sanitaria, con respecto a la base de datos de la inhumación segura y digna (SDB) en Port Loko.
Método: Un análisis retrospectivo de historias clínicas.
Resultados: Durante la epidemia del Ébola, el promedio mensual de consultas por paludismo e infección respiratoria aguda disminuyó un 27% y el promedio de consultas por diarrea líquida disminuyó un 38%; tras la epidemia no se recuperaron las cifras anteriores al brote. Al contrario, se observó un aumento de 80% de las notificaciones de sarampión durante la epidemia y una cifra 6,5 veces más alta después del brote epidémico. Durante la epidemia del Ébola ocurrieron desenlaces hospitalarios desfavorables en 52 de 397 pacientes (13%), lo cual representa un aumento con respecto al período anterior al brote, que fue de 47 en 496 hospitalizaciones (9%, P = 0,04). De las 6565 defunciones notificadas en la base de datos SDB de Port Loko, solo 2219 aparecían en el sistema corriente de información sobre gestión sanitaria (34%), lo cual corresponde a una deficiencia de notificación del 66%.
Conclusión: El brote epidémico del Ébola ocasionó una disminución de la utilización de los servicios de salud y al parecer desencadenó una epidemia de sarampión. Durante el brote, faltaban en el sistema corriente de información sobre gestión sanitaria cerca de siete de cada diez defunciones. Estos resultados deben contribuir a orientar las respuestas de los sistemas de salud durante los futuros brotes epidémicos.