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SORT IT SUPPLEMENT: POST-EBOLA RECOVERY IN WEST AFRICA

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

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Setting: All peripheral health units countrywide in Sierra Leone and one hospital in Port Loko.

Objectives: Sierra Leone was severely affected by the 2014–2015 Ebola outbreak, whose impact on paediatric care and mortality reports merits assessment. We sought to compare the periods before, during and after the Ebola outbreak, the countrywide trend in morbidities in children aged < 5 years and exit outcomes in one district hospital (Port Loko). During the Ebola outbreak period, gaps in district death reporting within the routine Health Management Information System (HMIS) were compared with the Safe and Dignified Burials (SDB) database in Port Loko.

Design: This was a retrospective records analysis.

Results: The average number of monthly consultations during the Ebola outbreak period declined by 27% for malaria and acute respiratory infections and 38% for watery diarrhoea, and did not recover to the pre-Ebola levels. For measles, there was an 80% increase during Ebola, which multiplied by 6.5-fold post-Ebola. The number of unfavourable hospital exit outcomes was 52/397 (13%) during Ebola, which was higher than pre-Ebola (47/496, 9%, $P = 0.04$). Of 6565 deaths reported in the Port Loko SDB database, only 2219 (34%) appeared in the HMIS, a reporting deficit of 66%.

Conclusion: 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.

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 3955 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 services[11] 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 health facility deaths, Ebola-related or not, were entered; this was a separate database operated by the burial teams outside of the Health Management Information System (HMIS). Assessing the discrepancies between the SDB database and the HMIS may provide information that is useful for improving vital registration, particularly the reporting of deaths, and would be critical to detecting future Ebola or other disease outbreaks.

A search of PubMed revealed no study that has assessed the impact of the Ebola outbreak on paediatric care before, during and after the Ebola epidemic. There is also no information on whether the HMIS system captured all deaths (facility and community) during the Ebola epidemic. We therefore compared, among under-fives in Sierra Leone for the periods before, during and after the Ebola disease outbreak: 1) trends in out-patient consultations for selected morbidities in the country and specifically for the Port Loko District, 2) standardised hospital exit outcomes, and 3) for the period between June 2014 and April 2015, the discrepancies in the number of reported deaths between the SDB database and the HMIS.

METHODS

Study design

This was a retrospective record analysis using routine programme data.

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

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

MCHP = maternal and child health post; CHP = community health post; CHC = community health centre.

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 for safe and dignified burials for all deaths across the country. A separate dedicated Excel database (the SDB database) was therefore developed and used in Port Loko from October 2014 to July 2015 to capture these deaths. All deaths recorded in the SDB database should ideally be captured in the HMIS.

Setting

General setting

Sierra Leone is a West African country bordered by Guinea in the north-east and Liberia in the south-east. The port city, Freetown, is the capital. With a population of approximately 6 million, of whom 40% are aged < 14 years, Sierra Leone is one of the poorest countries in the world.[14]

The health infrastructure is tiered into tertiary hospitals, district hospitals and PHUs, which include community health centres (CHCs), community health posts (CHPs) and maternal and child health posts (MCHPs) (Table 1). Sierra Leone has the fifth highest rate of maternal mortality and the eleventh highest rate of infant mortality worldwide.[14] Even before the Ebola outbreak, which resulted in the deaths of many health care workers, there were only two doctors and 17 nurses per 100 000 population, located primarily in urban areas.[15]

Out-patient consultations for the under-fives are held at all levels of health facility; admissions, however, occur mainly at the tertiary and district hospitals. The services provided in the PHUs are usually comprehensively documented in the HMIS, unlike hospital data, which are not adequately entered in the HMIS. As a result, only PHU-level data were used for the study.

Specific setting

Port Loko District, one of five districts in the northern province of Sierra Leone, has a population of 557 000, 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.[16]

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 health care workers, there were 32 infected cases and 24 deaths.[17]

Study population and period

The study population included all 1185 PHU-level reports 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 absconded), and unevaluated. 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 χ^2 test. For morbidity, we compared the periods before and during the Ebola outbreak and before

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Conflicts of interest: none declared.

TABLE 2 Average monthly consultations for four under-five morbidities before, during and after the Ebola virus disease outbreak* in Sierra Leone

	Pre-Ebola and during Ebola					Pre-Ebola and post-Ebola				
	Pre-Ebola		Ebola			Pre-Ebola†		Post-Ebola		
Morbidities	*n*	Average monthly consultations 11 months	*n*	Average monthly consultations	*P* value‡	*n*	Average monthly consultations 6 months	*n*	Average monthly consultations	*P* value
Malaria	989 068	89 915	724 881	65 898	<0.001	467 325	77 888	391 464	65 244	<0.001
ARI/ pneumonia	717 345	65 213	521 860	47 442	<0.001	401 660	66 943	302 923	50 487	<0.001
Watery diarrhoea	200 006	18 182	124 100	11 282	<0.001	122 206	20 368	96 794	16 132	<0.001
Measles	525	48	962	87	<0.001	443	74	2 907	485	<0.001

*Pre-Ebola period = 1 June 2013–30 April 2014; Ebola period = 1 June 2014–30 April 2015; post-Ebola period = 1 November 2015–30 April 2016.
†Comparison of the pre-Ebola and post-Ebola periods included only 6 months in the pre-Ebola period (1 November 2013–30 April 2014), corresponding to the 6 months of the post-Ebola period.
‡*P* value for difference in average monthly consultations (difference in means).
ARI = acute respiratory infection.

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 $P \leqslant 0.05$.

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 out-patient 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 ARI 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 were assessed in only one of the two selected hospitals, and there were some unknown outcomes. Our reported rates of unfavourable outcomes may therefore be subject to ascertainment bias. In

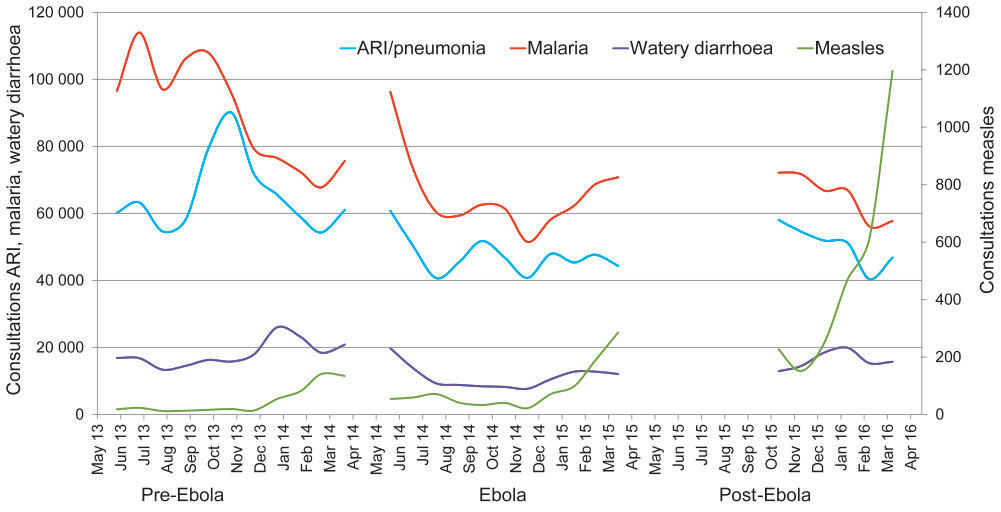

FIGURE 1 National trends in consultations for four childhood morbidities in the pre-Ebola, Ebola and post-Ebola disease outbreak periods, Sierra Leone. Pre-Ebola period = 1 June 2013–30 April 2014; Ebola period = 1 June 2014–30 April 2015; post-Ebola period = 1 November 2015–30 April 2016. ARI = acute respiratory infections.

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 minimising 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

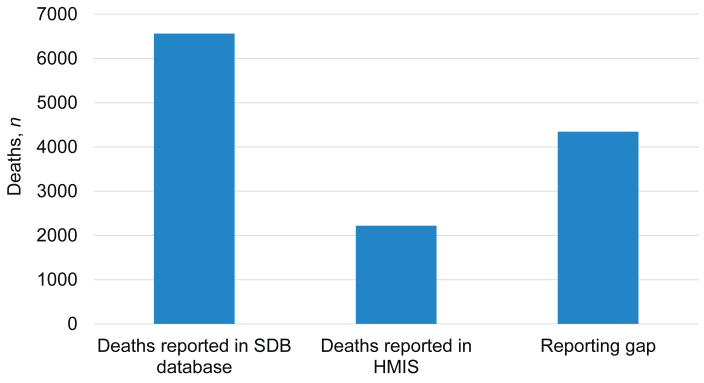

FIGURE 2 Reporting of deaths in the SDB database that were captured in the HMIS in Port Loko District during the Ebola virus disease outbreak, June 2014–April 2015. SDB = Safe and Dignified Burial; HMIS = Health Management Information System.

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[1]

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

*Pre-Ebola period = 1 June 2013–30 April 2014; Ebola period = 1 June 2014–30 April 2015; post-Ebola period = 1 November 2015–30 April 2016.
†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 Somalia[20] 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.

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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 décliné 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 apparues 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.

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