Impact Public Health

Original Research Paper

e-ISSN: 2978-1655

Protecting a healthcare facility during the Ebola outbreak: preparedness, mitigation, and continuity of care in Sierra Leone

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Abstract

Background: The indirect effects of epidemics on healthcare systems may cause harm equal to or greater than that of the pathogens themselves, as observed in both the COVID-19 pandemic and outbreaks of Ebola virus disease (EVD). Preparedness and the timely implementation of prevention and mitigation measures are therefore essential to limit indirect morbidity and mortality and to ensure the continuity of essential healthcare services during epidemics.

Methods: This retrospective observational before-during-after study was conducted at the EMERGENCY Surgical and Paediatric Centre in Goderich (Freetown, Sierra Leone) to assess the effectiveness of control and mitigation measures in preventing Ebola virus disease (EVD) transmission among patients and healthcare workers, as well as in maintaining hospital operational capacity during the outbreak.

Results: Between July 2014 and June 2015, 31,473 patients were screened before accessing the hospital. 88 were identified as suspected EVD cases, 19 of whom were subsequently confirmed, including one surgical emergency treated in isolation, and referred to an Ebola Treatment Centre. Paediatric and surgical services continued with only limited reductions; the outbreak mainly led to reduced access to outpatient services. In the post-EVD period, hospital activity returned to or exceeded pre-EVD levels. No undiagnosed EVD patients were admitted, no secondary transmission occurred within the hospital, and no healthcare workers (0/406) acquired EVD.

Conclusions: The EMERGENCY Surgical and Paediatric Centre in Goderich was kept Ebola-free at a time when many hospitals in the country were forced to close or substantially reduce activity. Timeliness, leadership, rapid implementation of comprehensive prevention and mitigation measures, and sustained attention to the health and retention of healthcare workers were key to success. These measures enabled the continuity of essential surgical and paediatric services while preventing in-hospital transmission. This field-validated approach identifies that hospitals can remain operational during epidemics in high-risk settings and informs preparedness programmes.

Cite as: Radicchi L, Gatti S, Guanti MD, Rolla L, Tomasina J, Portela G, Langer M. Protecting a healthcare facility during the Ebola outbreak: preparedness, mitigation, and continuity of care in Sierra Leone. *Impact Public Health*, 1(1), 1–8. https://doi.org/10.62463/iph.340

Introduction

Epidemics are a severe stress test for health systems. This was seen worldwide during the COVID-19 pandemic, which shook even high-income countries with solid health systems[1–3]. In middle- and low-income countries (MLICs), despite the available data consisting mainly of forecasts and estimates[4] The frailty of their health systems was already seen in the Ebola epidemic of 2014–2016, which hit Sierra Leone particularly hard[5].Transmission of Ebola virus disease (EVD) to HCWs and patients in the country's hospitals led to many (at least temporary) closures as well as to fear of and loss of trust in the health system[6]. Many HCWs became ill early in the outbreak. Out of 14124 suspected, probable or confirmed cases and 3956 deaths[5],199 HCWs acquired the disease in the first six months, accounting for 5.2% of the 3854 confirmed EVD cases at that point: a 103-fold incidence compared to non-HCWs[7]. The number of EVD-infected HCWs rose to 304 after one year (May 2015), 221 (72%) of whom died[8].The collapse of Sierra Leone's public health system caused a largely unmeasured increase in indirect morbidity and mortality, which was well recorded only in the case of maternal and malaria-related deaths[9,10]. Excess mortality due to difficulties in accessing surgery is more difficult to investigate. The overall functioning of a hospital is best assessed by analysing hospital admissions and major surgical procedures. This approach has been used in a multi-hospital survey by Bolkan et al.[11], who report a 51% decrease in median weekly, non-EVD admissions, and 41% fewer surgeries performed compared to the 20 weeks before the outbreak. An unchanged function in healthcare during an epidemic, both in and outside hospitals, is certainly not possible, but it is essential at least to discuss how to limit these dangerous, indirect effects in the future.

This report focuses on the EMERGENCY Surgical and Paediatric Centre in Goderich (Freetown, Sierra Leone), located in the Western Area of Sierra Leone, where 41% of all nationally documented cases were diagnosed[12]. Measures for prevention and mitigation were implemented to reduce the risk of EVD transmission within the hospital. The effectiveness of these interventions was assessed in terms of their impact on EVD transmission to healthcare workers and patients, as well as on the overall performance of the hospital during the outbreak.

Methods

Study Setting

The study was conducted at the EMERGENCY Surgical and Paediatric Centre, located in Goderich, Freetown, Sierra Leone. The centre opened in 2001, at the end of the Sierra Leonean Civil War, as a free-of-charge surgical and paediatric hospital operated by EMERGENCY ONG ETS. During the EVD epidemic, the hospital had 82 beds for surgical and 14 for paediatric patients. During the study period, the hospital employed a total of 406 healthcare workers, including 216 clinical staff (physicians, nurses, physiotherapists, and laboratory and X-ray technicians) and 190 non-clinical staff (administrative personnel, logisticians, maintenance workers, cleaners, security guards, and other ancillary personnel).

In July 2014, a tent-based Holding and Treatment Centre for Ebola patients was established near the Hospital. This facility was replaced in December 2014 by the Goderich Ebola Treatment Centre, equipped with laboratories and an intensive care unit[13]. All Ebola Treatment Centres were strictly separated from the Hospital. The study was approved by the Independent Review Board of EMERGENCY ONG ETS (April 2024, Protocol Number 05/2024).

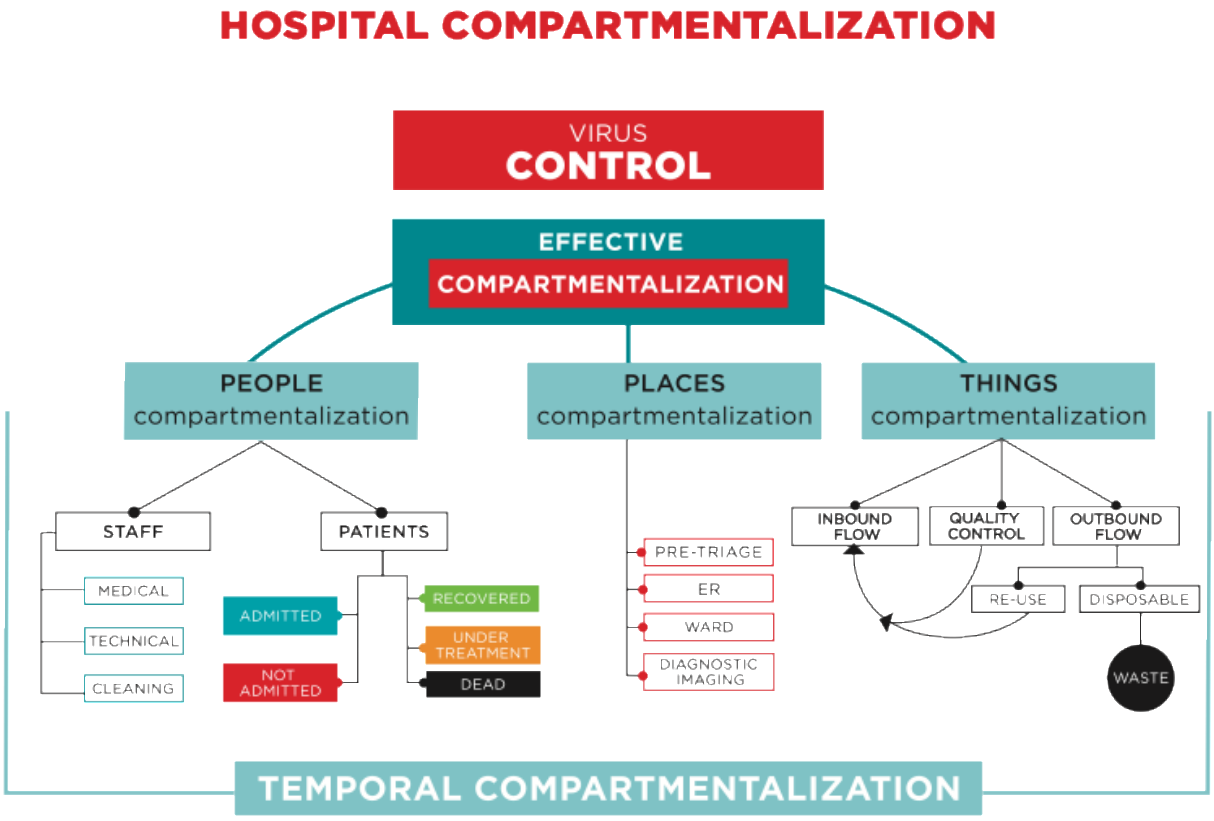
Interventions

At the onset of the Ebola outbreak in Sierra Leone on June 26, 2014, EMERGENCY responded swiftly by deploying a comprehensive series of preventive and containment measures led by its multidisciplinary team. The interventions were designed to protect healthcare workers (HCWs), patients, and the broader community, and to ensure the continued operation of the hospital during the epidemic.

Preventive Measures

An extensive educational programme was organised for all staff members, emphasising the prevention of EVD transmission. The programme targeted not only HCWs but also extended to their families and local communities, aiming to increase awareness and safe

Figure 1: The "four-dimensional logic" used for the effective compartmentalisation of EMERGENCY's Surgical and Paediatric Centre in Goderich, Freetown, Sierra Leone.



practices. Continuous, standardised screening procedures were implemented for both staff and patients, based on the assessment of clinical signs and symptoms. Access to the hospital was restricted to essential personnel only, and the usual "relatives' day" was suspended to minimise the risk of introducing the virus from outside sources. All materials brought into the hospital underwent decontamination according to specific protocols tailored for each category of item, reducing the risk of viral contamination via fomites. Limited to the duration of the epidemic, staff received a salary increase of approximately 25% and were required to work exclusively at EMERGENCY's hospital, a measure intended to limit their exposure to potentially infected patients elsewhere and to prevent uncontrolled community transmission.

Containment and mitigation strategies

To further mitigate and contain any potential introduction of EVD into the hospital, a series of targeted actions were implemented. The hospital was reorganised according to a compartmentalisation strategy designed to minimise the probability of viral transmission ("four-dimensional logic", Figure 1). This strategy addressed four key dimensions. Staff and patients were grouped by category, with each group assigned to specific workflows, and interactions between groups were minimised to prevent cross-contamination (people). Hospital spaces were designated for specific functions, with strict controls on access and detailed entry and exit procedures to prevent unauthorised movement between zones (places). Every item within the hospital was assigned a designated location and restricted for use by a limited group of individuals, eliminating shared items across different patient or staff groups (items). When exceptions to these protocols were necessary, activities were time-staggered, ensuring that different groups used shared spaces or items at separate times, with thorough decontamination between uses (time).

Table 1: Paediatric and surgical hospital activity across pre-Ebola, Ebola, and post-Ebola periods

Indicator	Period	N	% change vs pre-Ebola
Paediatric OPD visits	Pre-Ebola	31,569	-
	Ebola	25,989	-17.70%
	Post-Ebola	31,113	-1.40%
Surgical OPD visits	Pre-Ebola	15,886	-
	Ebola	13,959	-12.10%
	Post-Ebola	18,642	+17.30%
Paediatric admissions	Pre-Ebola	1,539	-
	Ebola	1,391	-9.60%
	Post-Ebola	1,491	-3.10%
Surgical operations	Pre-Ebola	3,948	-
	Ebola	3,588	-9.10%
	Post-Ebola	4,428	+12.20%

A new isolation unit was created, providing a dedicated area for managing suspected and probable EVD cases in a controlled environment. All staff participated in practical training sessions focused on proper handwashing with chlorine solutions and on the correct donning and doffing of personal protective equipment (PPE), preparing them to manage suspected EVD cases safely. The use of PPE was carefully calibrated to meet the specific risks of each hospital area; for example, the outpatient department (OPD), with its high patient throughput, and the operating theatre (OT), where exposure to bodily fluids was significant, required distinct PPE protocols. Essential supplies such as PPE, tents, and hygiene items were proactively procured and stockpiled, ensuring readiness for the evolving epidemic scenario. A specialised system for delivering blood samples to laboratories was established to safely handle and transport high-risk materials.

Screening and case management

Outpatient visits and surgical procedures continued throughout the epidemic, but all patients and visitors were screened before entrance in a separate area within the hospital compound. Screening focused on EVD symptoms and possible risk factors, including recent travel and contact history. The screening process was complicated by local cultural norms and fears; some individuals tended to conceal risky behaviours due to traditional beliefs or fear of stigma. In addition, several common paediatric diseases and surgical emergencies shared symptoms with EVD, making differential diagnosis challenging. Screening nurses, chosen for their familiarity with local customs and extensive knowledge of EVD, conducted thorough assessments of patient history, with special attention to risk factors such as place of residence, travel history, known contacts, and attendance at funerals.

Suspected EVD cases were immediately isolated in a tented area separate from the main hospital building for observation and blood testing. These tents were equipped to provide emergency medical care as needed. Patients confirmed to have EVD were transferred to an Ebola Treatment Centre (ETC), whereas those who tested negative were admitted for regular hospital care.

Study Design

This is a retrospective observational before–during–after study based on routinely collected hospital data. The study period spanned from July 2013 to June 2016 and was divided into three phases: pre-EVD period (July 2013–June 2014), EVD period (July 2014–June 2015), and post-EVD period (July 2015–June 2016).

Outcome measures

The primary outcomes were the number of healthcare workers acquiring Ebola virus disease (EVD) during the study period and the number of non-EVD patients who acquired EVD within the hospital. Secondary outcomes included indicators of hospital activity, specifically the monthly number of surgical outpatient department (OPD) visits, paediatric outpatient department visits, paediatric inpatient admissions, and surgical operations performed.

Data Collection

Hospital activity data were extracted retrospectively from routinely maintained paper-based hospital

registers, including outpatient attendance logs, surgical theatre registers, and inpatient ward admission records. Data extraction was performed by hospital clinical staff involved in routine data management, and records were available as monthly aggregated counts. No missing data were reported. Hospital activity indicators included all patients attending the surgical outpatient department (OPD) and paediatric OPD, as well as all paediatric inpatient admissions and surgical operations performed at the hospital, across all age groups treated at the facility. The scope of clinical Services and patient inclusion criteria remained unchanged throughout the pre-EVD, EVD, and post-EVD periods. Data on the number of healthcare workers were retrieved from payroll records by administrative staff and reported as aggregated figures. Data were analysed descriptively. Monthly aggregated counts and annual totals were compared across the pre-EVD, EVD, and post-EVD periods. No formal hypothesis testing or inferential statistical analyses were performed.

Figure 2: reports data on outpatient department (OPD) visits, paediatric admissions and surgical procedures registered at the Surgical and Paediatric Centre in Goderich, Freetown, Sierra Leone from July 2013 to June 2016. The 12 months from July 2014 to June 2015 are here considered the central period of the Ebola outbreak, and the figures for this period are reported as red bars. Blue bars illustrate data for the 12 months before the outbreak (July 2013 to June 2014), and grey bars for the 12 months after it (July 2015 to June 2016). The yellow line represents the number of confirmed Ebola-infected patients in Sierra Leone (July 2014 to June 2015). Upper graphs: numbers of surgical (left) and paediatric (right) outpatient visits. Lower graphs: numbers of major surgical procedures (left) and paediatric admissions (right).

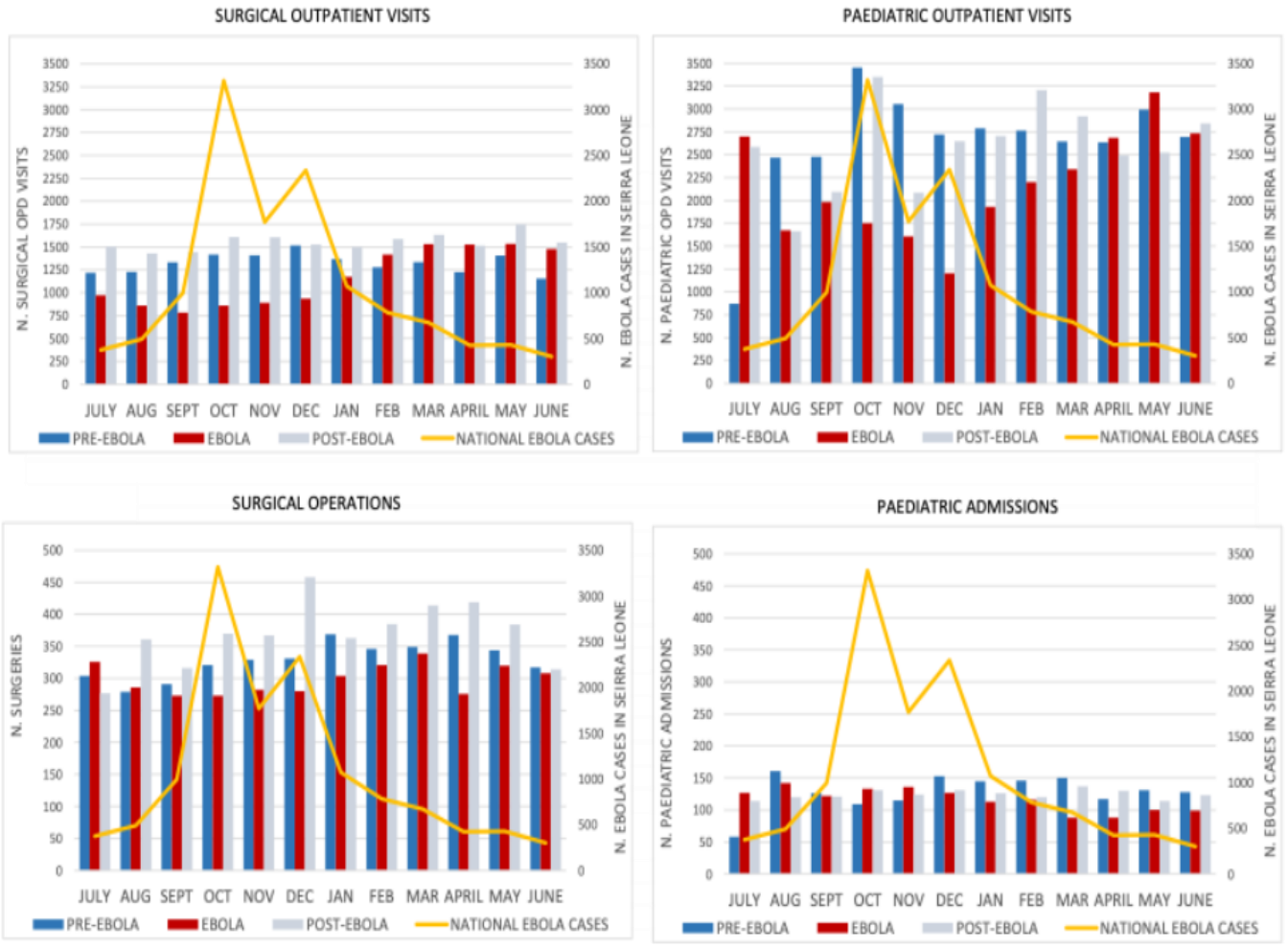
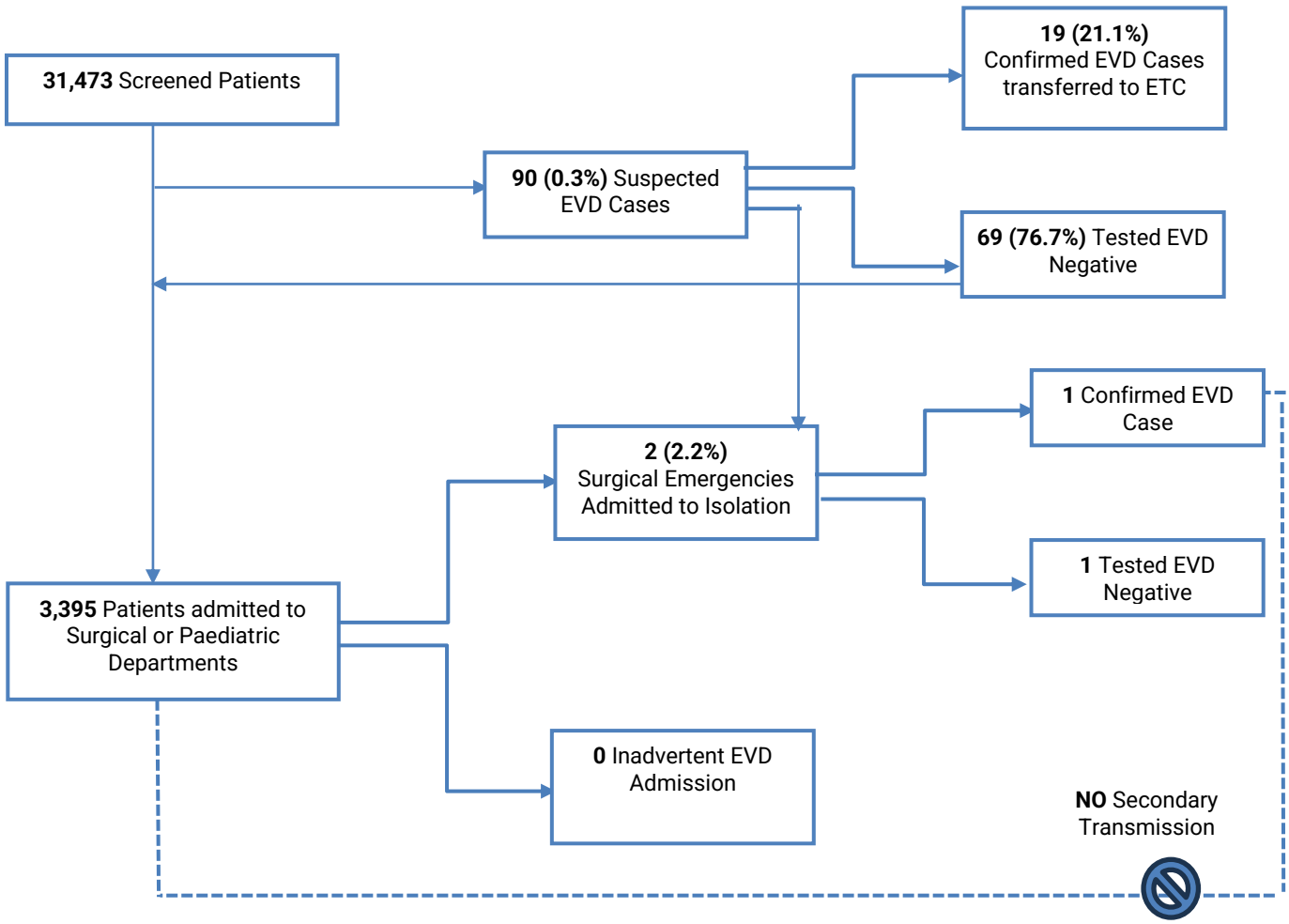


Figure 3: Ebola-related screening and infection outcomes during the EVD period (July 2014-June 2015)



Results

EVD transmission outcomes

During the EVD period (July 2014–June 2015), no healthcare workers (0/406) acquired Ebola virus disease, and no secondary in-hospital transmission occurred. No patients with undiagnosed EVD were inadvertently admitted to the hospital. A total of 31,473 individuals were screened before accessing the hospital during the EVD period. Eighty-eight patients were identified as suspected EVD cases through the pre-hospital screening procedure. Nineteen were subsequently confirmed and transferred to an Ebola Treatment Centre. Two suspected EVD cases presenting as surgical emergencies were admitted to the hospital isolation unit for assessment and treatment; one of these cases was confirmed as EVD. No secondary transmission occurred within the hospital.

Hospital activity during the EVD period

Between July 2014 and June 2015, 3,395 patients were admitted to either the surgical or paediatric departments. Compared with the pre-EVD period, paediatric outpatient department (OPD) visits decreased by 17.7% and surgical OPD visits by 12.1%. Paediatric admissions decreased by 10%, and surgical procedures by 9.1%. Despite these reductions, both paediatric and surgical services continued throughout the outbreak. The largest decreases were observed in outpatient activity.

Post EVD recovery

In the post-EVD period (July 2015–June 2016), hospital activity returned to or exceeded pre-EVD levels. Paediatric admissions returned to levels comparable to the pre-EVD period. Surgical activity increased by 12% compared with the pre-EVD period and by 23% compared with the EVD period. Overall,

the hospital maintained essential surgical and paediatric services throughout the outbreak while preventing in-hospital EVD transmission.

Discussion

The successful experience of the EMERGENCY Surgical and Paediatric Centre in Goderich (Freetown, Sierra Leone), although limited to a single centre, could be instructive to keep hospitals active even during outbreaks. It is important to remember that, at that time, understanding of secondary transmission from person to person was not that clear, therefore requiring a "broad spectrum" bundle approach aiming to block all possible contact. Albeit not extremely contagious (R_0 1.49-1.36)[14], the expected fatality rate was between 50 and 90% and eventually resulted as 62.9% (95% CI 61.9%–64.0%)[15]. Fear was therefore powerful, sometimes hindering a rational approach. The hospital required strong governance to establish and maintain protection.

Timeliness was essential. The organisation was on the alert since the first cases were diagnosed in Guinea, months before the official declaration of an outbreak in Sierra Leone (September 2014), and reacted immediately, giving its HCWs information, education, protection and practical training and strengthening their sense of loyalty and motivation, including financial and other benefits, such as medical aid for their families.

The measures taken allowed patients to access surgical and paediatric care in an area with many EVD cases; 41% of all confirmed Sierra Leonean cases were detected in this area, the Western Area region[12]. Our bundle approach does not allow us to analyse in detail the efficacy of every single measure taken to protect the hospital. Nevertheless, we believe that the great attention given to the safety and loyalty of our staff and the rigorousness of our anamnestic tests to screen patients – and in the case of children, their relatives – before accessing the facility were the distinguishing marks of our achievement.

Surgical activity and admission of children were less affected than OPD activity. Fear and transport challenges may have been the underpinning reasons for postponing non-life-threatening conditions. However, the full resumption of hospital activity in the year after the outbreak (Figure 2) indicates the unwavering confidence of local people.

The experience EMERGENCY NGO gained during the EVD outbreak, duly adapted to the different modes of transmission of Covid-19, helped the organisation keep its hospitals active in Sudan, Afghanistan and Uganda during the Covid-19 pandemic and when managing two Covid-19 units in Italy[16].

Data sharing: The dataset analysed during the current study are available from the corresponding author on reasonable request

Competing Interests: None declared

Funding: No specific funding was received for this research

Acknowledgements: The authors acknowledge the national and international staff of the "*Surgical and Paediatric Centre*" in Goderich, Freetown, for their scrupulous and proactive collaboration and Dr Guido Bertolini for revising the manuscript.

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