

The Effect of the West-African Ebola Crisis on the Sierra Leonean Health System

Hospital Admissions as an indicator for Health System Performance

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Master of International Health
12 September 2016 – 8 September 2017

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Thesis submitted in partial fulfilment of the requirement for the degree of
Master of in International Health

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Signature:



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I. Table of Contents

I. Table of Contents.....	iii
II. List of Tables and Figures	v
III. Abbreviations and Acronyms.....	vi
IV. Summary.....	vii
V. Introduction	viii
1. Background Information.....	1
Country setting – Sierra Leone.....	1
History	2
Economic and health indicators	4
Health system: governmental and private	4
Health system: primary and secondary care	5
Health system: finance.....	6
2. Problem Statement and Research Question	7
2.1. Problem statement and justification	7
The Ebola virus	7
The 2013-2016 West-African EVD Epidemic	7
The NTNU-KI-Ebola-dataset	8
WHO Health System Building Blocks and admissions.....	9
2.2 Study objective	10
2.3 Research questions	10
3. Methods.....	11
3.1 Routine hospital data	11
Study period	11
3.2 Health system analysis.....	13
4. Results – Routine hospital data	14
4.1 Overview of the data.....	14
4.2 Change in overall hospital admissions	15
Total admissions	16
Sex.....	17
Age.....	18
Sector	20
Districts	21
5. Results – Health System Analysis.....	25

5.1 Leadership / governance	25
5.2 Health care financing	26
5.3 Health Workforce.....	27
5.4 Medical products and technologies	28
5.5 Information and research	29
5.6 Service delivery.....	30
6. Discussion and Limitations.....	31
6.1 Linking the results	31
Total admissions	31
Sex and age	32
Sector	32
High and low incidence districts.....	32
Early and late affected districts	33
The concept of resilience	33
6.3 Lessons learnt	33
Preparedness	34
Infection prevention and control.....	34
Importance of information and research	34
Focus and partnership.....	34
6.4 The remaining challenges	35
Economic crisis.....	35
Human resources	35
6.5 Limitations.....	35
7. Conclusions and Recommendations	36
7.1 Hospital admissions	36
7.2 Lessons learnt	36
7.3 Recommendations	37
7.4 Closing remarks	37
8. References	38
Annex I. Organogram Ministry of Health and Sanitation	43
Annex II. Interviews, visited facilities and meetings	44
Annex III. Guide for key performant interviews.....	46
Annex IV. Population Figures	47
Annex V. Absolute admissions per facility per week.....	48
Annex VI. Change in admissions by district	50

II. List of Tables and Figures

Table 1	Economic and health indicators
Table 2	Definition of study periods
Table 3	Facility overview
Table 4	Change in admissions for total, sex and sector
Table 5	Change in admissions by age group
Table 6	Confirmed EVD cases and peak by district
Figure 1	Map Sierra Leone
Figure 2	Life expectancy at birth in Sierra Leone (1960-2014)
Figure 3	Schematic overview of levels of service delivery
Figure 4	WHO Health System Building Blocks
Figure 5	Location and sector of the 41 surveyed facilities
Figure 6	Confirmed EVD cases and change in total admissions
Figure 7	Confirmed EVD cases and change in admissions by sex
Figure 8	Confirmed EVD cases and change in admissions by age
Figure 9	Change in admissions by age group for P1 and P2
Figure 10	Confirmed EVD cases and change in admissions by sector
Figure 11	Map confirmed EVD cases per 100,000 population by district
Figure 12	Nation-wide Confirmed EVD cases and change in admissions for the two high and low incidence districts
Figure 13	Map peak EVD crisis by district
Figure 14	Confirmed EVD cases of early and late EVD peak districts and change in admissions

III. Abbreviations and Acronyms

AIDS	Acquired Immunodeficiency Syndrome
CHW	Community Health Worker
CI	Confidence Interval
EVD	Ebola Viral Disease
HIV	Human Immunodeficiency Virus
KI	Karolinska Institutet
M&E-Officer	Monitoring and Evaluation Officer
MoHS	Ministry of Health and Sanitation
MSF	Medecins Sans Frontieres
NGO	Non-Governmental Organization
NTNU	Norwegian University of Science and Technology
TB	Tuberculosis
UNFPA	United Nations Population Fund
UNMEER	United Nations Ebola Emergency Response
WHO	World Health Organization

IV. Summary

The West-African Ebola Viral Disease (EVD) outbreak, infected over 28,000 people with more than 11,000 deaths. In an attempt to assess the health system performance in Sierra Leone, weekly admission data was collected before and during the crisis.

All hospitals in Sierra Leone known to perform inpatient surgery were assessed for non-Ebola admissions, between January 2014 and May 2015. Changes in admissions was calculated compared to the situation before Ebola. Data was analysed in relation to weekly confirmed Ebola cases divided by sex, age, sector and districts. In addition the health system was analysed using the WHO health system building blocks framework.

Admissions dropped by 95% in the private for-profit sector. During the same period the admissions in the private non-profit sector decreased with 61%. Whilst the governmental sector with 46% reduction in admissions proved to be the most resilient sector.

The decrease in admissions can be explained by the health workforce that was experiencing the loss of staff and fear which resulted in challenges with continuation of the service delivery. Up-to-date information, rapid-tests, vaccines and treatment was essential. International assistance catalysed both the financial resources and the leadership to coordinate successful intervention.

With the right focus, strategy and tools it is possible to create impact. Strengthening the weak health system to improve under-5 and maternal mortality should be prioritized both in the national and international arena.

Key words: Ebola, Health System, Sierra Leone

Word count: 11,888

V. Introduction

From 2011 – 2013, I worked at Masanga Hospital in Sierra Leone as a tropical doctor. There I came across patients that died of pregnancy related causes and infectious diseases such as Leprosy, Cholera and Lassa. That period helped me realize how vulnerable the health system of this country is.

In 2012 I attended the scientific conference in Freetown, the presentation by Randal Schoepp struck me. He presented the results on blood test done for patients with haemorrhagic fever were tested negative for Lassa disease. He discovered that besides Lassa, other viral haemorrhagic fevers were around, including Ebola.(1) At that time no one could foresee the devastating effect that this virus would have over the years after.

To participate in strengthening the Sierra Leonean health system I became involved as in a task-shifting project to train Medical Doctors and Community Health Officers in basic life-saving surgery and obstetrics. This surgical training program was initiated by the Sierra Leonean Ministry of Health and Sanitation and implemented by the Norwegian organization CapaCare.(2)

During the peak of the West-African Ebola Viral Disease crisis, all training institutions were closed and asked to stop clinical rotations. As the surgical training program students were unable to attend classes, they were asked to participate in collecting routine hospital data. The main aim was to assess the impact of the crisis on the health system. The project was executed in cooperation between the Ministry of Health and Sanitation, CapaCare, the Norwegian University of Science and Technology and Karolinska Institutet.

In September 2014, during the first visit retrospective data was collected from January 2014 and from then on bi-weekly until week 20 in 2015. The dataset included total number of admissions (by sex and age group), deliveries, caesarean sections, hernia operations and total operations.

One article has been published from the dataset, with focus on the number of deliveries and caesarean sections during the outbreak. Both the number of in-hospital deliveries and caesarean sections substantially declined shortly after the start of the Ebola outbreak.(3)

This dataset is an important source of information on hospital performance in Sierra Leone during the Ebola Viral Disease (EVD) crisis situation. Hospital performance in terms of the total number of hospital admissions is used as the main indicator of health systems performance and how Ebola influenced the health system during and after the EVD crisis.

1. Background Information

Country setting – Sierra Leone

Sierra Leone is a country in West Africa surrounded by Guinea, Liberia and the Atlantic Ocean (see Figure 1). The country is divided into 3 provinces (the North, the South and East) and the Western Area. The Western Area is on the peninsula where the capital of Freetown is located and divided into an urban (the capital of Freetown) and a rural area.

The three provinces are divided in 12 districts, which are sub-divided into 149 chiefdoms. The chiefdoms are governed by section chiefs and paramount chiefs. As a result of the devolution of services to local communities, the country now has 19 councils which are sub divided into 329 wards. Each headed by an elected councillor.(4) Each district elects its own member of parliament. The head of state is the president. Both, the traditional (chiefs) and the official system (councillors and members of parliament) play an important role in governing the country.



Figure 1. Map of Sierra Leone with provinces.

Sierra Leone (71,740 sq. km land area) is smaller than its neighbouring countries. The climate is tropical with a dry and a rainy season. The total population is about 7.1 million of which 1.5 live in the Western Area.(5)

The majority of men and women are employed in the agricultural sector (54% and 52%). Of the women, 37 % are engaged in unskilled manual work compared to 27% of the men. Five percent of women and 3 % of men work in

sales. Two percent of women and 7 % of men are employed in professional, technical, and managerial occupations.

The country is rich in natural resources such as diamonds and gold. Most of the organized mining is performed by foreign companies. Local, small scale mining is done by individuals who manually look for gold and diamonds.

The country has more than 20 ethnic groups, most of them with their own language. The three largest groups are the Temne especially in the North, the Mende in the South and the Krio in Western Area. English is the official language but Krio is used most.(4)

Religion plays an important role in the lives of the Sierra Leoneans. About two-third of the population is Muslim and one-third Christians. Muslims and Christians are presented in all ethnic groups and there is basically no violence related to religion. Even within families the two religions live peacefully together.

Both Islam and Christianity are often merged with traditional beliefs as secret societies play an import role especially in the rural communities. The largest secret society is the Bondo society. This society is focused on teaching the traditional beliefs and rituals. To enter a society there is an initiation ritual where men and women undergo circumcision. Almost 90% of the women in Sierra Leone is circumcised and this accounts for both Christian (78%) and Muslim (93%).(6) These rituals are perceived as important part of the culture that needs to be carried to further generations.(7) In this light traditional healers and traditional birth attendants are competing with the regular health system.(8)

History

Between 1808 and 1961 Sierra Leone was a British colony. During this period the country had a functioning rail way system and participated in the commonwealth games. On 27 April 1961, Milton Margai led Sierra Leone to independence from the United Kingdom with thousands of Sierra Leoneans in the streets to celebrate the occasion. In the following year the Sierra Leone People's Party, the political party of Milton Margai, won the first democratic elections. Although the country was struggling with power issues, tourists came to enjoy the beautiful beaches.(9)

In 1991, the civil war made an abrupt end to this peaceful situation. Civil unrest from neighbouring Liberia infected Sierra Leone. The rebel leaders from Liberia were in need of the Sierra Leonean diamonds to finance the war.(10) The war was based on terror where child soldiers were put under influence of drugs and alcohol to be indoctrinated to follow the ideology of the rebel leaders. Many villages were burned down, women were raped and limbs were amputated. This all lead to the displacement of a large proportion of the population. This situation had large consequences for the health sector where health structures were demolished, equipment and supplies were stolen and national and international health workers killed.(9,11)

With help from a United Nations intervention and Guinean air support, the British Operation Palliser finally defeated the Revolutionary United Front. On 18 January 2002, President Kabbah declared the Sierra Leone Civil War over. The war left a

big scar in the history of the country with a fragile economic and health situation that was worse than before.(10) Foreign governments and NGOs came in to assist and rebuild the country. Roads and other structures were rehabilitated, schools were reopened and hospitals and other health facilities started to function again. Even though the health system before the war was fragile, improvement in health indicators like Life expectancy was visible (figure 2). During the war Life expectancy dropped and took some years to reach the same level as before the war. While still recovering from the devastating effects of the civil-war, the country faced the next disaster in the form of the 2013-2016 West-African Ebola Viral Disease (EVD) Crisis.

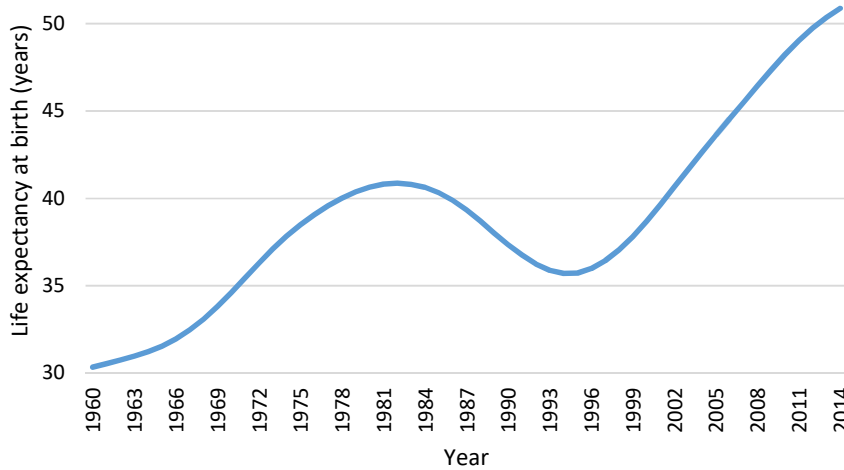


Figure 2. Life expectancy at birth in Sierra Leone (1960-2014).(12)

Economic and health indicators

As a result of all of this, economic and health indicators have dropped to one of the world's worst. Before the EVD crisis, Sierra Leone was ranked 178 out of the 187 countries in the Human Development Index (UNHDI, 2008). The national gross domestic product growth was constant at 7% per year for the period 2003-2007, being one of Africa's success stories. Unfortunately as a result of the EVD crisis and low prices of iron ore, the Annual GDP had decreased with more than 20 %. With an average national income per person in 2015 is 620 US\$, many people are living below the poverty line (see table 1).(12)

The health indicators follow the same pattern as the economic indicators and are among the world's worst. Life expectancy is 51 years at birth, under-5 mortality 120 per 1000 live births and maternal mortality ratio of 1,360 per 100,000 live births (Table 1). Some of the indicators have worsened since the start of the EVD crisis.(12)

Economic indicators	
Gross Domestic Product	4.2 Billion US\$
Annual GDP growth	- 20.6 %
Gross National Income per capita	620 US\$

Health indicators	
Life expectancy at birth	51 years
Under-5 mortality	120 per 1,000 live births
Maternal Mortality Ratio	1,360 per 100,000 live births
Fertility rate	4.6 births per woman

Table 1. Sierra Leone Economic and Health Indicators 2015.(12)

Health system: governmental and private

The health system can be divided in the governmental and the private sector. The governmental sector has 1184 Primary Healthcare Units (PHU) and 24 governmental hospitals making it the largest actor.

On central level, the Ministry of Health and Sanitation (MoHS) is in charge through its directorates (see Annex I). On district level the District Health Management Team is in charge of implementing the policies from central level. The head of the District Health Management Team is the District Medical Officer who is in charge of both the primary health and hospitals.(13)

The private sector can be divided in for-profit and non-profit. The for-profit can be found in the larger cities and mainly consists of smaller clinics run by doctors. These clinics run only on out-of-pocket expenditure and are more expensive for patients. This attracts in general patients that can afford to pay more.

Within the hospital sector, the private non-profit sector consists of faith-based and Non-governmental organization (NGO) hospitals. These facilities are complementing the governmental system with hospitals, usually placed in remote areas far from the district hospitals. Although not part of the governmental system, hospitals can take part in MoHS programs like the free health care initiative, Malaria, TB and HIV/AIDS programs. Some of the non-

profit hospitals have staff on governmental pay-roll and report back to the District Health Management Team.

Health system: primary and secondary care

Besides the division in governmental and private the system can be divided in primary and secondary care. The primary care within the communities and the secondary care at hospitals (figure 3). The provincial and national hospitals function both as first line hospitals from patients from that area (secondary care) and as referral centre from district hospitals (tertiary care).

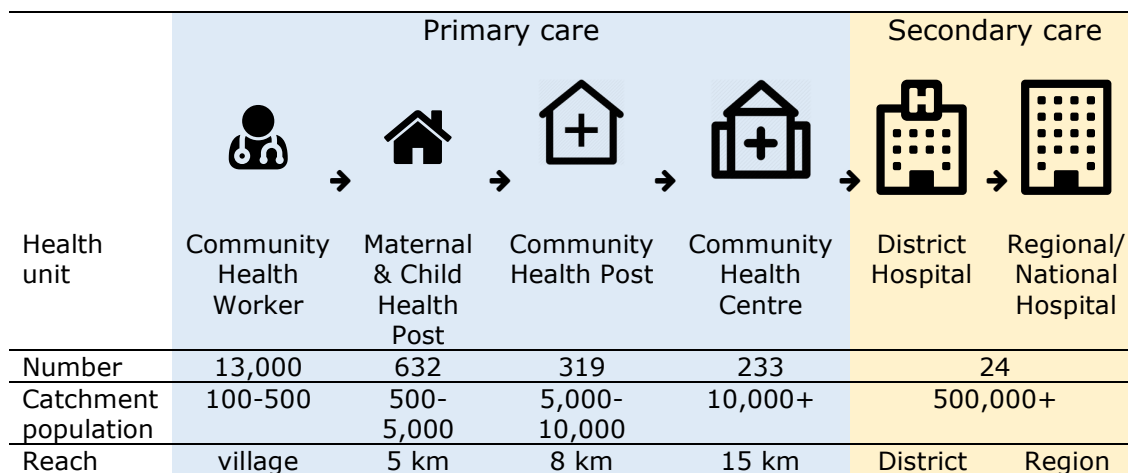


Figure 3. Schematic overview of levels of service delivery.(13)

In the communities there are many different types of community volunteers including and traditional birth attendants, social mobilizers and community drug distributors. In 2012 the MoHS has developed a Community Health Worker (CHW) policy guideline to harmonize the various community volunteers under one umbrella with standardized selection criteria, roles, and training requirements.(13,14) The main task for the CHWs are now sensitization and advocacy and have undergone a minimum training of 10-days but no official diploma or degree. Presently CHWs are working as volunteers, often supported by NGOs. During the EVD crisis the CHWs group played an important role which will be discussed later.

The Primary health care facilities are subdivided into Maternal and Child Health Posts, Community Health Posts and Community Health Centres. Maternal and Child Health Posts focus primarily on antenatal care, safe deliveries, post-natal care, and child health services including immunization and integrated management of neonatal and childhood illness. These posts are the first line for many patients. Community Health Posts have similar capacity, with added curative functions such as the distribution of HIV medication. While Maternal and Child Health Posts are staffed by Maternal and Child Health aides, Community Health Centres are typically run by a community health nurse.(13)

Community Health Centres are the most highly skilled services within the primary care level and are often situated in the chieftdom headquarters. Each Community Health Centre is supposed to have a laboratory and a pharmacy.

Since 2010, the MoHS has been working towards facility readiness goals to certify 65 Community Health Centres for basic Emergency Obstetric and Neonatal Care, corresponding to five Community Health Centres per district. Community Health Centres should be able to offer basic surgical procedures such as manual placenta removals, wound treatment and abscess drainage.

Most surgeries are referred to the hospital level. District and regional hospitals are open 24 hours and serve the entire district. They provide emergency medical services, general surgery and obstetric care, and ideally qualify as comprehensive emergency obstetric and neonatal care facilities. Hospitals are staffed by doctors, Community Health Officers, Surgical Assistant Community Health Officers, nurses and midwives, and should have laboratory, ultrasound and X-ray facilities. Most specialist physicians practice at the tertiary level. The most complicated cases are managed at the two referral hospitals in Freetown, Princess Christiana Maternity Hospital and Connaught Hospital, which also serve as primary facilities for many Freetown residents.(13,14).

The importance of the private sector in relation to the national health system can be seen for example in the number of surgeries. Before the EVD crisis, the majority (54%) of surgeries was performed in the private non-profit sector, followed by the governmental (37%) and private for-profit (7%).(15)

With an estimated number of 150 medical doctors of which only a few specialists there is a shortage of higher cadre health workers. Shifting specific tasks from specialists to non-specialist doctors and non-physician clinicians is a tool to increase capacity. Although this is well established and accepted concept in East-Africa, it was only introduced by MoHS and the Norwegian NGO CapaCare in Sierra Leone in 2011.(2,16) Medical Doctors and Community Health Officers are now trained in basic life-saving surgery and obstetrics.(17)

Health system: finance

In 2013, the total health budget was 590 million US\$, which equals an average of 95 US\$ per person. The biggest source of funding for health is out-of-pocket expenditure (61%), followed by donors (24%), NGOs (7%) and Government of Sierra Leone (7%).(18) There are only a few private insurances, but the vast majority of the population has no form of insurance.

Since 2010, the country has initiated the free health care initiative for children under-5, pregnant and lactating mothers. Under this initiative these vulnerable groups are supposed to receive free consultation, medication, surgical treatment, etc. Despite this initiative, the country has not been able to reach the health related Millennium Development Goals.(19,20) Lack of supplies, out-of-pocket payments, staff-shortage and non-medical costs hinder healthcare utilization.(21)

2. Problem Statement and Research Question

The previous chapter described Sierra Leone and its health system. This chapter focusses on the 2013-2016 West-African EVD epidemic and the consequences for Sierra Leone. It will further define the problem statement and justification. This is followed by the research objective and research questions.

2.1. Problem statement and justification

The Ebola virus

In 1976, the Ebola virus was identified for the first time in the Democratic Republic of Congo in the area of the Ebola River.(22) The Ebola virus is part of the Filoviridae family together with the Marburgvirus (with the single species Marburgvirus and Cuevavirus.(23,24) Bats are the natural reservoir for the virus.(25) Humans may acquire the disease by close contact with biological fluids from infected animals or patients. During the acute phase of illness, the Ebola virus has been detected in a variety of body fluids including breast milk, saliva, semen, stool, sweat, tears and urine. The incubation period has been reported from 2 – 21 days.(25)

The case fatality rate has been described to be between 57% (<30 years) and 87 % (>30 years).(26) The viral load, and therefore the chance of transmission of the virus is highest around the time that the patients dies. This causes high risk for of transmission to health workers and burial teams.(25)

Since the discovery of the Ebola virus, there have been 23 documented outbreaks in Congo, Ivory Coast, the Democratic Republic of Congo, Gabon, South Sudan and Uganda. (25) Before the EVD crisis, the Ebola Virus was detected in Sierra Leone in blood samples of patients that initially were tested for Lassa fever, although this did not lead to great concerns.(1)

The 2013-2016 West-African EVD Epidemic

The first reported human case in the 2013–2016 epidemic was a 2-year-old boy living in Meliandou village in Guéckédou prefecture, Guinea, not far from the Liberian and Sierra Leonean border. On December 26, 2013, the boy became ill and died 2 days later. Although the source of infection cannot be confirmed, it is most likely that he was infected from an animal, possibly a bat. About five months after the first case in Guinea, the first patient in Sierra Leone was detected.(27)

In the months that followed the virus was able to spread drastically in the three main affected countries, Guinea, Liberia, and Sierra Leone. On the 8th of August 2014, after more than 1,700 reported cases, including more than 900 deaths, the WHO announced the situation to be a public health emergency.(28) This finally lead to global concern about the epidemic and an influx of international assistance in the three countries.

The scope and magnitude of this epidemic was of a different scale compared to any earlier outbreak.(11,27). Over 28,000 people were infected and more than 11,000 people died. Sierra Leone, with over 8,500 confirmed cases was most

affected.(29) Together, Sierra Leone, Guinea and Liberia, have reported a total of 881 infected health workers of which 513 died.(29) Besides the three mentioned countries, an additional 36 cases were also reported in Italy, Mali, Nigeria, Senegal, Spain, the United Kingdom, and the United States.(27)

Socio-cultural factors contributed significantly to Ebola spread, and also complicated the implementation of control interventions. In particular cultural practices involving touching the body of the deceased contributed to the dissemination of the Ebola virus.(24) Similar observations were made in Liberia where epidemiological and surveillance response to the EVD outbreak in Lofa County was studied, underlining the contributions of the weak health systems as well as sociocultural factors in fuelling the epidemic. Cooperation between local authorities, community leaders and civil societies and other partners to overcome these challenges had a positive impact.(30)

The crisis led to a change in health seeking behaviour with a reported reduction in the number of people seeking care in health facilities and an increase in self-medication.(31) Three months into the epidemic, 35% fewer children under-5 were treated for malaria in Sierra Leone.(32) A similar reduction in the use of healthcare services was described in early stages of the crisis for major surgery (50%) and for general admissions (70%).(33) From Guinea a 40% reduction was observed in out-patient HIV clinic attendance during the EVD epidemic.(34,35)

In December 2014, following the international intervention to support local efforts in the three main affected countries, the numbers of newly infected cases started to decline rapidly. Despite all the efforts, it took many months before the chain of transmission was stopped completely. The last case detected in Sierra Leone was on January 14th 2016. The outbreak was declared no longer an emergency on March 29th 2016.(36)

[The NTNU-KI-Ebola-dataset](#)

After the EVD crisis was declared a public health emergency, schools and universities were closed down. Students from the CapaCare Surgical Training Program were recruited to collect routine hospital data in order to establish a system that could monitor the effects on the health system in real-time. This was done in collaboration with MoHS of Sierra Leone, the Norwegian University of Science and Technology and Karolinska Institutet in Sweden.

This data collection was additional with the health information system that is functioning under the directorate of policy, planning and information of the MoHS. It contains additional parameters (for example number of surgeries) and is not only covering the governmental sector but also the private. In addition, it has been a challenge to collect reliable routine hospital data, analyse it and to make it available.

The dataset contains the total number of admissions (by sex and age group), deliveries, caesarean sections, hernia operations and total operations, hospital activity and staff presence. The 72% of the facilities that performed surgery before the crisis, contributed to the dataset. The dataset is described in more detail in the methods section.

Based on the NTNU-KI-Ebola-dataset one article was published in 2016.(3) The article focused on the number of deliveries and caesarean sections during the outbreak. Nation-wide, both the number of in-hospital deliveries and caesarean sections substantially decreased shortly after the onset of the EVD outbreak with 20%. The decline was mainly due to the close of some of the private non-profit facilities. Since access to emergency obstetric care, such as caesarean sections, is associated with decreased maternal mortality, many women are likely to have died due to the reduced access to appropriate care during delivery.(3)

WHO Health System Building Blocks and admissions

The WHO has designed a conceptual framework to describe and assess health systems known as the WHO Health System Building Blocks (figure 4). The framework describes the key elements of the health system and its expected outcomes.(37)

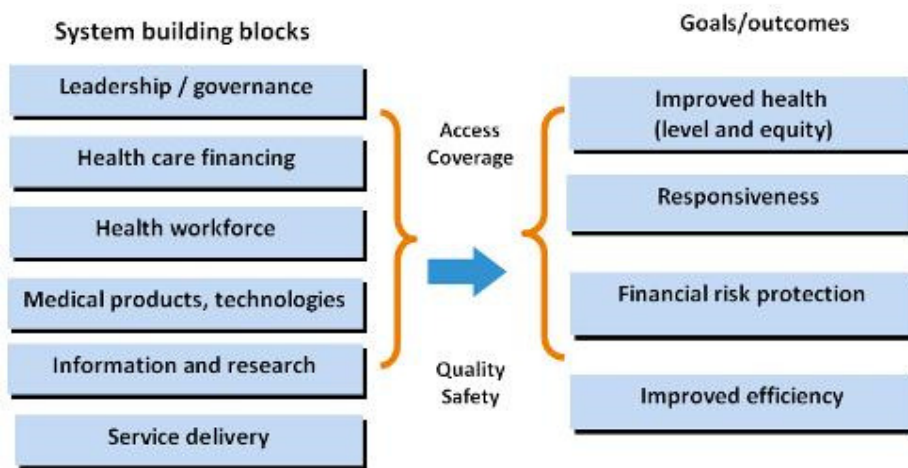


Figure 4. WHO health system building blocks.(37)

Service delivery, besides one of the building blocks, is also an immediate output of the health system and is strongly related to access and coverage. To be able to create output all elements of the system needs to be in place.(38,39) Crisis situations, like natural disasters, have a negative impact on the availability of health services.(40) Measuring health system functioning by collecting indicators is challenging even in stable settings in low-income countries.(41) It becomes even more complex in situations of humanitarian emergency such as the 2013-2016 EVD crisis.(42)

There is need to understand better how catastrophes like the EVD crises impact the health system. This is done by assessing hospital admissions as an indicator for output. The output is directly linked to access to health services and to health seeking behaviour. In parallel, a brief health system's analysis will be done linked to the changes at output level during the crisis.

2.2 Study objective

The objective of this study is to assess the effects of the EVD crisis on the functioning of the health system in Sierra Leone by assessing hospital admissions, performing a health system analysis and linking the two together.

2.3 Research questions

The first main research question is:

1. What was the effect of the crisis on the number of hospital admissions?

With sub questions:

- Was this the same for different patients groups (age and sex)?
- Was this the same across different sectors?
- Were districts with a high number of Ebola cases affected more than districts with a low number of Ebola cases?
- Were districts with confirmed Ebola cases early in the epidemic affected in the same way as districts late in the epidemic?

Putting the answer of the first research question in a broader perspective leads to the second:

2. What are the lessons learnt from the EVD crisis?

With sub questions:

- Did the EVD crisis change the health system?
- Is the impact still visible today?

3. Methods

The study is primarily based on quantitative with additionally a limited number of key informant interviews. For the quantitative data-collection, weekly hospital admissions were analysed from the NTNU-KI-dataset. The information from the key informant, in combination with available literature and other sources, is used for the health system analysis and illustrate the changes in the health system during the crisis.

3.1 Routine hospital data

In September 2014, the NTNU-KI-dataset was initiated wherein weekly routine hospital data was collected. The study was done as an initiative to monitor effects of the Ebola epidemic on the use of inpatient health services in Sierra Leone. The director of research and Non-Communicable diseases and the Director of Laboratory and Hospitals of the Ministry of Health and Sanitation approved the study.

All facilities that were identified to perform surgery during a mapping exercise in 2013 performed by the same group, were used as the basis for the dataset.(15) Facilities provided surgery were selected as caesarean sections, hernia operations and total number of surgeries were some of the data elements collected. In addition to this selection, one of the district hospitals was added as it was closed during the 2013-survey. The facilities represent the governmental, private for-profit and private non-profit sector. Ebola treatment centres, psychiatric and ophthalmic hospitals and paediatric hospitals without surgical activity are not included in the study. Twenty-one Community Health Officers that were participating in the CapaCare Surgical Training Program were provided with a one-day training before the start of the data-collection.

Between September 2014 and May 2015, the data collectors visited the facilities bi-weekly. Weekly admission data for male and female patients were retrospectively retrieved from the admission books. Aggregated data was entered using tablets (Huawei Mediapad 7) with DHIS2 software.(43,44) Data was transferred and stored on a central data server.

Besides the data from the above mentioned database other additional data sources included:

- Sierra Leone 2015 Population and Housing Census.(5)
- WHO Ebola situation report.(29)
- Database of Global Administrative Areas.(45)

Study period

The study period is divided in three parts: before Ebola, Early Ebola, and Late Ebola (see table 2). The "before Ebola" is defined as the time from the start of the study (week 1, 2014) to the week before the first confirmed Ebola case in Sierra Leone (week 20, 2014). The "early Ebola" period starts in the week of the first confirmed Ebola case (week 21, 2014) and goes on until the week with the highest total number of weekly confirmed cases (week 48, 2014). The last

period is the “late Ebola” period from the first week after the peak (week 49, 2014) until the end of the study period (week 20, 2015).

Period	Description	Weeks	Dates
Before Ebola	Time from the start of the study to the start of the Ebola epidemic.	week 1 to 20, 2014	30 th December 2013 to 18 th May 2014
Early Ebola	From the start of the Ebola epidemic to the peak of the Ebola epidemic.	week 21 to 48, 2014	19 th May 2014 to 30 th November 2014
Late Ebola	From the peak to the end of the study period	week 49, 2014 to week 20, 2015	1 st December 2014 to 17 th May 2015

Table 2. Definition of study periods

For every week, change (%) in admissions is calculated as the number of admissions minus the average number of weekly admissions during the period before Ebola, divided by the average number of weekly admissions before Ebola. These results are presented in graphs. The data is not corrected for seasonal variation which potentially influences the number of admissions. Two of the most relevant examples of seasonal variations are the rainy season (May to September) with mainly increased paediatric admissions and the festive season (December to January) when money is spend on parties and presents rather than healthcare.

For the early and late Ebola period, change in admissions is calculated as the average number of admissions minus the average number of weekly admissions before Ebola, divided by the average number of weekly admissions before Ebola. These results are presented in tables.

For the analyses, related to sex, age and sector (government, private non-profit, private for-profit), average number of weekly admission numbers are calculated before further statistical testing. Confidence intervals (CI) were calculated for change in weekly admissions for the early and late Ebola periods. The T-test is used to compare groups and Pearson test is used to identify correlation. Age groups were determined following the standards of the MoHS.

For the district sub analysis the number of new weekly confirmed Ebola cases were divided by 100,000 population. For every district the peak week (with the maximum number of new cases) was identified. Weekly district admissions are calculated by adding the weekly admission numbers of the hospitals located in the district, before further analysis. The two districts with the highest EVD incidence were compared with the two lowest EVD incidence and the two districts with the earliest peak were compared to the two with the latest peak in Ebola incidence.

For the district analysis, besides the 12 districts, Western Area (rural and urban merged) is included (figure 4).

For the statistical analysis Stata 13 and Microsoft Excel 2013 are used. For geographical presentation of the data QGIS 2.8 is used.

3.2 Health system analysis

In order to be able to translate the results from routine data collection into a health system perspective, an analysis of the health system is done based upon key performant interviews. These interviews were conducted in February 2015 during an assessment to identify possibilities to restart the CapaCare Surgical Training Program during the end of the Ebola epidemic. The list of participants can be found in annex II and the interview guide in annex III.

The health system analysis follows the structure of the WHO health system building blocks. In addition to the key performant interviews, the analysis is based upon different sources including journal articles, reports, student thesis, hospital visits and official strategic MoHS meetings. These meetings were at the directorate of human resources and reproductive health and took place during autumn 2016. All these visits and meetings were opportunities for formal and informal discussions with many different stakeholders including local leaders, directors from MoHS, representatives of WHO and UNFPA, representatives of NGOs, health workers from hospitals, primary health care units and Ebola treatment centres, traditional and religious leaders and patients.

This contextualised and broadened the understanding of the impact EVD crisis in the country at district and local levels, in public and private sectors. Information gathered through formal and informal discussions were triangulated with observations and literature to check reliability and relevance. A list of facilities visited and meetings attended are attached in Annex II.

4. Results – Routine hospital data

An overview of the data will first be given followed by a presentation of the change in admissions nation-wide and by age and sex strata. Afterwards comparisons are made for districts that were hit early and late by Ebola and between districts that were hit soft and hard.

4.1 Overview of the data

The 58 facilities identified during a mapping exercise for surgical activity in Sierra Leone in 2012 were selected.⁽¹⁵⁾ Since 2012 two new hospitals had opened up and performed surgery and were added to the 58, while three hospitals were excluded because they performed only eye surgery. Of the remaining 57 hospitals, data from 16 hospitals were excluded because of missing or incomplete data (Table 3). The remaining 41 facilities were included for data analysis. From the 16 excluded facilities, 11 are private for-profit, 3 are private non-profit and 2 are governmental.

	Facilities identified in 2014	Included in analysis
Total	57	41
By sector		
Governmental	20	18
Private non-profit	19	16
Private for-profit	18	7
By area		
Eastern Province	7	6
Northern Province	14	14
Southern Province	9	7
Western Area	27	14

Table 3. Facility overview

The included study facilities cover the whole country (all 12 districts and Western Area; see figure 5). Within the governmental sector, all district hospitals (10), regional hospitals (3) and tertiary referral centres (2) were included. P private non-profit sector 84% of the identified facilities are included. The private non-profit hospitals exist in 7 of the 12 districts and in the Western Area.

For the included private for-profit facilities only 39% of the identified facilities were included in the analysis. Main reason for this is that during the data collection many of the facilities were closed as a measure to prevent EVD spread and data was physically not accessible for the data-collectors. From the seven private for-profit facilities that were included, six are located in the capital Freetown, in the Western Area.

Out of the 57 identified hospitals 41 were included. Nine of the 16 hospitals that were excluded were as a result of a measure taken by the government to close down private clinics. Because the hospitals were closed the data was not accessible for the data collectors. From the 2012 study it is known that the private for profit sector contribution to the health system is limited.⁽¹⁵⁾

- Governmental
- Private for-profit
- Private non-profit

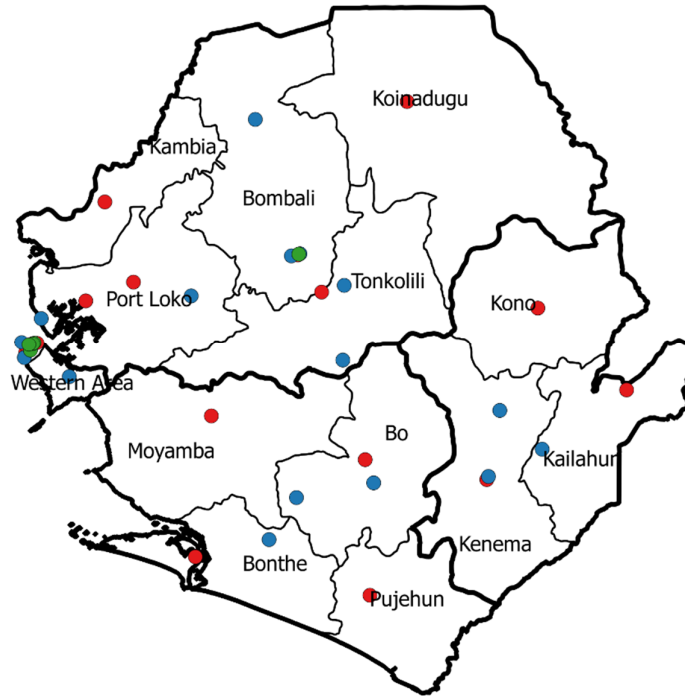


Figure 5: Districts, location and sector of the 41 surveyed facilities.(45)

4.2 Change in overall hospital admissions

As discussed in the previous chapter number of weekly admissions is followed up over time as an indicator for hospital performance before and during the EVD outbreak. Analysis are made for the total numbers, subdivided by sex, age and sector. These will be followed by comparison of high and low affected facilities and comparison of early and late affected facilities.

Total admissions

Figure 6 shows the number of weekly confirmed EVD cases (grey bars) and the change in total weekly admissions. The number of weekly confirmed Ebola cases start to raise from the first case in week 22 until the peak in week 48 in 2014. After the peak there is a fast decline until after week 5 of 2015 where the number of new cases remains 100 or less.

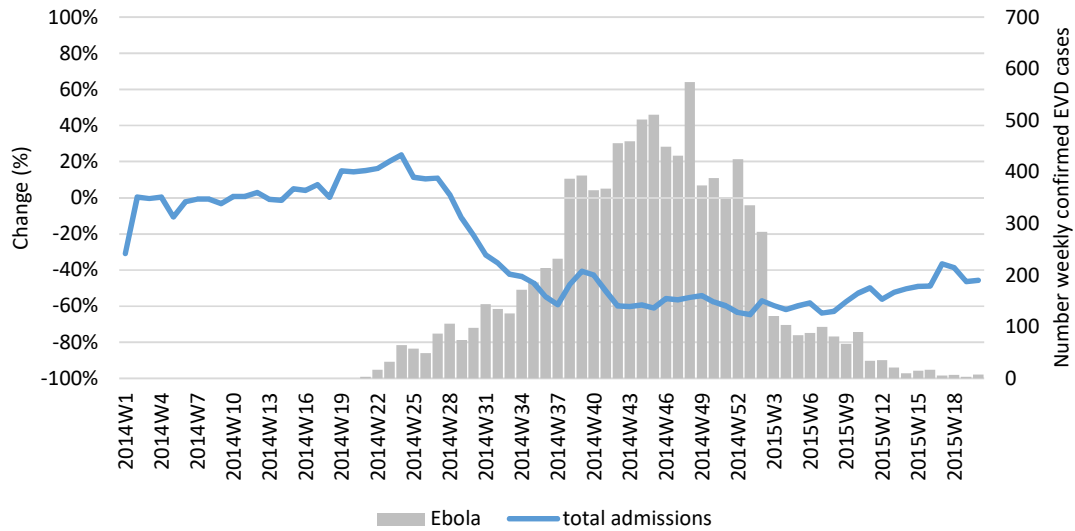


Figure 6. Confirmed EVD cases and change in total admissions.(29)

Before the first detected EVD case in Sierra Leone the number of admissions were increasing. Even in the first 8 weeks during the crisis, weekly admissions were higher than in the first months of the year, probably due to seasonal variation. In week 29 in 2014, the first week after the number of weekly confirmed EVD cases passed the 100, the number of admissions started to fall. The change reached -60% in week 37 and remained that level until week 9 in 2015. After this the number of admission slowly started to rise again but was still not more than 50% in the last weeks of the study period compared to what it was in the beginning of the study period. The number of total weekly admissions significantly decreased for both early and late EVD period with -30% and -55% (see table 4).

	Early Ebola period Change in % (CI)	Late Ebola period Change in % (CI)
Total	-30% (-41%; -18%)	-55% (-58%; -51%)
Sex		
Male	-33% (-45%; -21%)	-59% (-63%; -55%)
Female	-27% (-38%; -16%)	-51% (-54%; -48%)
Sector		
Governmental	-27% (-37%; -16%)	-46% (-51%; -42%)
Private non-profit	-32% (-45%; -20%)	-61% (-63%; -56%)
Private for-profit	-39% (-61%; -19%)	-92% (-93%; -90%)

Table 4. Change in admissions for total, sex and sector.

Sex

The graph for male and female follows the same pattern (see figure 7). For every week during the study period four or five more females were weekly admitted per facility than males (Annex IV). For both the early and late Ebola period, change in admissions was significant lower for males (-33% and -59%) than females (-27% and 51%). For the early Ebola period, the difference between male and females was not significant ($P=0.24$) whilst for the late Ebola period, the number of male admissions decreased more than for females ($P<0.001$).

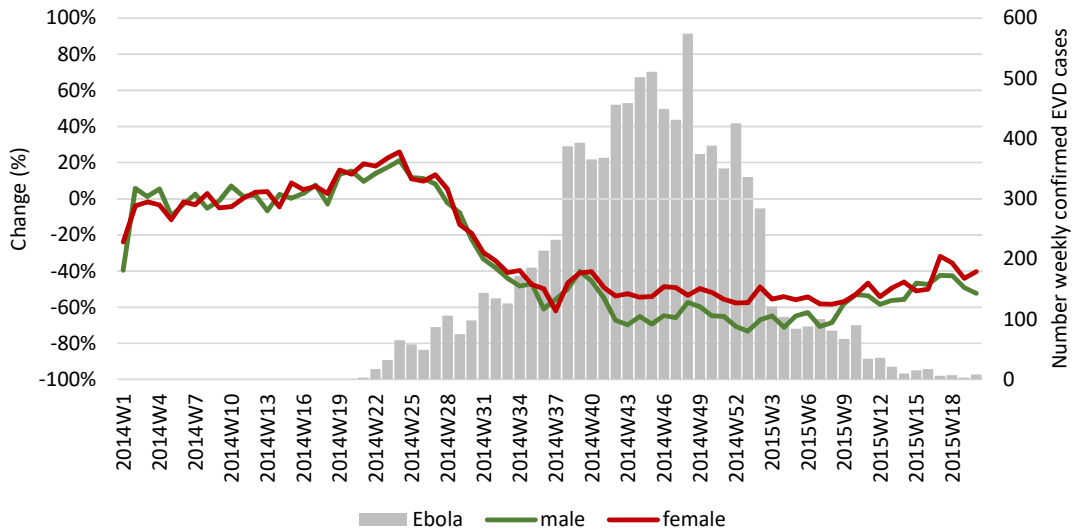


Figure 7. Confirmed EVD cases and change in admissions by sex.(29)

Age

Figure 8 shows that, approximately all 6 age groups follow the same pattern in change of admissions over time. Although in absolute numbers some age groups, like 25 years and older, contributed more than others (Annex V). Normally you would expect a raise in paediatric admissions during the rainy season (May to September) because of the increased incidence of malaria. In figure 4 you would expect this to see in the period with the first confirmed EVD cases (2014 week 22) and this is exactly the time with the steepest reduction of weekly admission.

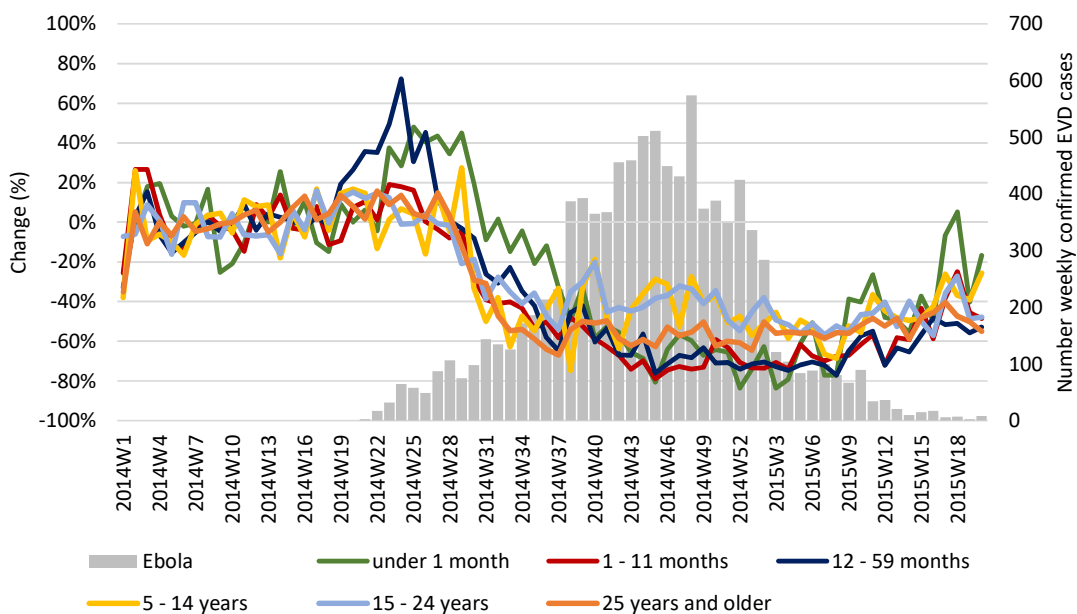


Figure 8. Confirmed EVD cases and change in admissions by age group.(29)

All age groups are more affected in the late EVD period (see Table 5 and Figure 9). In the early period, the most affected age group is 1 – 11 months (-37%). This change is significantly different (P=0.02) compared to the least affected age group under 1 month (16%).

For the late Ebola period, the decrease change is significantly different (P<0.01), comparing the most affected age group 12-59 months group (-65%) and the least affected age group 5 – 14 years (-47%). There is no clear trend or relation between age and decrease in admissions.

Age group	Early Ebola Change in % (CI)	Late Ebola Change in % (CI)
Under 1 month	-16% (-31%; -0%)	-52% (-62%; -42%)
1 – 11 months	-37% (-49%; -25%)	-61% (-66%; -56%)
12 – 59 months	-24% (-41%; -8%)	-65% (-68%; -61%)
5 – 14 years	-28% (-38%; -18%)	-47% (-51%; -43%)
15 – 24 years	-24% (-32%; -17%)	-47% (-50%; -44%)
25 years and older	-35% (-46%; -23%)	-54% (-56%; -51%)

Table 5. Change in admissions by age group.

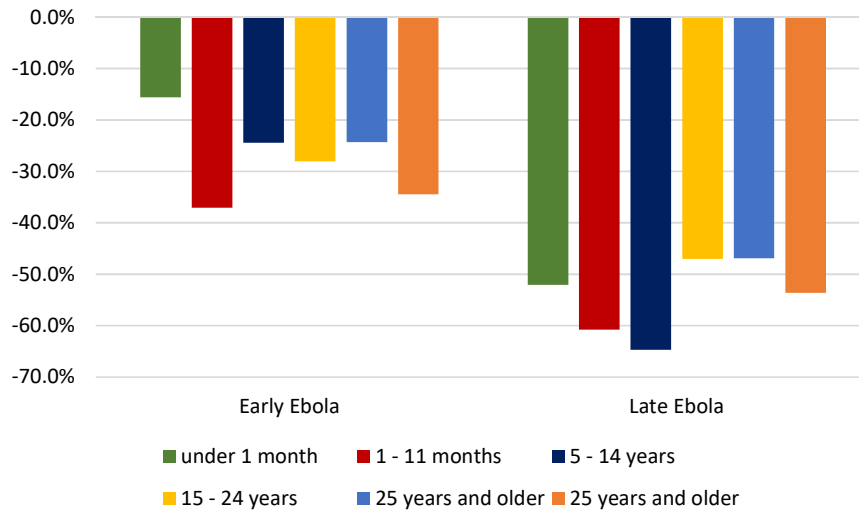


Figure 9. Change in admissions by age group early and late Ebola period.

Sector

Figure 10 shows the change in weekly admissions for governmental, private non-profit and private for-profit facilities. Before the start of the crisis the three sectors followed the same pattern with a steady increase of activity. Before Ebola, the governmental sector was responsible for 48% of the admissions followed by the private non-profit (38%) private for profit sector (14%). This changed during the early and late Ebola period with an increased share for the governmental sector (to 51% and 62%); more or less stable share for the private non-profit sector (37% and 35%) and a decreased share of the private for-profit sector (13% and 3%).

For the EVD period before the peak, the number of weekly admissions decreased rapidly in all three sectors although most rapidly in the private for-profit sector. After the peak, the private-for profit sector was most affected (-92%) followed by the private non-profit (-61%) and the governmental sector (46%). This is a significant difference ($P < 0.01$) Both the governmental and the private non-profit sector showed some form of recovery towards the end of the study period while the private for-profit sector saw little improvement because the government ordered to keep the private for-profit facilities closed.

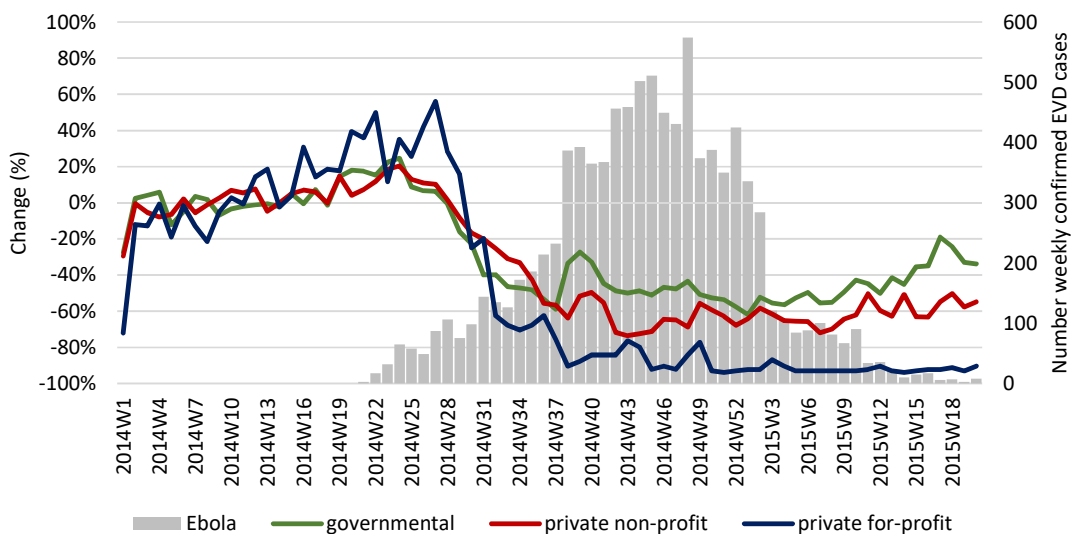


Figure 10. Confirmed EVD cases and change in admissions by sector.(29)

Districts

Districts were not equally affected in terms of number of confirmed EVD cases per 100,000 population. Some districts were more affected early in the EVD crises while others encountered the peak weeks after the peak of the crisis.

Table 6 and figure 11 present for every district the first EVD case, the absolute and relative number of confirmed EVD cases and the peak. The two districts with the most confirmed Ebola cases are Port Loko (256 per 100,000 population) and Western Area (296 per 100,000 population). The 2 districts with the lowest incidence of EVD were Bonthe (1 per 100,000) and Pujehun (16 per 100,000).

Annex V shows the table with the change in admissions for all district separate and the district groups.

District	First case (week)	Confirmed Ebola Cases (n)	Confirmed Ebola Cases (per 100,000 population)	Peak (week)
Bo	2014W25	358	84	2014W35
Bombali	2014W24	1064	215	2014W38
Bonthe	2014W29	1	1	*
Kailahun	2014W21	658	141	2014W28
Kambia	2014W37	255	74	2015W2
Kenema	2014W23	532	115	2014W30
Koinadugu	2014W32	155	38	2014W45
Kono	2014W31	450	89	2014W52
Moyamba	2014W24	276	99	2014W38
Port Loko	2014W23	1573	256	2014W39
Pujehun	2014W31	54	16	2014W39
Tonkolili	2014W32	500	115	2014W40
Western Area	2014W25	3867	296	2014W48
Nation-wide	2014W21	9743	174	2014W48

Table 6. Confirmed EVD cases and peak by district and nation-wide.(29) *Bonthe district does not have a peak as there has been only one confirmed case during the study period.

Figure 12 shows the change in weekly admissions for the 2 high and 2 low incidence districts and the national number of weekly confirmed EVD cases. The high (red line) and low (green) districts follow the same trend before and during the early EVD period. After the peak, the low incidence districts are able to increase the admissions until even better than before EVD level while the most EVD-affected districts remain on a level of around -40% (Port Loko) and -60% (Western Area). The change in admissions for the 2 low incidence districts together is significantly different from the 2 high incidence districts (Annex V).

Figure 13 shows the map with districts coloured by early peak (orange) and late peak (blue). The 2 districts with the early peak are Kailahun (week 32, 2014) and Kenema (week 30, 2014). The 2 districts with the late peak are Kono (week 52, 2014 and Kambia (week 2, 2015). Bonthe district is not selected as there was only one confirmed EVD case in week 29, 2014.

Figure 14 shows the confirmed EVD cases for the early (Kailahun and Kenema in orange) and late (Kono and Kambia in blue) affected districts and change in admissions for the same districts. In general there are big variations in the weeks which makes it more difficult to look at the trends. For both Kailahun and Kenema the drop in admissions starts after the first cases are diagnosed in these districts. For Kono and Kambia the drop follows more or less the same pattern until week 37, 2014. Thereafter, for the late districts the number of admission decrease even further while the early peak districts start to recover. At the end of the study period, only Kailahun district is above the level as before Ebola, while the other districts have about 60% less weekly admissions.

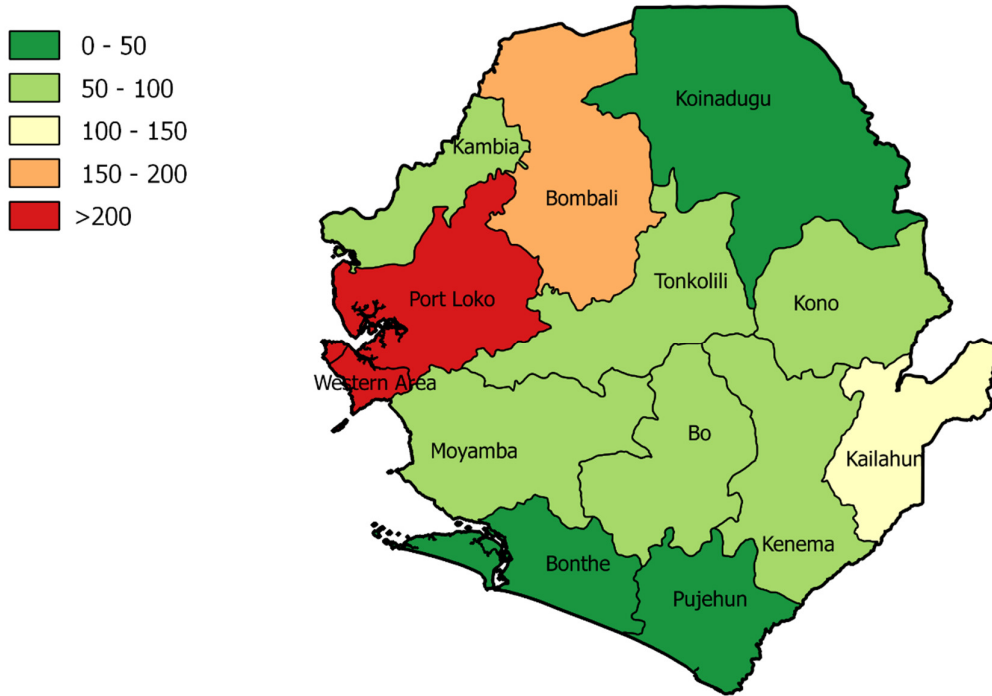


Figure 11. Map confirmed EVD cases per 100,000 population by district.(5,29,45)

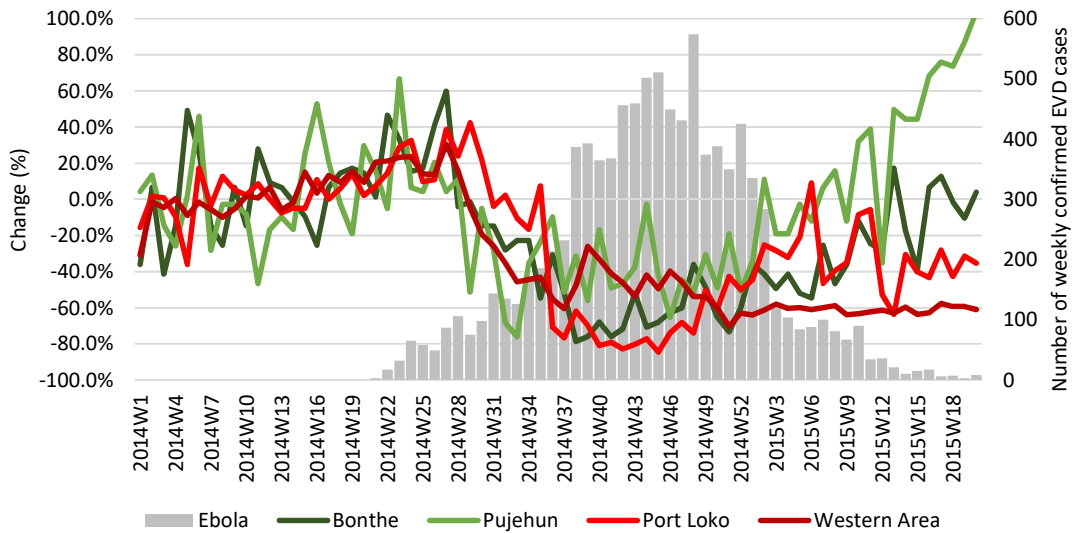


Figure 12. Nation-wide Confirmed EVD cases and change in admissions for the two high and low incidence districts.(29)

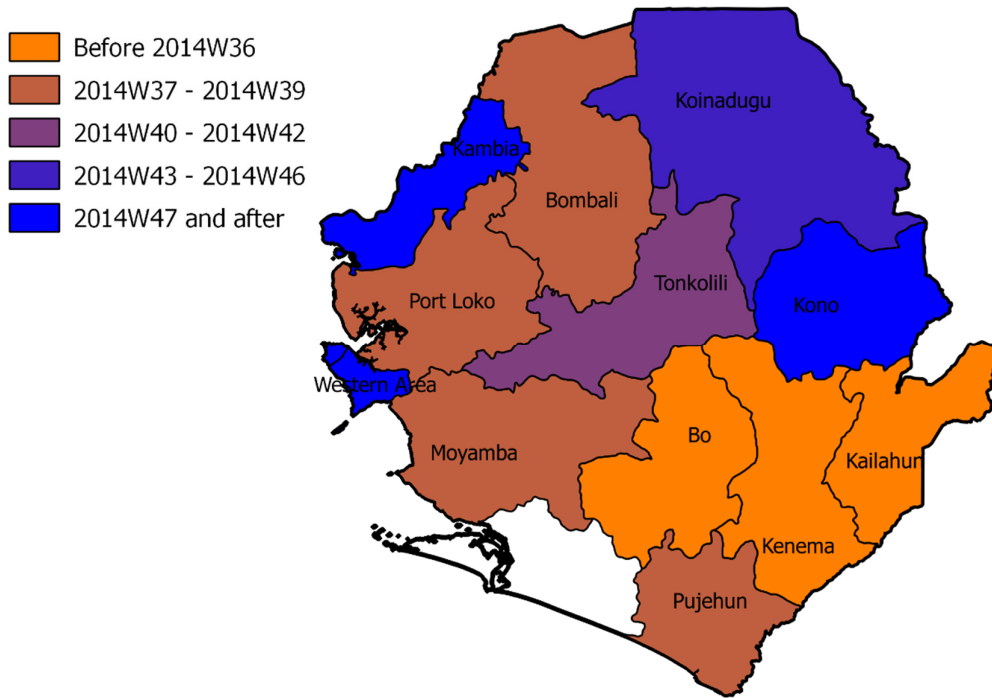


Figure 13. Map peak EVD crisis by district.(29,45) Bonthe district is not coloured as it does not have a peak with only one confirmed case during the study period.

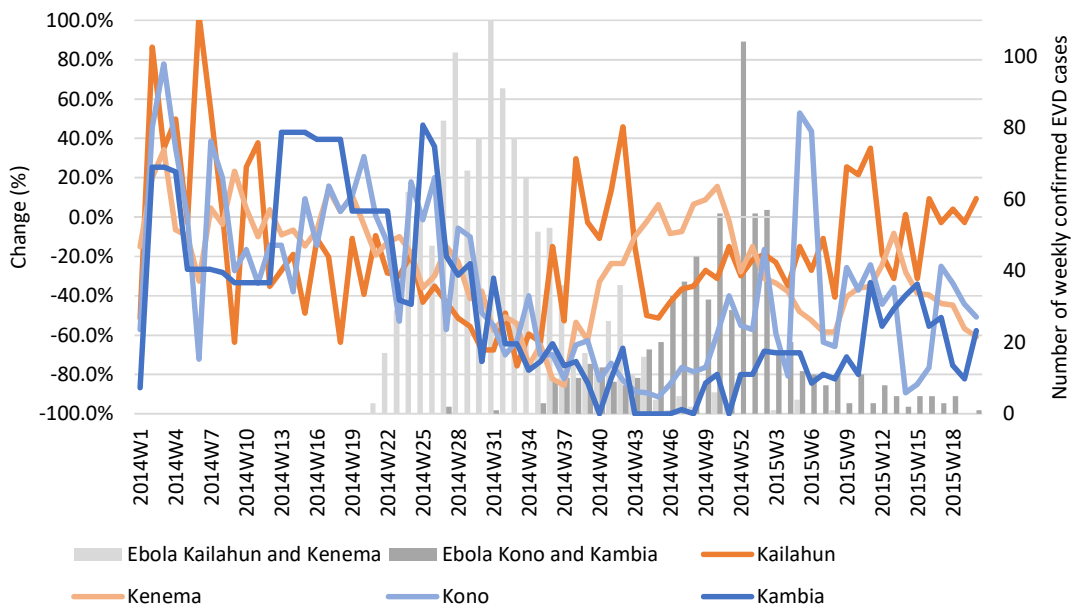


Figure 14. Confirmed EVD cases of in the early and the late EVD peak districts and change in admissions.(29,45)

5. Results – Health System Analysis

This health system analysis in this chapter follows the structure of the WHO health system building blocks.(37) For every health system building block the situation before, during and after is discussed.

5.1 Leadership / governance

Before the EVD crisis, the country experienced annual economic growth of over 20%. This was mainly due to the mining sector where the investment of international companies led to increased number of jobs and revenue for the government.(46) This created opportunities for the health sector. In 2010 the Free Health Care initiative was introduced for children under five, pregnant and lactating women, dramatically increased the access health care for vulnerable patient groups.(19,20) The Free Health Care initiative is implemented in all governmental hospitals and Peripheral Health Units and in some of the private non-profit hospitals.

The fight against corruption remains one of the major challenges in the public domain. It is deeply rooted in all levels of society and the health sector is unfortunately not exempted. Even within the MoHS, where in the years before the EVD crisis the turn-over of ministry officials was high, some of them leaving their post as a result of investigation related to corruption scandals.(47)

When the Ebola virus reached Sierra Leone in 2014, the country was not prepared for a crises of this magnitude. As a result of limited capacity in both leadership and governance to handle the situation, the international community had to step in. In the beginning of the crisis Medecins Sans Frontieres (MSF) was the first organisation to recognize the significance of the situation and started with the first Ebola Treatment Centres. During late summer of 2014, when the situation completely got out of control and was declared a public health emergency, additional international NGOs and governmental agencies came in to assist. The UN took over the coordination with the United Nations Emergency Ebola Response (UNMEER) in strong cooperation with MoHS.

Cooperation between all actors and strong partnership towards the same goal were important elements of reducing further spread. As the information from CHWs, burial teams and contact traces was sent to the district teams and further to national level, from national level the district teams were directed and in their turn directed the teams working in the communities. As required by the situation, both the flow of communication and governance was stronger than before the crisis.

The Sierra Leonean government, and specifically the President's office, is committed to move the health system in the right direction after the crisis. This is outlined in the 2015-2017 post-Ebola recovery strategy and focusses on restoring basic access to healthcare, getting kids back to school, social protection and restoring economic growth.(48)

Although the majority of the international assistance in terms of leadership left the country after Ebola, there are several NGOs that work together with the MoHS to assist both in developing policies, planning and implementation. Also the United Nations agencies such as WHO and UNFPA are involved in the ministry with technical assistance.

5.2 Health care financing

In 2013, the year before the start of the crises, the total health expenditure was about Le 2.5 trillion, which equals about USD 590 million. In other words, each Sierra Leonean consumed health services valued about Le 400,000 (about USD 95). Most of the money was paid as out-of-pocket expenditure (62%), followed by donors (24%), NGOs (7%) and the government of Sierra Leone (7%). In the five years before the crisis, expenses to the health sector accounted for about 10% (between 8.2% and 11.2%) of the national budget.(18) This is significant less than what is contributed to the construction of roads.

The high amount of out-of-pocket expenditure and the fact that there is no form of insurances or other ways to pool and distribute health funds, results in unequal access to services. This effects mainly the vulnerable and the poor to access health care.

In addition, the system relies for the major part on external funding. Donor-dependency makes the system vulnerable to changes in the international political climate. As we can see happening with the global refugee crisis which absorbs funds that were previously allocated to development aid. In addition, donors tend to invest in vertical programs, while health system strengthening is more difficult to fund.(49)

During the EVD crisis increased financial resources were made available by the international community to build a strong response in order to stop the transmission of the virus. Although there is criticism about the timing of the response, there is no doubt it was important. Most of the funding was labelled directly to the treatment, vaccine development, contact tracing, development of diagnostic tools etc. The increased need for protective supplies, the need for health personnel working for NGOs in communities and treatment centres, risk-allowances pushed the total costs for health care.

After the crisis, the remaining Ebola funding was used for strengthening the health system and some NGOs are working within governmental hospitals to improve healthcare. However the additional financial resources that came in during the crisis stopped and the country is in the same situation as before Ebola.

The EVD crisis in combination with the low prices for raw materials like iron ore, lead to the fact that some of the bigger international mining and agricultural companies left the country. As a result many workers lost their jobs and revenues have gone down. Two years after the EVD crisis, the country finds itself in an economic crisis.(46,50) As a response to the situation, the president announced the austerity measures to reverse the economic situation, including

the raise in fuel price by 60% and a moratorium on new recruitment in the public and civil service.(51)

5.3 Health Workforce

Before the crisis, in 2011, Sierra Leone had 1746 nurses, 76 midwives, 566 community health officers, 40 house officers, 79 medical officers, 5 registrars and 41 specialists on payroll. A concentration of the doctors are found in the capital Freetown and many do administrative work instead of clinical work. Although in lesser extent, the maldistribution of health workers is present in other health cadres.(14)

Limited local capacity to train more health professionals and minimal absorption capacity of the government because of lack of financial resources within the MoHS, are two of the main reasons for the lack of qualified health workers. Before the crisis, an annual number of 10-15 new doctors were graduating from the only medical school in the country between 2008-2012.(52)

With a total of 2553 doctors, nurses and midwives for a population of over 7 million gives about 3,6 doctors, nurses and midwives per 10,000 population.(5,14) This is only 15% of the critical threshold of 23 doctors, nurses and midwives per 10,000 population determined by the World Bank to be able to carry out the minimum standard of essential maternal and child health services.(53)

For the nurses, there was a shortage in the governmental service of high cadre nurses (state registered nurses) but a group of 3,000 low cadre nurses (state enrolled community health nurses) that are waiting to be enrolled in the civil service. The normal procedure for enrolment is a minimum of 2-3 years of volunteering in a position before official posting is organized. This leads to unofficial fees being paid by patients to the volunteers.

The EVD crisis affected the health work force. First of all there is the health workers that were infected by the virus of which many lost their lives. Fear to be infected caused patients to avoid going to the hospitals and made the hospitals to minimize patient intake or close down completely.(54) Staff tried to avoid patient contact and took excuse from work. Other staff were highly motivated and saw it as their obligation to continue to fight for the lives of mothers and children and to set an example for others.(55)

When the international NGOs came in, workers were employed to build up the Ebola Treatment Centres and worked in the community for infection prevention and control and contact-tracing. Working for the NGOs in the fight against Ebola was a risk, but a well-paid risk.

Different NGOs that worked in community sanitization and contact tracing made use of the CHWs and trained them. About 13,000 CHWs were selected and trained and became a valuable resource to stop the transmission chain by communicating with community and their role in surveillance system. Their role in the community gave them the opportunity to identify suspected patients before they reached a health facility and communicate this information to the District Health Management Team. This provided possibilities for early isolation.

As they are part of the community they could bridge the communication gap between the District Health Management Team and the community. Issues as the belief that Ebola was not real, fear for ambulances and burial teams, and risk-full cultural behaviour around burials, could be addressed by the CHWs. Changing individual behaviour is one of the main factors determining the outcome of the crisis.(56)

Besides the loss of national work-force, there was a huge temporal increase in international health workers. Doctors, nurses, lab-technicians etc. came from all over the world to Sierra Leone to work in administrative and clinical functions for international NGOs and governments. Most of the workers stayed for only a few weeks and left when the numbers of new confirmed cases dropped.

After the country announced the end of the crisis and Ebola Treatment Centres were dismantled, the international staff was sent home and the national staff lost their jobs. Some of the NGOs, with remaining Ebola funding, started with programs to assist the governmental hospitals. For example MSF is based in Magburaka and Kabala Hospital to assist the hospitals to provide obstetric and paediatric care.

After Ebola increasingly efforts have been made to raise the number of graduating doctors from 10-15 to about 45 per year. In addition, a task-shifting program in basic life-saving surgery and obstetrics is training Medical Doctors and Community Health Offers to increase capacity.(17) However training takes time and is only successful if graduates are absorbed within the system. With the current moratorium on the new intake of civil servants this is unfortunately not the case.(57) The crisis did not change the maldistribution of health workers and attracting qualified staff in rural areas remains a challenge.

5.4 Medical products and technologies

Before the crisis, Sierra Leone had problems with the procurement and distribution of medication and consumables.(21) This led to stock-outs of essential medication at the hospital pharmacies. It was common that a pregnant woman who needed a caesarean section had to send her family shopping to buy iv-fluids, fuel for the generator or sutures on the street before the operation.

The same problem was true for the ambulance service. Every district hospital was equipped with ambulances that were standing still as a result of mechanical problems, lack of spare parts and fuel, and empty tires.

When the virus arrived in the country, nobody was prepared in terms of enough availability of consumables and medication. Even though, Lassa fever is endemic in the country, and hospitals should have some experience to handle haemorrhagic fever cases, almost nothing was in place. It took months before enough personal protective equipment was available for all health facilities.

To enforce the strategy of early identification and isolation, an ambulance system was put in place with a central phone number. All cases were brought to the hospital for free for triage and treatment. Big signposts communicating: "there is always a safe ambulance ready", tried to convince the public.

The epidemic catalysed interest in the development for quicker laboratory testing, treatment and vaccines. In the start of the crisis, testing took several days but safety for patients and staff improved with increased number of lab-facilities and quicker tests. In the beginning some forms of experimental treatment were available although scarce.(23) Treatment was mainly available for expatriates flying back to their home-countries for intensive care treatment. At the tale of the epidemic different consortiums started with the testing of vaccine. The target population were health-workers and preliminary results are positive about the immune responses initiated.(58)

After the crisis, things are back to normal. Especially hospitals that do not have NGO support, stock-outs and fuel-problems are not uncommon. The most recent facility assessment report concludes that only two district hospitals satisfy all the criteria required for providing safe Emergency Obstetric and Neonatal Care services. Identified areas of constraints are lack of basic equipment, essential drugs, running water and electricity.(59) The report pictures a situation that is comparable with before the epidemic.

Most of the ambulances that started operating during the crisis are still collecting patients. The system, including the free phone number is still working. The government has started to train paramedics for the ambulance services and the plan is that each chiefdom should have an ambulance station.

5.5 Information and research

The collection, analysis and distribution of data related to the health information system is under the responsibility of the directorate of policy, planning and information of the MoHS. In every district monitoring and evaluation officers (M&E-officers) were posted under the District Health Management Team, that were responsible for the collection of the information. All health facilities within the district reported monthly to the M&E-officer, which in its turn informed the MoHS. For certain infectious diseases, like Lassa and Cholera, immediate information to the M&E-officer is obligatory.

During the EVD crisis WHO and UNMEER took the responsibility to assist the MoHS to gather, analyse and disseminate information on suspected and confirmed cases, number of admissions and deaths. To make sure that new cases were identified early, CHWs were trained in early detection and contact tracing.

Weekly Ebola situation reports were made available throughout the epidemic and were easily accessible for professionals and the general public through internet and other media.(29) Radio and text-messages were also used to inform the public on how to recognize EVD, general hygiene principles and what to do in a situation with suspected cases.

After the crisis the Ebola surveillance system has not only been extended for other infectious diseases like malaria, measles and cholera but a new component that has been added is maternal death reports. Weekly epidemiologic bulletins are now produced by the WHO and the MoHS, reporting on maternal deaths, malaria and measles cases.(60) CHWs continue to work in the community under

the guidance of the District Health Management Team to do health promotion and surveillance.(13)

5.6 Service delivery

Under the health service delivery building block WHO defines “effective, safe, quality personal and non-personal health interventions to those who need them, when and where needed, with minimum waste of resources”.(37) As described in the previous sections, before the crisis the health system was dealing with shortages of supplies and human resources resulting in sub-optimal service delivery.

In the beginning of the crisis, there was a lack of protective equipment and testing took several days. Suspected patients needed to be isolated with other suspected cases, to protect the health workers. It was absolutely possible that patients were infected with the Ebola virus during this isolation period. While waiting for the test result, any form of interventional treatment was avoided. This delayed treatment and resulted in an increase in stillbirths and uterus ruptures.(55)

The situation resulted not only in the increased need for costly Personal Protective Equipment but also increased the amount of hazardous waste. Safe waste disposal was one of the elements supported by the international intervention.

The influx of international resources with supplies and medical equipment resulted, for some hospitals in that service delivery improved. Also the newly donated ambulances improved the access to the hospitals.(55)

Increased attention to Infection Prevention and Control is one of the most prominent things that the country has gained from this crisis. Most facilities still have some form of triage including temperature check and hand washing before entering the facility. Patients with suspected infectious diseases are isolated and handled with more care than before. An Infection Prevention and Control team, often headed by a matron, is responsible for training staff, checking the adherence to protocols and awarding certificates to the best workers and wards. The government is supporting this with organizing trainings and supervision visits. Part of the hospital income is dependant the adherence to the Infection Prevention and Control protocols as part of performance based financing. This form of funding is channelled through the MoHS budget.

6. Discussion and Limitations

In the discussion the results of both research main questions will be linked together. Furthermore the lessons learnt from the crisis and remaining challenges will be discussed. The chapter closes with limitations of the study.

6.1 Linking the results

To get a broader perspective the results of the changes in the overall hospital admissions have to be linked to the analysis of the health system. The structure and subheadings of 4.2 Change in overall hospital admissions will be followed whilst linking this to the findings of the health system analysis section.

Total admissions

From the first confirmed EVD case in Sierra Leone, the number of weekly admissions significantly decreased for both early and late EVD period. From week 37, 2014 it reached a stable level about 60% lower than the number of admissions in the period before the crisis. This is a few weeks after the WHO declared Ebola being a public health emergency.

The international community acknowledged the global consequences of the situation. This catalysed influx of resources into the three most affected countries. Although the timing of the international response has been debated, the need was paramount. With the arrival/access of isolation and treatment units, laboratory facilities, epidemic experts, early identification and isolation became possible. In addition with the medical supplies and ambulances this has contributed to the stabilization of the number of weekly hospital admissions.

After January 2016, the weekly admissions slowly increased again reaching a level that was 40% below the level of before Ebola. Although the CHWs assisted in gaining trust back in the health system, it took a much more time for the admission numbers to rise after the peak than to fall in the start of the crisis.

Service provision is not only related to the availability of service but also to health-seeking behaviour. The crisis has resulted in change in health seeking behaviour because of fear to become infected in the hospitals or other health facilities. The fear was fed by the strict triage and isolation protocols in the health facilities and the negative appearance of the protective clothing of workers in the Ebola Treatment Centres and the burial teams.

The effect of the health-seeking behaviour and the service provision is highly related. It is not undesirable that non-acute patients such as hernias that were not strangulated and for example club-feet could usually wait for treatment after the crisis with lower risks. This does not count for the acute patients like obstructed labour and road traffic accidents, where delay in treatment worsened the outcome of the patients.

The availability of services and the health seeking are interrelated. When patients do not expect to receive care in a facility, the motivation of seeking health-care will be less. But also the other way around, when the demand is decreasing the patients wards will be closed to reduce costs and exposure.

The change in health seeking-behaviour during the crisis affects male and female, all age-groups, sectors and districts. Although some might be more affected than others and will be discussed in the specific sections.

Sex and age

In the late EVD epidemic, the number of admissions for male decreased more than for females ($P < 0.01$). This has to do with the fact that female admissions are often related to obstetric care. While women are admitted for obstetric complications needing emergency care, men are more in need of care that can be planned, for example hernia operations.

The continuation of emergency care during the crisis is an interesting observation from the dataset. Positive attitude of workers, quicker testing possibilities and increased supply and ambulances all contributed to this.

Although there are significant differences between age groups, all age groups follow more or less the same trend. There is no clear trend or relation between age and decrease in admissions. So far we cannot conclude that consequences of the crisis are dependent on age specific factors.

Sector

To get a comprehensive overview of the health system, all three sectors (government, private for-profit and private non-profit) are included in the analysis. For the private for-profit sector 11 of the 18 facilities were excluded because no or incomplete data was collected. This is due to the fact that data was physically inaccessible because facilities were closed during data collection as a measure to prevent spreading of the EVD. This has no or little consequences for in absolute numbers in the private for-profit as can be assumed that the closed facilities did not admit patients during the study period. Relatively, the exclusion of these facilities, gives an over estimation in the number of weekly admitted patients per facility in this sector, as the closed facilities do not admit patients but are also not included in the denominator.

Another reason for private facilities to close down was to prevent national and international staff of being infected. Governmental hospitals did not have the option to close down, although some of the facilities were quarantined for limited periods. Other facilities were closed or transformed to focus on the mission of fighting the EVD. Some of the patients that otherwise would have attended a private facility now went to a governmental facility.

High and low incidence districts

Bonthe and Pujehun district are the two districts with the lowest EVD incidence. Both districts are located in isolated areas which could have given them a relative protection of attracting EVD. On the other hand, because of the difficulty to access, there might be a higher tendency for underreporting because contact-tracing is more challenging in remote areas.

The two districts with the highest incidence of EVD, the Western Area and Port Loko, are easier accessible by road and connected to other districts. The analysis shows that low incidence districts recover faster than high incidence districts. It is understandable that in facilities with many confirmed EVD cases the impact is

higher and that it takes more time to restart the normal work and create a safe environment for both patients and staff. In some facilities the loss of doctors and nurses and the need for replacement was another reason for slow recovery.

In the high incidence district it can be expected a bigger change in health-seeking behaviour as patients are more exposed to the consequences of the crisis. When comparing districts it should be noted that patients travel between districts. The analysis does not correct for migration.

Early and late affected districts

When comparing early and late affected districts, based on peak week, we see the same trend when it comes to decline in admissions during the start of the EVD epidemic but the early districts recover before the late affected districts. Both early affected districts are located close to the area where the epidemic started in the area between Guinea and Liberia. This might be a relative advantage as they were maybe better aware and prepared than districts that were further away from the area where the epidemic started.

The earlier recovery of the two earliest affected districts is probably not only related to the peak but also related to the last confirmed case in these districts. Kailahun and Kenema had the last confirmed case week 50, 2014 and week 8, 2015, followed by a trend where admission numbers normalized, although this process took many months.

The concept of resilience

In the recent literature the term resilience has been frequently used in relation to the EVD crisis to describe how the health system can benefit and become stronger after a crisis situation. Kruk et al. define resilience of the health system as: "the capacity of health actors, institutions, and populations to prepare for and effectively respond to crises; maintain core functions when a crisis hits; and, informed by lessons learned during the crisis, reorganize if conditions require it." (61) In other words there are three aspects that can be identified namely: preparedness, maintenance of core functions and adjustment.

Two of the three aspects, namely maintenance of core functions and adjustment, are reflected in the change observed in the admissions analyses. In figure 10 page 20, the governmental sector had the slowest decrease in admissions and therefore managed best to maintain its core function. The same government sector also had the fastest recovery compared to the private sector. Based on this one can argue that the governmental sector is the most resilient and the private for-profit sector is the least resilient system. The private non-profit sector is intermediate.

6.3 Lessons learnt

As Mr Anders Nordström (WHO country representative in Sierra Leone) rightly mentioned during the Reproductive Maternal Neonatal, Child and Adolescent Health strategy meeting in Freetown, January 2017: "During Ebola there was a very clear strategy for the goal of getting to zero, but also clear steps in terms of what would be done first, second, and third, as well as use of data. We can do the same things with Reproductive Maternal Neonatal, Child and Adolescent

Health that we did for Ebola, with the same level of rigor and high quality of interventions.”

This underlines the importance of understanding lessons learnt from Ebola to be able to extract recommendations that can be applied to the health system in general. Knowing its limitations and the fact that horizontal programs face different challenges and limitations compared to vertical, disease specific programs.(62)

Preparedness

As discussed in the health system analysis, Sierra Leone was not prepared for this type of epidemic. For the future, there is a real threat that similar events can occur. There is chance that the Ebola virus can infect new people, especially knowing that live virus can be found in semen even more than 6 months after a person is considered free of EVD. Also other haemorrhagic fevers like Marburg, West-Nile and Rift-Valley viruses have been detected in blood samples of patients, tested for Lassa.(1)

Improved preparedness for a new threat to the health system can reduce the potential impact and improve the resilience of the health system. Early detections can be done using the CHWs for surveillance. Suggestions have been made to strengthen the health system after the EVD crisis by increasing human resources.(22)

Infection prevention and control

Increased attention to Infection Prevention is one of the most important changes that, more than a year after the end of the crisis, is still visible in most health facilities. It is more than posters that ask attention for hand-washing. It is a way of working where with continuous focus on how to properly execute hygiene procedures to prevent infection for both patients and health staff.

How sustainable these changes are can be questioned. As one of the drivers recently mentioned when I noticed an animal in the back of the car “we have started to eat bush meat again”. The fear of Ebola is over and things start to go back to normal. This can definitely also happen to the infection prevention protocols if attention from those who set the example drops.

Importance of information and research

Ebola has shown the importance of information. Making weekly numbers of suspected and confirmed EVD cases publicly available, helped gain control over the situation and assisted in focusing on one common goal. Real-time information is the basis for rational decisions and monitors the effects of it.

Through accelerating the research in relation to diagnostics, rapid-tests became available and decreased the isolation time for suspect cases. Towards the end, vaccines became available for immunizing health-workers working with EVD patients. For some patients experimental treatment became available. All of this shows that research during the crisis was of immediate (potential) importance.

Focus and partnership

Only after the international recognition of the magnitude and seriousness of the situation, which catalysed a partnership between governments, international

agencies, NGOs and civil society, the approach to the crisis became effective. With one goal in mind, “getting to zero”, all actors worked together to stop transmission.

Sierra Leone its high maternal and infant mortality are announced to be of the highest priorities set by the president in the post-Ebola recovery plan.(48) The same focus and priorities will be lined out in the next Reproductive Maternal Neonatal Adolescent and Child Health strategy. This focus can be the tool that can help Sierra Leone to the next level. To keep focus on this “real-time” for instance a weekly update on maternal deaths will contribute to this.

6.4 The remaining challenges

Even though the EVD crisis is over and some of the lessons learnt can be used for the future, Sierra Leone still has to work with two main challenges the economic crisis and the work-force shortage.

Economic crisis

Sierra Leone its economic situation is one of the main areas of concern. If there are no additional funds allocated for health system strengthening in terms of investing in additional training of health workers and investing in facilities, equipment and supplies the system will remain weak. In fact, when the NGO programs for assisting the governmental hospitals end, the situation can be worse.

The government needs to increase the budget for health. Proper financing mechanisms need to be in place where revenue is collected and funds are pooled. Efforts to create a national insurance scheme should be reinforced and the commitment from the international community is needed for long-term financial and developmental support.

Human resources

Human resources can be increased by increasing the intake of students for the relevant health cadres and implement task-shifting program.(57) Another option that has been suggested is reverse brain drain (diaspora), where Sierra Leonean citizens residing outside the country (for example United Kingdom) come back to serve their home land in the health profession.(63) The effort to train and reverse brain drain, increase the capacity is only successful if there is the capacity to absorb new health staff in the system, which is a problem with the current hostility measures.

6.5 Limitations

Data collection during the crisis was difficult as traveling was restricted and some of the facilities were closed. The study period is limited from 4 months before the start of the crisis until one year after the start of the crisis. A longer period before and after could have contributed to adjust for seasonal variation and could have contributed to a better understanding of the post-Ebola recovery.

For the key performant interviews a more structured approach could have contributed to a more in-depth analysis of the health system.

7. Conclusions and Recommendations

This chapter goes back to the two research questions providing an answer with recommendations. The chapter closes with some final remarks.

7.1 Hospital admissions

As discussed in the previous chapters, the EVD had a big impact in the functioning of the health system in Sierra Leone. This is clearly visible in the number of weekly hospital admissions that decreased during the crisis. It took much longer for the system to recover compared to the time that it took to fall apart. The number of male admissions were more affected than female, although females were more affected as a result of the challenges with the need for emergency obstetric care. Some districts were more affected than others or were able to recover faster than others which could be related to the geographical placement and timing of the peak of confirmed EVD cases in the specific district.

The most remarkable differences were between the different sectors. Where the private for-profit sector as a measure to protect transmission and the private non-profit sector was struggling to continue providing services, the governmental hospitals were best able to keep the hospitals open and continued admitting patients. With maintaining its core function, the governmental sector can be considered the most resilient.

All the six health system building blocks are important to understand the relation between the EVD crisis on the functioning of the health system indicated by the number of admissions. The health workforce was experiencing the loss of staff which created further fear. This had disastrous consequences for the availability of services and the continuation of the service delivery. Only with the most up-to-date information available and the newly developed rapid tests, vaccines and treatment staffs were equipped for the job. Finally, the international assistance catalysed both the financial resources and the leadership to coordinate the successful response.

7.2 Lessons learnt

The most important lesson learnt is that with the right focus, tools and strategy it was possible to do the impossible. Cooperation between the government, civil society, United Nation bodies, international governments, universities, private sector, NGOs, etc. was the way to reach common goals. Infection prevention and control applies the same principles but on micro-level. Cooperation of all the staff is essential to successfully apply the protocols. It only works with the right focus, tools and strategy.

How to prepare Sierra Leone and its neighbouring countries for a situation like this is difficult to answer. Preparedness through a functioning surveillance system and a well-established health system is are prerequisites. The health information systems together with the surveillance work of the CHWs that are introduced during the epidemic should be developed further and integrated in the national strategies.

7.3 Recommendations

Based on the lessons learnt recommendations are made following the health system building blocks framework.

- Leadership and governance: Organizing well-managed partnerships between MoHS, donors, NGOs, civil society, etc. that work through focussed health strategy plans.
- Health care financing: Improve access to health care and reducing out-of-pocket expenditure by implementing a national health insurance.
- Health Workforce: Increase training and absorption capacity for higher cadre health care workers such as medical officers and specialists.
- Medical products and technology: Secure supply of essential medicines and basic laboratory materials. Build a sustainable ambulance system.
- Information and research: Maintain and continue to develop the health information system including the surveillance with the CHWs.
- Service delivery: Continued focus on infection prevention and control to maintain save service delivery for patients and staff.

7.4 Closing remarks

The above mentioned lessons should now be applied to the health system as a whole. But, here the international priorities come into the picture. When did the intervention start to become successful? Only after the crisis was declared a public health emergency and high income-countries realized the potential damage the situation could have for the world economy. Is there support to recognize the high under-5 and maternal mortality in Sierra Leone as a public health emergency? Will it be possible to find the focus, tools and strategies to make this happen?

The signs are not too promising. Attention has dropped and things are getting back to normal. This does not count only for the consumption of “bush-meat” but also for the continuous struggle to find sufficient resources to even provide basic health-care. The current economic situation and the shortage of staff does not make this situation easier.

However there is hope as president Ernest Bai Koroma mentioned in his statement in the national Ebola recovery plan: “I am very hopeful that, with the lessons learned from this epidemic and sustained commitment from my Government and our Development Partners, this recovery programme shall heal affected communities and institutions, and build a foundation for a more resilient Sierra Leone that is better prepared to face future shocks and epidemics”.(48)

Hopefully this will motivate national and international policy makers, donors, health staff, civil society, NGOs, researchers etc. to focus on improving the Sierra Leonean health system in order to reduce under-5 and maternal mortality in the country.

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Annex I. Organogram Ministry of Health and Sanitation

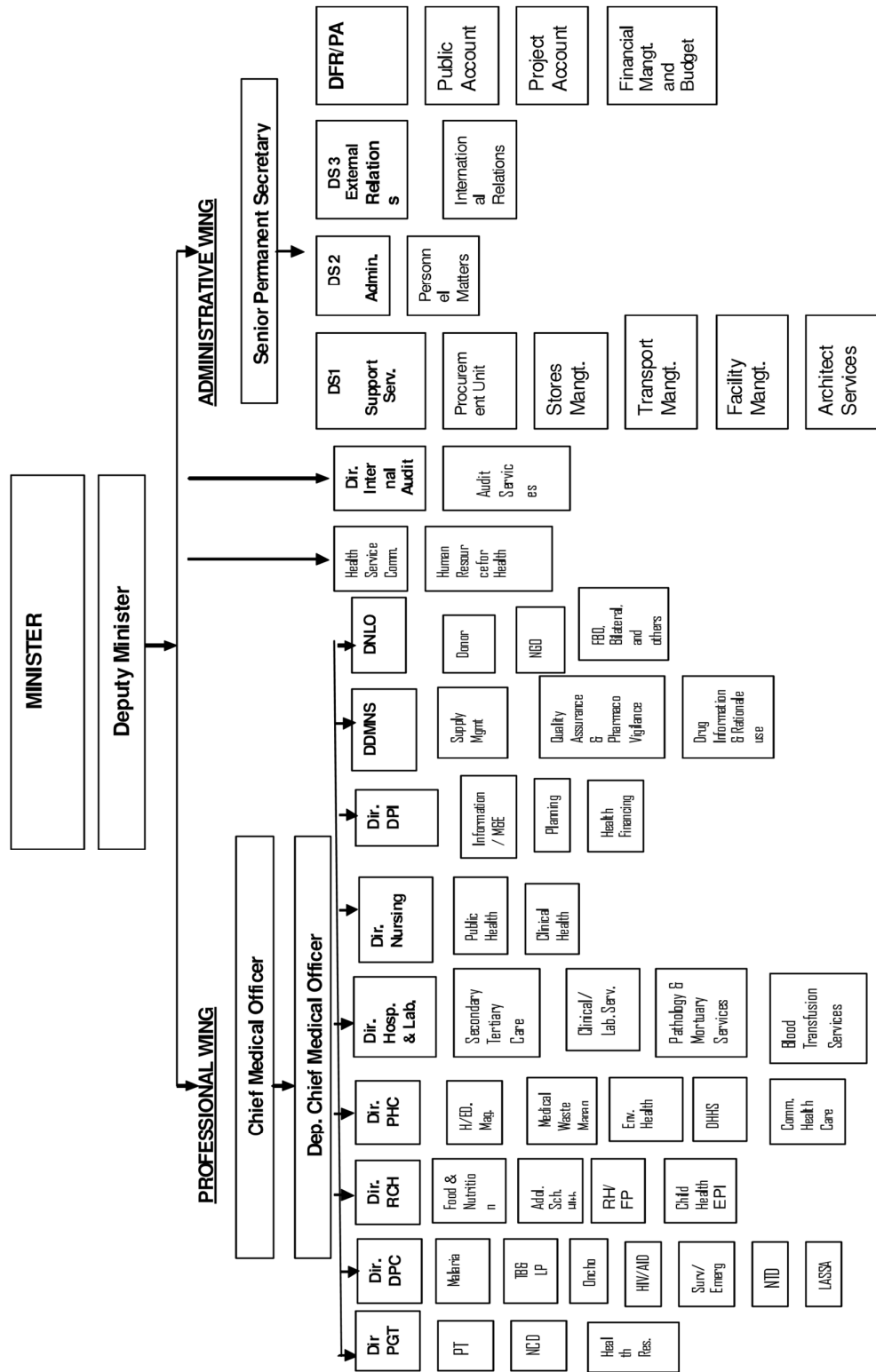


Figure Ia. Organogram MoHS of Sierra Leone.(64)

Annex II. Interviews, visited facilities and meetings

Key performant interviews (February 2015)

Governmental

1. Specialist at Connaught Hospital, Freetown, Western Area
2. Surgical Assistant Community Health Officer at Princess Christiana Maternity Hospital, Freetown Western Area
3. Medical Superintendent at Bo Governmental Hospital, Bo district
4. Medical Superintendent at Kenema Governmental Hospital, Kenema district
5. Medical doctor at Makeni Governmental hospital, Bombali district
6. Medical Superintendent at Port Loko Governmental hospital, Port Loko district
7. Medical Superintendent at Magburaka Governmental hospital, Tonkolili district
8. Medical Superintendent at Kabala Governmental hospital, Koinadugu district

Private non-profit

9. Expatriate ophthalmologist at United Methodist Church Kissy Eye Clinic, Freetown, Western Area
10. In charge, Emergency Hospital, Goderich, Freetown, Western Area
11. Midwife at Aberdeen Women Centre, Freetown, Western Area
12. General manager at Magbenteh hospital, Makeni, Bombali district
13. Medical doctor at Holy Spirit Hospital, Makeni, Bombali district
14. In charge at Serabu Catholic Hospital, Bo district
15. In charge at Panguma Mission Hospital, Kenema district
16. Manager at St John of God hospital, Lunsar, Port Loko district
17. In charge at Masanga Hospital, Tonkolili district
18. In charge at Lion Heart Medical Center, Yele, Tonkolili district

Private for-profit

19. Medical Superintendent, Choitram Hospital, Freetown, Western Area

Other facilities visited during Ebola (February 2015)

1. Moyamba Ebola Treatment Center, Moyamba district
2. MSF Ebola Treatment Center, Magburaka, Tonkolili district

Facilities visited after Ebola (December 2015 - February 2017)

Governmental

1. Kambia Governmental Hospital, Kambia district
2. Port Loko Governmental Hospital, Port Loko district
3. Magburaka Governmental Hospital, Tonkolili district
4. Connaught Hospital, Freetown, Western Area

5. Princess Christiana Maternity Hospital, Freetown, Western Area
6. Makeni Governmental Hospital, Bombali district
7. Kabala Governmental hospital, Koinadugu district
8. Kenema Governmental hospital, Kenema district
9. Bo Governmental hospital, Bo district

Private non-profit

10. Aberdeen Women Center, Freetown, Western Area
11. Blue Child Hospital, Freetown, Western Area
12. Masanga Hospital, Tonkolili district
13. Lion Hearth Medical Centre, Yele, Tonkolili district
14. Magbenteh Community Hospital, Makeni, Bombali district
15. Holy Spirit Hospital Makeni, Bombali district
16. St John of God Catholic Hospital, Lunsar Port Loko district
17. Serabu Mission Hospital, Bo district

Private for-profit

18. City Garden Clinic, Makeni, Bombali district
19. Blue Child Hospital, Freetown, Western Area

Attended meetings

- National Surgical Forum, Freetown, May 2016
- Human resource strategy meeting, October 2016
- Reproductive Maternal Neonatal Adolescent and Child Health strategy meetings, Freetown, November 2016 and January 2017
- Technical Coordination Committee Meeting of Directorate of Reproductive Health, December 2016

Annex III. Guide for key performant interviews

1. What is the status of the facility during the interview (open/closed)?
2. How are uncomplicated deliveries managed?
3. How are complicated deliveries managed? Are emergency obstetric services available?
4. How are spontaneous miscarriages managed?
5. Are there any changes in quantity of visiting patients at the out-patient department since the outbreak? What are the reasons for this?
6. In case of drop in patient numbers, what is necessary to increase the number of patients that are attending the hospital?
7. If the hospital is closed or has been closed before, which factors have contributed to the closure of the hospital?
8. If the hospital is closed or has been closed before the visit, what is necessary to re-open the facility?

Annex IV. Population Figures

Province / District	Population
Eastern Province	1,641,012
Kailahun District	525,372
Kenema District	609,873
Kono District	505,767
Northern Province	2,502,805
Bombali District	606,183
Kambia District	343,686
Koinadugu District	408,097
Port Loko District	614,063
Tonkolili District	530,776
Southern Province	1,438,572
Bo District	574,201
Bonthe District	200,730
Moyamba District	318,064
Pujehun District	345,577
Western Area	1,493,252
Western Rural	442,951
Western Urban	1,050,301
<u>Total</u>	<u>7,075,641</u>

Figure IVa. Population figures by province and district.(5)

Annex V. Absolute admissions per facility per week

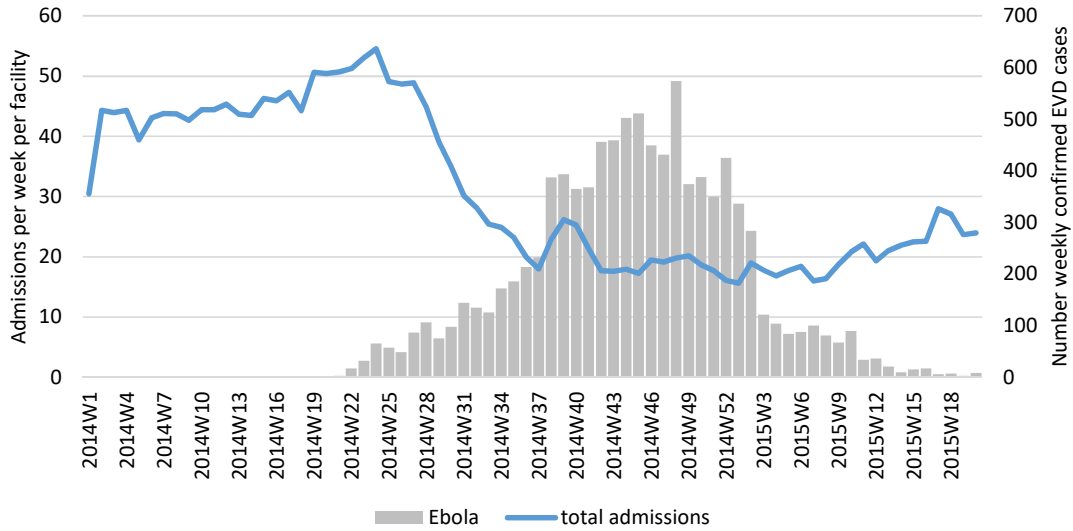


Figure Va. Confirmed EVD cases and total number of admissions.(29)

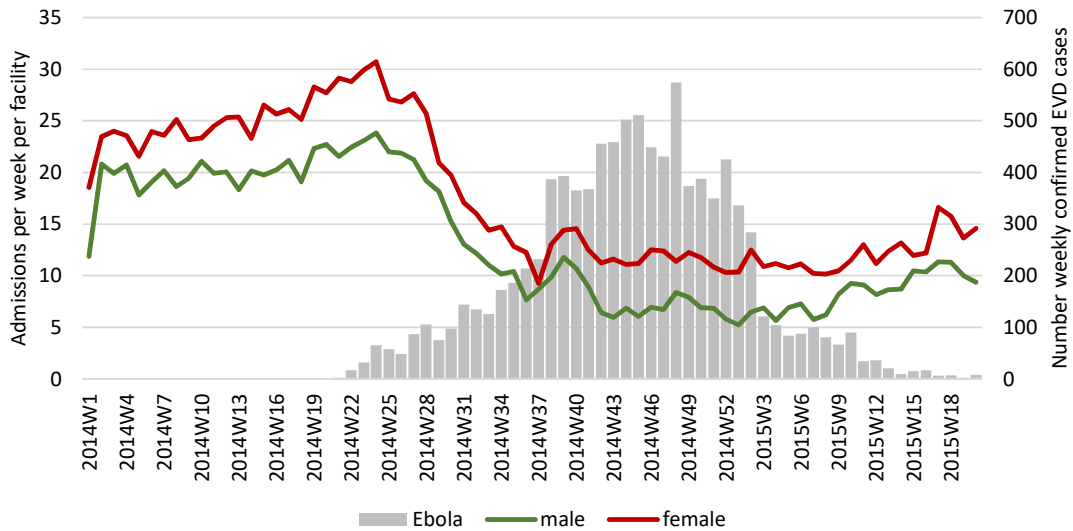


Figure Vb. Confirmed EVD cases and number of admissions by sex.(29)

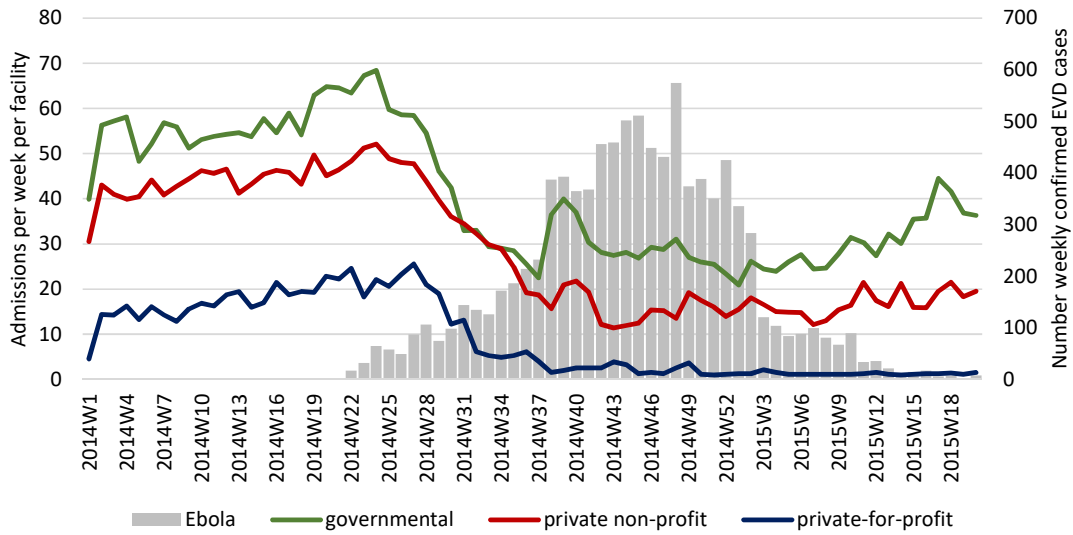


Figure Vc. Confirmed EVD cases and number of admissions by sector.(29)

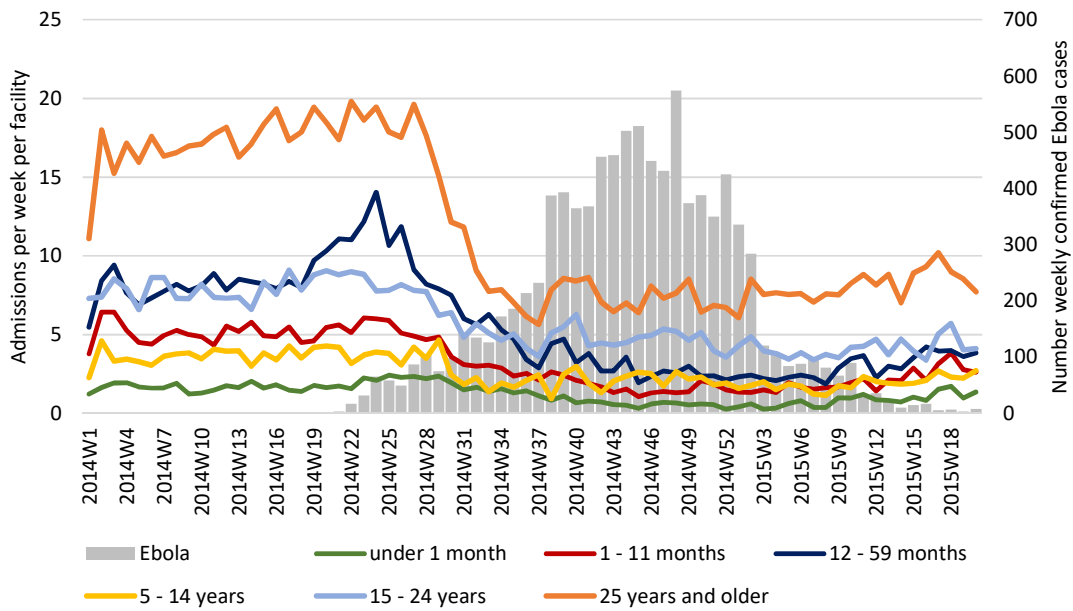


Figure Vd. Confirmed EVD cases and number of admissions by age group.(29)

Annex VI. Change in admissions by district

District	Early Ebola Change in % (CI)	Late Ebola Change in % (CI)
Bo	-43% (-56%; -31%)	-71% (-74%; -68%)
Bombali	-15% (-28%; -2%)	-62% (-72%; -51%)
Bonthe	-27% (-43%; -11%)	-30% (-41%; -20%)
Kailahun	-33% (-44%; -22%)	-12% (-20%; -3%)
Kambia	-57% (-73%; -41%)	-68% (-75.0%; 61%)
Kenema	-33% (-43%; -23%)	-33% (-42%; -25%)
Koinadugu	-30% (-45%; -15%)	-58% (-66%; 50%)
Kono	-53% (-66%; -40%)	-44% (-58%; -30%)
Moyamba	-30% (-48%; -12%)	-44% (-53%; 35%)
Port Loko	-28% (-45%; -10%)	-35% (-42%; 29%)
Pujehun	-24% (36%; -12%)	15% (-3%; 34%)
Tokolili	-48% (-66%; -29%)	-62% (-69%; 55%)
Western Area	-23% (-35%; 12%)	-61% (62%; 60%)

Figure VIa. Change in admissions by district.

District group	Early Ebola Change in % (CI)	Late Ebola Change in % (CI)
Low incidence (Bonthe/Pujehun)	-25% (-38%; -13%)	-6% (-20%; -8%)
High incidence (Port Loko/West. Area)	-24% (-37%; -12%)	-55% (-57%; -54%)
Early peak (Kailahun/Kenema)	-33% (-42%; -24%)	-30% (-36%; -23%)
Late peak (Kambia/Kono)	-55% (-69%; -41%)	-56% (-63%; -48%)

Figure VIb. Change in admissions by district group.