The impact of an electronic medical records system on health centres in Africa

June 2017
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### Abbreviations

- **EMR**: Electronic Medical Records
- **PPP**: Purchasing Power Parity

Written by Eilís Lawlor and Kim Harper.
With research contributions from Gemma Houldey and Emmanuel Ngungoy.
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Executive summary

Developing countries face a series of health crises such as HIV/AIDS, tuberculosis and other chronic conditions that threaten the lives of millions of people. Lack of infrastructure, and the lack of availability of trained, experienced staff are some of the most important barriers to scaling up treatment for these diseases. Electronic Medical Records systems have been identified as a way to enable low income countries to offer better quality health care at lower cost. Yet, outside of large hospitals such systems are still rare.

In 2012, BT undertook an ambitious project with international children’s charity SOS Children’s Villages, where we connected 30 villages across 13 countries in sub-Saharan Africa, thereby bringing much needed ICT access to over 145,000 people in some of the poorest countries in the region. Following on from that work, in 2015, BT embarked on an ambitious project to install an EMR system in seven medical centres in Sub-Saharan Africa. Run by the international children’s charity SOS Children’s Villages, the centres aim to provide high quality, affordable healthcare tailored to the needs of local communities. In addition, each medical centre received ICT infrastructure, training and access to broadband services, some of which was provided by BT. Alongside the investment, BT commissioned Just Economics to carry out a robust evaluation of the impact the investment was having on efficiencies for the centres and where possible – patient outcomes. Four of the seven locations were involved in the research: Eldoret, Kenya, Entebbe, Uganda, Hargeisa, Somaliland and Mbalmayo, Cameroon. Additional centres in Burundi and Rwanda were not included in the research as the installation timetable did not fit with the research.

The research followed a mixed methods study design and took place between 2015 and 2017. It comprised of preparatory, baseline and follow-up phases. This is the final report of the project, which describes the outcomes of the follow-up research. At the outset, a theory of change was established for the project and a series of survey instruments were developed to measure changes in outcomes before and after the installation of the system. The tools were constructed to measure a) clinic efficiencies including patient waiting times, time spent on administrative or duplicative functions b) clinic costs in terms of administration, stationary and financial management and c) the extent of errors in patient records, pharmacy and laboratory function and d) patient attendance at clinic for follow-up appointments. In addition to the quantitative research, semi-structured interviews (16 in total) were carried out with staff in all four locations.

In terms of clinic efficiencies, there were large decreases in the amount of time spent on administrative functions by all staff between baseline and follow-up. In Hargeisa, this was estimated at 10.7 hours per day. In Mbalmayo the figure was 7.5 hours per day. Patient wait times had decreased in Mbalmayo by an average of 5 mins per patient. If Mbalmayo were achieving similar patient numbers as to Hargeisa this would lead to 28 person hours of time savings per week. There was also a 72% decrease in time spent at registration (3.6 minutes).

Hargeisa did not see a decrease in patient wait times. However, this clinic also saw a big increase in patient numbers (79% increase on baseline). The clinic was operating with the same staff without changes to working practices, and this would explain why wait times had not decreased. This is supported by qualitative evidence that the patient journey is now shorter. There was also an increase in the number tests being carried out from an average 24 per day at baseline to 119 at follow-up. In addition, there was a big drop in the reported time spent communicating test results from almost 4 hours between two lab staff per day to 1.8 hours at follow up. Although the quantitative survey did not pick up evidence of stock outs, the pharmacist in Hargeisa told us in interview that they were quite common, occurring in about 30% of cases. However, the new system means they rarely occur. We estimate the value of the savings in person hours to the clinic to date at $6,753, or $15,869 at Purchasing Power Parity (PPP).

Eldoret also saw an increase in productivity and patient numbers. As a direct result of efficiencies brought about from having the system, the clinic has increased in size by about 20% (an additional 1,200 patients have been registered). Turnover has also increased by one third. The doctor estimated that about half of this (about $10,000) was directly attributable to the system. They have opened a new gynaecological clinic, which sees about 500 women over the course of the year, and have leveraged funding to open a full maternity unit.

1 These refer to person hours i.e. it is hours saved across the whole clinic not in one specific role.
We estimate an additional saving to their stationary bill of $1,000 per year. The total estimated value of the system in Eldoret is $11,000 ($25,850 in PPP).²

Eldoret have also brought the SMS package on stream and now has close to 100% attendance at clinic appointments. None of the other clinics have been able to do this yet but it is due to start in Entebbe in 2017. Our baseline data show poor clinic attendance for chronic conditions in both Hargeisa and Mbalmayo. Postnatal appointments are particularly poorly attended. If these gains in attendance could be achieved at these clinics there would be substantial impacts on maternal health and for serious conditions like HIV and hypertension. Analysis of patient records in all locations found big gaps in the completeness of records, in some instances with only a handful of fields filled in. All records are 100% complete at follow-up.

Some environmental benefits were also identified. In Eldoret, it is estimated that about 100,000 sheets of paper are saved per year. A key environmental saving comes from the reduced air and car travel from using the internet. The dollar value of these savings is estimated at $619 per year for Eldoret ($1,452 in PPP). Internet access also provides benefits in terms of professional development, online procurement and online communications. These have been valued at $2899 per year or $6,812 in PPP.

See Table 1 for a breakdown of these figures.

The total discounted value³ of these benefits in PPPs over five years is $71,649 for Hargeisa and $154,056 for Eldoret or $225,675 in total.

With any new technology teething problems are to be expected. Nonetheless, in three of the clinics involved – Hargeisa, Entebbe and Eldoret – the results of both the qualitative and quantitative research suggests that significant time savings are being achieved by the clinic, particularly in relation to the administrative functions. We have qualitative evidence that there are increased efficiencies in the lab and pharmacy. Substantial time and efficiencies savings were also found in Mbalmayo, however perceptions of the system by staff were less positive. Due to an internal review, a decision had been taken by SOS to close the Mbalmayo centre and news was announced just before the follow-up evaluation took place with as expected impacts on staff morale. The system is to be migrated to another site and recommendations specific to that location are provided in the report.

To conclude, although it is still early in the life of the EMRs to evaluate their impact, initial findings are very promising for these centres. This is particularly important if they are embarking on a new phase of their existence as social businesses. As we have seen with Eldoret, an effective EMR can increase the appeal of the centre to donors and may help ensure the sustainability of the service for their communities into the future.

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Table 1: Summary of monetised benefits in Year 1

<table>
<thead>
<tr>
<th>Clinic</th>
<th>Type of saving</th>
<th>Total savings in PPP</th>
</tr>
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<tbody>
<tr>
<td>Eldoret</td>
<td>Turnover attributable to the system</td>
<td>$23,616</td>
</tr>
<tr>
<td>Eldoret</td>
<td>Stationary</td>
<td>$2233</td>
</tr>
<tr>
<td>Eldoret</td>
<td>Environment</td>
<td>$1,452</td>
</tr>
<tr>
<td>Eldoret</td>
<td>Connectivity benefits</td>
<td>$6,812</td>
</tr>
<tr>
<td>Hargeisa</td>
<td>Time saving</td>
<td>$15,869</td>
</tr>
</tbody>
</table>

**Total monetised benefits from both clinics in Year 1.** $50,185

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² Based on Kenyan PPP conversation rate as no PPP data available for Somalia.
³ Based on 3.5% discount rate.
1.0 Introduction

Developing countries face a series of health crises including HIV/AIDS, tuberculosis and other chronic conditions that threaten the lives of millions of people. Lack of infrastructure and the lack of availability of trained, experienced staff are some of the most important barriers to scaling up treatment for these diseases (Fraser, 2005).

For example, it is estimated that the world needs more than 4 million additional physicians, nurses, pharmacists, laboratory technicians, midwives, community health workers (CHWs) and other front-line health workers (Bolinger et al. 2013). The World Health Organisation has described Electronic Medical Records (EMR) as a necessary tool for improving the quality of care and patient safety (Bolinger et al. 2013). However, computer-based records systems are rare in the developing world. Advocates of these systems argue that they have the potential to ‘leapfrog’ the normal stages of development, enabling low income countries to offer high quality health care without developing costly, traditional healthcare infrastructure (Bolinger, ibid).

To that end, the role of technology in the development process has been enshrined in the Sustainable Development Goals, not just as an end in itself but as a means to achieve transformative change in areas such as health.

In 2012, BT undertook an ambitious project with international children’s charity SOS Children’s Villages, where we connected 30 villages across 13 countries in sub-Saharan Africa, thereby bringing much needed ICT access to over 145,000 people in some of the poorest countries in the region. Following on from that work, in 2015, BT embarked on an ambitious project to install an EMR system in seven medical centres in Sub-Saharan Africa. Run by the international children’s charity SOS Children’s Villages, the centres aim to provide high quality, affordable healthcare tailored to the needs of local communities. In addition, each medical centre received ICT infrastructure, training and access to broadband services, some of which was provided by BT.

Prior to the EMR being installed, patient visits were typically recorded in logbooks or forms maintained by the administrator. These were stored in a cabinet, which held all files for patients since the clinic opened. In some locations, identical information is recorded in each clinic the patient visited and by the patient themselves. There was, therefore, a substantial amount of duplication, and an onerous administrative burden. For patients, there were long waits, a complex patient journey, poor communication between clinic and patient, as well as risks of clinical errors from poor administrative functions.

The aim of the investment is to enable the medical centres to:

- Digitise patient records
- Automate pharmacy and laboratory facilities
- Automate billing and finance functions
- Provide new methods of communicating with patients, e.g. via SMS
- Enable better collaboration and communication between professionals

Alongside the investment, BT commissioned Just Economics to carry out an evaluation of the impact the investment was having on efficiencies for the centres and – where possible – patient outcomes. The research took place between 2015 and 2017 and comprised of the following three phases.

A preparatory phase to analyse the internal business case for the project, review the existing literature and EMR evaluations and develop draft theories of change and research tools. This phase included a study visit to Eldoret, Kenya to pilot several of the research tools. This also provided an opportunity for some additional data collection.

A baseline phase to collect data ex-ante. In advance of the system being installed, baseline data collection was carried out in Hargesia, Somaliland and in Mbalmayo, Cameroon.

A follow-up phase to gather data ex-post in the same locations. This phase also included some additional follow-up interviews with clinic staff from Eldoret, Kenya and Entebbe Uganda. These interviews provided additional material for the case studies and data analysis.

An important caveat to the research is that throughout the evaluation there was some uncertainty over the future ownership of the clinics. SOS is currently undertaking a review of its operations in Africa, the rationale being that it is refocusing on its core mission of providing care services to children that have lost, or are at risk of losing parental care.
In some cases, SOS will continue managing the centres. In others, the management will be handed over to a community partner with some involvement by SOS. In a small number of cases the clinics will be closed because another service provided is better positioned to offer the service. This includes Mbalymayo, which has received the BT investment. A decision has therefore been taken to migrate the system there to an alternative location. The news about the future of the clinics was announced just before the site visits took place, which had an impact on staff morale. This was especially the case in Mbalymayo where the clinic was due to close and staff were concerned about their jobs. Carrying out an evaluation in this context is challenging, particularly where the measurement relies on self-reports by staff. Understandably, there was a lot of discontent and less willingness to participate in the research. This meant that some of the survey responses were either incomplete or not considered reliable. Disentangling staff discontentment from perceptions of the clinic and the EMR was difficult and for some of the outcomes we have been unable to report on findings from this clinic.

1.1 Research questions and report structure

1. The evaluation sought to address the following questions:

2. What was the theory of change for the EMR installation in these clinics?

3. What potential outcomes could be identified ex-ante?

4. What were the ex-ante needs of the clinics?

5. What was the evidence that those outcomes were being achieved ex-post, specifically was there evidence for:
   a. An improved patient journey?
   b. Clinic efficiencies?
   c. Reduced risk of error?
   d. Better clinic attendance by patients?
   e. Improved clinic productivity/growth?

6. Could any financial savings be identified that are attributable to the system?

7. What are the recommendations for improvement/lessons for future investments?

The report begins in Section 2 with some background on the evaluation. It describes SOS Children’s Villages, the medical centres and the BT investment. It then goes on to discuss some of the issues relating to ICT in healthcare by providing some wider context for the research and summarise what can be learned from previous evaluations.

The research is a mixed methods study, combining both qualitative and quantitative methods. These methods are discussed in Section 3 along with the measurement tools that were employed. It also sets out the theory of change for the EMR installation, describing each outcome and how it will be measured.

Sections 4 and 5 summarise the findings. Section 4 discusses evidence for each of the outcomes set out in Research Question 4 and section 5 sets out the monetary values that have been identified for those outcomes. Section 6 concludes the report and provides some recommendations.
2.0 Evaluation background

This section provides some background on SOS Children’s Villages, the medical centres and the BT investment. A thorough review of the literature has already been carried out as part of the preparatory phase. However, some of the key findings are summarised in 2.2. Previous EMR evaluation findings are summarised in Box 1 and evidence of financial savings are collated in Appendix 1.

2.1 About the project

SOS Children’s Villages is a charity that has been working for over 60 years to support families and children all over the world. In the first instance, the organisation supports families to stay together – for example by providing additional care for children, plus support and training for carers. Typically, these children are living in families which are facing difficult situations, for example the main carer is chronically ill, or where the household is headed by a grandparent or older sibling. If a child becomes orphaned or cannot stay with their families, then long-term family care is provided in an SOS Children’s Village. Children living in an SOS Children’s Village are cared for by an SOS mother and live with other children as an SOS family. SOS Children’s Villages also specialize in harnessing technology to improve outcomes for children, their families and communities and oversee several ICT4D projects globally.

A typical SOS Village has 10-15 family homes and is integrated with the local community. Worldwide, 62,000 children and young people are cared for in 547 SOS Children’s Villages across 125 countries in Africa, Asia, the Middle East, Europe and the Americas. In addition, 383 SOS Youth Homes provide a shared home for young people who grew up in an SOS Children’s Village to help prepare them for living independently. In 2016 SOS was managing approximately 65 medical centres across 27 countries. As discussed in the introduction, following a review of the viability of the clinics, some are changing ownership or a decision has been taken to close them.

Depending on the location, centres offer treatment, antenatal and postnatal care, immunisation and education programmes, as well as counselling services. Some of these medical centres are located within Children’s Villages, and some without. Most of the medical centres are medium-to-large, handling from 10,000 to 20,000 patients per year. The centres typically have 2 to 4 treatment rooms. The number of staff ranges from 6 to 13 for smaller centres and 22 to 33 for larger centres. This includes non-clinical support staff – in some cases accounting for 40% of all staff. Most of the medical centres offer a range of different clinical services. Typical services delivered include health consultations; child health immunisations; HIV screening, treatment and education; pharmacy/drug dispensing, and laboratory testing. Some centres have in-patient facilities and provide antenatal and maternity services.

Medical centres operate with both fee and non-fee paying patients, including managing payments through health insurance schemes. This process includes billing patients and insurance companies directly for services delivered. In some cases, both patients and insurance companies will need to be billed, for example where a patient pays 10-20% costs upfront and the remainder is invoiced directly to the insurance provider.

The medical records system was piloted in the following locations:

- Bujumbura (Burundi)
- Gitega (Burundi)
- Eldoret (Kenya)
- Hargeissa (Somaliland)
- Mbalmayo (Cameroon)
- Entebbe (Uganda)
- Kayonza (Rwanda)

Prior to investment, most SOS Medical Centres were using paper based systems without any, or only very limited, access to ICTs. Challenges identified in the baseline study were as follows:

- Difficulties handling large quantities of paper patient records (some patients are required to retain their own health records which presents additional problems, e.g. through loss of records)
- Difficulties performing consistent patient management, including recording of data, patient follow up, and ensuring adherence to clinical guidelines
- Problems managing an efficient and error-free pharmacy and laboratory, including with respect to stock management (lab test reruns, pharmacy stock-outs etc.)
- General lack of current, reliable, and easily accessible data for reporting to donors and government (typically there are 3-6 donors requiring specific information to satisfy and
support ongoing funding arrangements), and
• Resource intensive billing requirements (for example in Burundi they need to employ a full time medical secretary to support billing processes).
• Loss of income through billing errors/unpaid bills

Prior to the investment, medical centres using ICT were primarily using it in a limited and ad hoc way. However, there were big differences across the group of clinics in terms of skills and readiness for investment. The implications of this will be discussed in Section 4.

2.2 ICT in healthcare – some context

The medical centres involved in the pilot are located in some of the poorest countries in Africa. Health outcomes are also some of the worst in the world (see Table 2 for an overview).

These are also the countries with some of the poorest ICT infrastructure. The proportion of individuals using the internet, with the exception of Kenya, is significantly below the average level for developing countries, with Burundi and Somalia both falling below 2 per cent of the population. ICTs in Africa are some of the most expensive in the world. Fixed line broadband is ten times less affordable in Africa than in developed countries and in 14 Sub-Saharan African countries the costs of internet subscriptions are higher than the average income.

In low and middle-income countries EMRs are sometimes available in larger specialist hospitals but are rarely available in smaller health centres. There is a growing evidence base for the efficacy of mHealth interventions in low and middle income countries (Hall, 2014). However, the quantity and quality of the evidence is still limited (Black et al., 2011; van Gemert-Pijnen et al., 2012). Although there is widespread support for the use of EMR, there are few robust evaluations of their impact in developing country settings. Most of the evaluations that take place are process evaluations or model expected benefits ex-ante. Because electronic health records are the core clinical application, they usually encompass different (sometimes bespoke) functions, which makes their implementations complex and prone to failure and their evaluation also difficult (Blaya, 2010). Nonetheless, there are some evaluation findings that are useful by way of context for this study (see Box 1). Barriers to the adoption of EMRs include poor quality infrastructure, lack of skills training and cost.

<table>
<thead>
<tr>
<th>Country</th>
<th>Infant mortality rate (per 1,000)</th>
<th>% HIV (age 15–49)</th>
<th>TB (per 100,000)</th>
<th>Health spending per capita (US$) (2012 data)</th>
<th>Physicians (per 1,000 people)</th>
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</thead>
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<td>128</td>
<td>20.00</td>
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<td>Kenya</td>
<td>47.50</td>
<td>6</td>
<td>268</td>
<td>44.58</td>
<td>0.181 (2011 data)</td>
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<tr>
<td>Somalia*</td>
<td>89.80</td>
<td>0.5</td>
<td>285</td>
<td>No data</td>
<td>0.035 (2010 data)</td>
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<td>Cameroon</td>
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<td>4.3</td>
<td>235</td>
<td>59.08</td>
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</tr>
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<td>Uganda</td>
<td>43.80</td>
<td>7.4</td>
<td>166</td>
<td>43.61</td>
<td>0.117 (2010 data)</td>
</tr>
<tr>
<td>Rwanda</td>
<td>37.10</td>
<td>2.9</td>
<td>69</td>
<td>66.07</td>
<td>0.056 (2010 data)</td>
</tr>
</tbody>
</table>

*No data available on Somaliland.
Box 1: Some previous EMR evaluation findings

Research suggests that a web-based medical record system can be effectively used to track clinical outcomes, laboratory tests and drug supplies, report to funding agencies (Fraser et al., 2004), improve accuracy of medication lists, prescriptions and enhance healthcare delivery and decision-making processes (Blaya et al., 2010; Williams, 2008).

An evaluation of the PIH-EMR, in Peru found that the medication order entry system was shown to produce significantly fewer errors than the previous paper and spreadsheet approach. In Malawi the RapidSMS system has resulted in an increase in data quality reported by health workers. Post-implementation analysis found that the error rate had reduced substantially.

SMS reminders have been found to improve attendance at clinic for chronic conditions (Piette et al., 2012; Hasvold and Wootton, 2011). Their use is also being explored to improve treatment adherence for HIV, TB and Malaria. There is some evidence of its success with HIV (Pop-Eleches et al., 2011) and TB (Rosen et al., 2007). An evaluation of SMS reminders for paediatric malaria found increased post-treatment return to the health facility (Talisuna et al. 2017).

In terms of community health, the RapidSMS in Malawi has automated basic diagnostic tests and as a result more children with moderate malnutrition are being diagnosed who were previously going undiagnosed.

In Papua New Guinea, a computerised disease monitoring system was shown to be more timely more complete and more sensitive than the existing systems (Rosewell et al., 2013). In Nigeria, a mobile app was found to reduce the time to report Ebola outbreaks by half.

In terms of financial/efficiency impacts, a return on investment analysis of RapidSMS found a net financial gain by the third year of operation. However, this was based on projections drawn from a US evaluation. In Kenya, an evaluation of the Mosoriot EMR found that patient visits were 22% shorter, provider time per patient was reduced by 58%, and patients spent 38% less time waiting in the clinic (Rotich, et al. 2003). Clinic personnel spent 50% less time interacting with patients and two-thirds less time interacting with each other. Other studies that have sought to monetise outcomes are set out in more detail in Appendix 1.

EMRs tend to have high rates of satisfaction. Watkinson-Powell (2012), found that health workers reported positively on the introduction of an EMR in Nepal and that it could provide a relatively low-cost means of improving patient care and health worker efficiency in developing countries. A review of impacts from e-health initiatives by Lewis et al. found user satisfaction to be the most common outcome reported (Lewis et al., 2012).
3.0 Methodology and theory of change

The research followed a mixed methods study design and took place in three phases: a preparatory baseline and follow-up phase. Four out of seven centres were chosen to take part in the research. An overview of these is provided in Table 3.

3.1 Preparatory research

The aim of this phase was to:
- Review existing BT data on the business case for investment
- Develop theories of change
- Design measurement tools
- Gather contextual information from the literature on EMR and ICT4D more generally

This phase was largely conducted through desk research and literature review. Three interviews with experts in the ICT4D field and technology evaluation were carried out. In addition, a study visit to Eldoret was undertaken to with SOS and BT staff. This enabled the team to observe the patient journey, pilot the research tools and gather additional data on how the system worked.

3.2 Quantitative research

Two locations were chosen for the quantitative analysis: Hargeisa and Mbalmayo. The choice of locations was constrained by the timing of the roll-out and how it fitted with the evaluation timeline. Baseline visits took place to each location in the winter of 2015, and follow-up visits took place 12 months later. On each occasion the researcher spent a week at the clinic overseeing data collection. At follow-up, the researcher also used the opportunity to interview staff to capture qualitative data on their experiences.

The following measurement tools were used:
- **Activity diaries** to capture the **time spent on different activities** by centre staff. Self-administered activity diaries are one of the main methods available for capturing data on time use (Crosbie, 2006). Increasingly these are used to examine issues relating to change in time use brought about by the introduction of ICTs and the internet (Crosbie, 2006; Kenyon, 2008; Lyons and Kenyon, 2003). An activity- based diary research involves the recording of a log of how people allocate their time during the day, often focusing on specific activities pertinent to the research. Staff completed a diary each day stating how long they had spent on different activities. Each was tailored to the staff member and their duties. The same survey was completed at follow-up to measure changes in the length of time spent on different activities. The centre staff asked to complete the survey are as follows:
  - Pharmacist
  - Laboratory
  - Doctor
  - Nurse
  - Reception/administration
  - Cashier
  - Accountant/finance

<table>
<thead>
<tr>
<th>Location</th>
<th>Involvement</th>
<th>Methods</th>
</tr>
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<tr>
<td>Hargeisa (Somaliland)</td>
<td>Quantitative research</td>
<td>Baseline and follow-up using various survey instruments</td>
</tr>
<tr>
<td>Mbalmayo (Cameroon)</td>
<td>Quantitative research</td>
<td>Baseline and follow-up using various survey instruments</td>
</tr>
<tr>
<td>Eldoret (Kenya)</td>
<td>Case study</td>
<td>Interview with clinical staff and observation of patient journey</td>
</tr>
<tr>
<td>Entebbe (Uganda)</td>
<td>Qualitative</td>
<td>Interview with clinical staff</td>
</tr>
</tbody>
</table>

We begin by describing the preparatory phase before going on to describe the quantitative and qualitative methods used.
A **time motion study**, which observes a patient journey through the clinic to measure how long they spent on at each clinic in the centre. The observation begins as soon as the patient enters the clinic and continues until they leave the grounds. Data were entered into a pre-prepared spreadsheet that identified each clinic in advance. Time outside of these stations was recorded as ‘waiting’, unless the patient was socializing or engaged in some other way. This was completed by the researcher at baseline and follow-up to compare differences in the patient journey and wait times. Time motion studies have been used in previous evaluations of EMR (e.g. Were et al. 2010; Rotich et al. 2003; Pizziferri et al. 2005).

**Analysis of patient records** to measure completeness of fields that have been identified as mandatory under the new system. This is completed by the researcher at baseline. As all fields were mandatory, we assume 100% completeness at follow-up.

**Surveys** to capture a record of pharmacy dispensing and patient attendance at appointments for patients with routine support needs — including those with chronic conditions or who require ongoing support for other reasons (e.g. antenatal care). These were completed by the pharmacist and clinician under the supervision of the researcher. Although baselines were captured, the SMS module was not live at any of the clinics by follow-up, which means that outcomes on management of conditions and adherence could not be reported on.

### 3.3 Qualitative research

Semi-structured interviews were carried out with staff in all four locations. In total, 16 interviews were carried out. Five of these were conducted in Eldoret (Kenya) just after implementation and the remainder were carried out at follow-up in Mbalmayo (Cameroon), Hargeisa (Somaliland) and Entebbe (Uganda) about a year after installation.

The purpose of the interviews as to capture clinical staff’s impressions of how well the system was working, to help explain unexpected findings from the quantitative data and to gather recommendations for improvement.

### 3.4 Outcomes and theory of change

A series of theory of change models were developed based on the findings from the preparatory phase. The evaluation posed a substantial challenge in terms of capturing data on the outcomes. This is common in evaluations of technology impacts where outcomes are often diffuse and difficult to measure. The theory of change process, enabled the identification of tangible outcomes. These are summarise in **Figure 1**.

**Figure 1: Theory of change for Medical Records System**

- **Digitisation of records**
  - Shorter registration time
  - Complete and standardize patient records
  - Interoperability
  - Better communication between staff and patients
  - Automation of billing/finance/administration
  - Automatic of clinic
  - Better stock control
  - Automation of pharmacy and lab
  - Patient communication
  - Patient communication
  - Patient communication

- **Shorter registration time**
- **Reduced risk of clinical error**
- **Better patients wait times/clinic efficiencies**
- **Time and cost savings**
- **Fewer stock outs**
- **Fewer medication/test errors**
- **Patient communication**
- **Patient communication**
- **Patient communication**
From Figure 1, we identified 11 measurable indicators:

- More complete patient records
- Reduced patient wait times
- Increased clinic productivity
- Fewer pharmacy stock outs
- Fewer lab test reruns
- Fewer missed appointments
- Better adherence to treatment
- Better provision of preventative healthcare
- Better financial management – patient and insurance billing
- Less time spent on donor reports
- Lower administration costs

Some of these directly measure an outcome, such as less time spent on donor reports and lead to a direct financial saving. Others are 'leading indicators' of longer term outcomes. For example, completeness of records measures the short-term benefit of time saved in clinic but also leads to fewer clinical errors in the future.

It should be remembered that a theory of change is a theoretical representation of the outcomes we expect to see. The purpose of the evaluation is to test whether these outcomes are being achieved and to what degree. Notably, none of the clinics involved in the quantitative study had imitated the patient SMS reminders during the lifetime of the evaluation. This aspect of the system could not therefore be evaluated. The branch of the TOC related to patient communication is shaded in purple to denote that these outcomes have not yet taken place. However, baseline measures of clinic attendance were taken which can be followed up in the future. In addition, some qualitative data was gathered that is relevant to this outcome from the Eldoret case study.

Table 4 shows how each of the remaining nine indicators were measured as part of the data collection.

### Table 4: Indicators and measurement tools

<table>
<thead>
<tr>
<th>Location</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>More complete patient records</td>
<td>Analysis of patient records</td>
</tr>
<tr>
<td>Shorter patient journey</td>
<td>Activity diaries/ Time motion survey</td>
</tr>
<tr>
<td>Increased clinic productivity</td>
<td>Activity diaries/ Time motion survey</td>
</tr>
<tr>
<td>Fewer pharmacy stock outs</td>
<td>Record of dispensing</td>
</tr>
<tr>
<td>Fewer lab test reruns</td>
<td>Activity diary</td>
</tr>
<tr>
<td>Fewer missed appointments</td>
<td>Monitoring clinic attendance</td>
</tr>
<tr>
<td>Better financial management – patient and insurance billing</td>
<td>Activity diaries/financial monitoring</td>
</tr>
<tr>
<td>Less time spent on donor reports</td>
<td>Activity diaries</td>
</tr>
<tr>
<td>Lower administration costs</td>
<td>Activity diaries</td>
</tr>
</tbody>
</table>
4.0 Summary of findings

In this section, we describe the findings from the analysis. This section covers:

- The patient journey
- Clinic productivity
- Clinic efficiencies
- Completeness of patient records.

It also reports on the baseline findings from the clinic attendance and the case study.

4.1 Patient journey

The patient time-motion survey recorded the journey of a random sample of consenting patients around the clinic, recording how long they spent at different departments. Overall 60 patients were ‘followed’ at baseline and 58 at follow-up in two participating clinics. The average amount of time spent at clinic at baseline was 112 minutes (27 minutes for Hargeisa and 86 for Mbalymayo). The average total wait time at baseline was 33% in both clinics and was the largest single activity. See Box 2 for a description of the patient journey before and after the EMR was installed.

Box 2: Comparing the patient journey before and after implementation

Under the paper-based system the patient journey was quite lengthy. The patient would register at the clinic and the receptionist would complete their registration by hand. If they were an existing patient, s/he would go to the cabinet to locate their file. If this cannot be located a new file is created. The patient would then go to the cashier and pay for whatever treatment they needed e.g. to see the clinician. On return, their file would be taken to the doctor and added to the queue. Once the doctor was seen, a test might be ordered. The patient would go to the cashier again to pay for the test and once the receipt had been taken back to the doctor the patient would be sent to the lab with a hand-written request for a test. Assuming no errors are encountered, the lab technician would take the test back to the doctor who would then call the patient. At this point the patient may need some medication. The patient must go again to the cashier to pay for the medication and then the prescription is taken to the pharmacy. Sometimes the pharmacy will need to communicate back to the doctor if there is an issue with the prescription. If the patient needs additional tests or to see other clinical staff such as the nurse, the same steps are followed. A staff member in Hargeisa described the journey as follows:

“Previously, the system was quite confused as the patient didn’t know where to go, they would go to the wrong place or records would be missing. When there were lots of patients you’d forget to write down the report of the patient. Now it is much simpler.”

Under the new system, patients will be registered electronically with pre-filled fields, which should speed up the registration process. The receptionist is also able to call up existing patients’ details without searching for their files, or creating new entries. The system will then prompt the relevant medical staff of their arrival and reduce the need for communication between staff. Patients will still need to pay for treatments but as the system is being updated all the time, staff are aware when a stage in the journey is complete without anyone having to physically go to another part of the clinic. Two additional efficiencies for both patient and clinic should come from reduced stock outs in the pharmacy and fewer errors in prescriptions/lab tests. These should mean that alternative drugs do not need to be prescribed and that lab tests do not need to be rerun. Both of these should save time for the patient and clinic. The pharmacist in Hargeisa described the change in the patient journey since installation as follows:

“...the patient would come to the pharmacy and I would write the payment. They would go to cashier, then back to pharmacy. Now, they visit doctor, go to cashier and pay and then come to pharmacy. Before they would come here twice. They only come here once after they have paid. Then I read medication, then I give. I had to use three register books before, it took a lot of time with lots of questions. Now a lot of the questions are already addressed during the doctor’s appointment and put on the system.”
4.2 Clinic productivity

At follow-up, the length of time at clinic had reduced by six minutes in Mbalymayo (to an average of 80 minutes). A reduction in the proportion of time spent waiting from 33% to 28% was also observed (approximate 5 minutes per patient). There were other promising results from patient wait times. For example, the length of time spent at reception reduced from an average of 5 minutes at baseline to 1.4 minutes at follow-up suggesting that the receptionist was retrieving records and registering patients more quickly.

There was a big increase in patient numbers recorded in Hargeisa (from 191 at baseline to 341 at follow-up (78% increase). It is not clear what, if any of this is due to the system installation. Unfortunately, patient numbers were not reported in Mbalymayo, however, to put changes in patient wait times in context, if Mbalymayo were reaching a similar number of patients to Hargeisa, this would lead to 28 person hours of time savings per week.

In Hargeisa both the time at clinic and wait times had doubled at follow-up. There were a few factors impacting on this finding:

- There was a big increase in the number of patients that the clinic was dealing with between baseline and follow-up but the staff team had not increased. The cashier confirmed that the numbers had increased and staff in interviews told us that they believed that processes were happening more quickly.
- On one day of the evaluation there had been a change to a scheduled ante-natal clinic, which not all patients knew about and this was also the day that under-5 check-ups and vaccinations were taking place.
- On another day of the evaluation, a group of donors from the Ministry of Health, UNICEF and WHO were visiting the clinic. This held up the appointment process as various staff members spoke with the donors, leaving some of the patients waiting longer than usual.
- The system connection is not always working smoothly, which means that the information being uploaded does not fully integrate so it cannot be seen on other staff members’ desktops.

However, it is not clear whether the increase in wait times reflects the success of the clinic in attracting new patients, is an anomaly due to unforeseen circumstances or suggests the system is not working as well as it might. Data from clinical staff show that tasks are being completed much more quickly, which would suggest that it relates to the first two factors. Figure 2 shows responses to survey questions on overall impressions of wait times, health impacts and efficiency. As we can see, most staff either agree or strongly agree that there has been a positive impact on these measures.

Laboratory services took up a significant proportion of wait time at both clinics. At baseline in Mbalymayo the researcher observed that once the laboratory has processed a test, the results were taken to the medical secretary’s office for entry into the computer system, before being checked and signed by the senior laboratory officer. This data entry and the subsequent checks and signature might add an additional hour or more to the waiting time of the patient. These had improved at follow-up but were still long in some cases.

In Entebbe, although they did not think there had been an impact on the number of patients, they had observed improvements in waiting times. Previously patients may have been waiting for an hour for a short procedure and these times have been reduced substantially.

Figure 2: Staff reports on overall productivity

<table>
<thead>
<tr>
<th></th>
<th>Since the EMR was installed patients are waiting less</th>
<th>The EMR has had a positive impact on the health of our community</th>
<th>The EMR saves us time and money</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neither agree or disagree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strongly disagree</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.3 Completeness of patient records

Patient records in four of the locations were sampled to assess how complete the fields were using the paper-based system (n=200). This found that there are many incomplete records in all three locations. Basic information such as address, next of kin, blood pressure, height, temperature, weight was not provided. In Hargeisa, family history and allergies were completed in about 40% of the sample but only a handful were completed in Eldoret, and none were completed in Mbalmayo. Hargeisa recorded chronic conditions but these fields did not exist in the other locations.

As well as creating risks for clinical errors, the paper-based system led to much duplication. For example, in Mbalmayo, each of the different departments had their own separate set of patient records, each with their own unique identifier numbers. Furthermore, patients had their own record booklets, which contained information not recorded in the records held by the hospital. Despite there being several different records, it was observed that none recorded things like allergies for the patients.

A clear benefit of the EMR system is that these data will be standardized across the clinics i.e. all the clinics will be gathering the same data. In addition, it will be mandatory to complete all fields, which means that 100% of fields were complete in all locations at follow-up.

4.4 Clinic efficiencies

Cashier/admin

Cashiers and administrators are responsible for a range of tasks that are directly impacted on by the EMR. Table 5 shows the change in time spent on these tasks before and after the system was introduced. This results in a net daily saving of 6.5 hours in Mbalmayo and 3.2 hours in Hargeisa.

As we can see, there is a reduction in average number of minutes spent on each task per day. There are two exceptions. Registering patients in Hargeisa increases by 27 minutes but as discussed above that may reflect a higher number of patients being registered. In interview, the cashier made clear that registration was now much more efficient. Time spent communicating with other staff increased in both locations, most notably in Hargeisa. The reasons for this are not clear, however, given the decrease in time on other tasks, it may be that more time is freed up for this, and that the communication related to clinical concerns. The donor visit most likely had an impact as explained by the doctor. The nurse in Hargeisa also spoke of reduced administration:

“Today was busy, previously I would be writing things up at the end of the day. But now I finished earlier because of the system.”

Admin/cashier staff in Hargeisa felt that the biggest saving related to finding information for donors and the ministry, which prior to the introduction of the system could take from one hour to several days to find the correct clinical notes and results. This was echoed by the doctor in Entebbe:

“In Uganda, the ministry for health gives us a register. We need lots of very specific information, next of kin, address etc. We need all this detail on every patient who comes in. When the system came in it made that part of our work so much easier.”

Improvement in billing is a further benefit that was identified in the qualitative research. Under the new system patients cannot see the doctor unless they have paid in advance. This ensures that patients don’t leave without paying or that their bill is forgotten. In Entebbe, they used to have a system of being billed at the beginning of the visit and pay at the end. Although patients complained initially about paying at each stage, they are used to it now and it has improved the revenues of the

<table>
<thead>
<tr>
<th>Role</th>
<th>Location</th>
<th>Patient billing</th>
<th>Insurance company billing</th>
<th>Reporting to donors</th>
<th>Registering patients</th>
<th>Communicating with staff</th>
<th>Filling and admin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cashier/admin</td>
<td>Mbamayo</td>
<td>-131</td>
<td>-4</td>
<td>-156</td>
<td>-60</td>
<td>24</td>
<td>-66</td>
</tr>
<tr>
<td></td>
<td>Hargeisa</td>
<td>-141</td>
<td>-30</td>
<td>-51</td>
<td>27</td>
<td>63</td>
<td>-81</td>
</tr>
</tbody>
</table>
Another administrator described how accountability has improved because payment from patients is more prompt and reliable and that money given to the cashier is immediately transferred to the clinic account, which reduces paperwork. The finance staff also have experience time savings with invoicing, financial reporting and providing receipts:

“It saves a lot of time with invoices as we no longer have to check them – they just come up automatically. Sometimes we were checking all the day, up to 12 o’clock to see if amounts are correct”.

In interview, the cashier in Hargeisa noted that there was also a big drop in the number of mistakes, as previously patients’ names would get confused, particularly as many Somalis share the same names. The system has rectified this by providing middle names for each person.

Clinicians

The main savings for the clinician were identified as working on test results, communicating with pharmacy, compiling donor reports, communicating with administration and making referrals. Table 6 shows the changes in time on these tasks between baseline and follow-up.

As we can see, in Hargeisa substantial time savings were reported (about 3.5 hours per day in total). The exception was communicating with administration but the doctor explained to us that this level of contact was unusual and related to the donor visit described earlier. In Mbalmayo, communicating with administration and referrals were the only areas that saw a decrease in time. The doctor there explained that a lot of time had to be spent in the lab to oversee processes on two of the days. In addition, this clinic is facing closure, as described above, and this may impact on how comparable the two results are. There were only two days on which referrals were made in Mbalmayo. Both of these were dealt with very quickly at follow-up. At baseline, the doctor had to accompany the patient, which accounted for the big change in time.

Laboratory

In Hargeisa, where a large increase in patients has been recorded between baseline and follow-up, an increase in the number tests being carried was also recorded from an average 24 per day at baseline to 119 at follow-up. In addition, there was a big drop in the reported time spent communicating test results from almost 4 hours between two lab staff per day to 1.8 hours (1 hour 48 minutes) at follow up. One lab technician described how the system ensures that they never forget to run tests:

“Before we were writing [each test] in the book. So now we don’t miss any tests, before we would forget to record [each test in the book]. It is a good improvement, because I can get the monthly report easily. After I finish each day I can count how many tests instead of putting it in the book.”

There are, on occasions, problems in the running of tests by the laboratory which require them to be re-run. This may be, for example, because the initial instruction from the doctor about which test to run was unclear, or because the test results were lost. Although the labs are already automated to a certain degree, the new EMR system should reduce the number of errors due to reasons such as these by allowing doctors to automatically request lab tests through the EMR and for patient results to be attached to their electronic record. However, this did not emerge as a big problem at either baseline or follow-up, there were few or no incidents of tests needing to be rerun. It is not clear if the weeks that the tests were taken were anomalous or if this is less of an issue than sometimes perceived. The qualitative interviews with staff suggested that this was an improvement they were experiencing.

<table>
<thead>
<tr>
<th></th>
<th>Working on test results</th>
<th>Communicating with pharmacy</th>
<th>Compiling donor reports</th>
<th>Communicating with administration</th>
<th>Making referrals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mbalmayo</td>
<td>27</td>
<td>60</td>
<td>96</td>
<td>-63</td>
<td>-117</td>
</tr>
<tr>
<td>Hargeisa</td>
<td>-179</td>
<td>-129</td>
<td>-60</td>
<td>54</td>
<td>0</td>
</tr>
</tbody>
</table>

4 Unfortunately, the follow-up results from Mbalymayo were not sufficiently clearly reported upon and could not be used.
Pharmacy
There were four areas where savings were likely to accrue for pharmacists: stock management, maintaining files, communicating with other clinical staff and fewer stock outs or prescription errors. In Mbalymayo, there were reductions in time spent on two of the tasks, stock management (reduced by 1.7 hours (1 hour 42 minutes) per day) and communicating with staff (reduced by 1.2 hours (1 hour 12 minutes) per day). There was an increase of 48 minutes in time spent on maintaining files. It is not clear why this task seemed to take longer.

In Hargeisa, the nurse also acts as the pharmacist and therefore did not complete an activity diary for the pharmacist. We do not therefore have data on time savings in the pharmacy. The nurse did share some observations in interview however. He spoke of now being able to do drug assessments (expiry dates, leakages) which he never had time to do before because he was too busy registering patients. He also said that much time was saved in finding medication for patients:

“If there were 5 patients, it could take 40 minutes to 1 hour to get the medication to them. Now I can do it in 5 minutes, even if it’s 10 patients.”

The last outcome for the pharmacy relates to problems with dispensing. It was anticipated that the system will help to reduce errors in prescribing, such as illegible handwriting. The system will also help to ensure that doctors only prescribe drugs to patients that are in stock in the pharmacy as well as providing helpful reminders to doctors about appropriate dosage levels etc. At baseline, pharmacists were asked to record during the week how many times they had difficulties with prescribing, for what reasons these difficulties arose, and what happened as a result. Across both locations, there were only five incidents where new prescriptions needed to be written.

However, the qualitative data painted a different picture. The nurse/pharmacist in Hargeisa told us that stock outs were much more common than this, occurring to 3 out of every 10 patients on average.

This compares with the new system where medication can be provided 99% of the time. He also described how much simpler the system was:

Before, I didn’t know how many paracetamols were on the shelf. If someone asks, I had to go and count. Now, I go to the stock column and I check there. Before I didn’t know the ordering system and when I would run out. Now I have an alarm that tells me to re-order.

A similar report was received from Uganda. The doctor explained how the system flagged when a drug was due to expire, and that they had gone from regular stock problems to no stock outs or expiries. In the past, they may have gone for two months without stock before it was replenished with implications for patient health.

4.5 Follow up of routine patients
At baseline, we also tracked how many patients who are required to attend the clinic on a routine basis actually do attend. These patients may need to attend because they have a chronic disease, such as arthritis or for other routine reasons, e.g. because they are pregnant. This information is interesting because the new system will have the capacity to send SMS reminders to routine patients to remind them of their appointments. This is anticipated to result in a decrease in missed appointments, or ‘no-shows’. Other studies have found this to be an effective way to improve clinic attendance and adherence to medication (see Box 1).

At the Hargesia clinic, there is no specific appointment system and as such for many conditions it was not possible for them to say how many patients they expected to see. However, for some conditions they could say how many they were expecting, and therefore how many did not attend as expected (see Table 7).

<table>
<thead>
<tr>
<th>Condition</th>
<th>Expected</th>
<th>Attended</th>
<th>Number missed</th>
<th>% missed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients with STIs¹</td>
<td>20</td>
<td>18</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Arthritis</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>40</td>
</tr>
<tr>
<td>Gastrointestinal tract</td>
<td>6</td>
<td>5</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>Postnatal</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>80</td>
</tr>
</tbody>
</table>

¹ Hargesia clinic did not record any expected attendees for HIV, so this figure may include that condition.
At Mbalmayo clinic, data was collected over 4 days, during which almost exactly half of all expected patients did not attend (25 missed out of 51 expected) (Table 8). For many conditions, the numbers recorded are very small and therefore are difficult to draw any meaningful conclusions from. However, the following conditions are interesting to note, either because of the number of unattended appointments, or because of the severity of the condition. It is particularly interesting to note that postnatal appointments are poorly attended in both Hargeisa and Mbalmayo.

At follow-up, the SMS system had not been introduced in either Hargeisa or Mbalmayo. However, the SMS has been introduced in Eldoret and has led to 100% attendance at clinic. If these gains could be achieved, there would be substantial impacts on postnatal care and attendance for serious conditions like HIV and hypertension. In Uganda, the SMS is not yet up-and-running but is in their budget to bring on stream next year.

Table 8: Missed appointments – Mbalmayo

<table>
<thead>
<tr>
<th>Condition</th>
<th>Expected</th>
<th>Attended</th>
<th>Number missed</th>
<th>% missed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>100</td>
</tr>
<tr>
<td>HIV Positive</td>
<td>8</td>
<td>3</td>
<td>5</td>
<td>63</td>
</tr>
<tr>
<td>Patients with STIs</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>75</td>
</tr>
<tr>
<td>Hepatitis</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>Postnatal care</td>
<td>16</td>
<td>6</td>
<td>10</td>
<td>63</td>
</tr>
<tr>
<td>Mother and child with HIV</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>25</td>
</tr>
</tbody>
</table>
As a direct result of efficiencies brought about from having the system, the clinic now opens for an extra 2 hours per day with the same staff team. They have introduced a shift system so that they can open for longer. As a result of this, the clinic has increased in size by about 20% (an additional 1,200 patients have been registered). Turnover has also increased by one third. The doctor estimated that about half of this (about $10,000) was directly attributable to the system.

As well as impacting on the overall financial position through improved patient numbers and patient/staff ratios, several other financial savings had been identified. The stationary bill is about a fifth of what it used to be. In Uganda, where they have had a similar impact, this saving was estimated at about $1,000 per year. They have been able to combine the roles of cashier/reception/admin and have two staff members working a shift system to cover longer opening hours. In addition, there are no problems with payments being forgotten as patients cannot be seen until they have paid and this is logged on the system.

The doctor described the benefits in terms of administration as follows: “when I sit at my desk I can monitor what is happening across the clinic. It is very efficient and has certainly contributed to our performance”. In the pharmacy, there are far fewer cases of drugs expiring, which saves them money because they are arranged by expiry date. In addition, there are big time savings for the pharmacist because of better stock control. Because the pharmacist’s role is less taxing she is able to work for longer to cover the opening hours.

They have also introduced the SMS package and now have close to 100% attendance at clinic appointments. They have opened a new gynecological clinic, which sees about 500 women over the course of the year. They also have plans to expand this. It is easy to track and stay in touch with pregnant women and the doctor believes their service has improved a lot. Partly as a result of how effective they now are, they have secured funding from a pharmaceutical company to open a full maternity unit next year.

A further benefit that the doctor identified is improved confidentiality of patient data, for example with lab results. As these appear on the doctor’s computer, there are fewer verbal reports and no incidents of tests going astray. This was echoed by the doctor from Uganda who described how much easier it is to keep patient information private because only the clinical staff see it, and it is not lying around on paper.

There are also fewer mistakes in the lab and less movement between the lab and clinician’s office. Confidentiality is also improved through the electronic registration system where doctors are sure they are speaking to the correct person even if they share names. The improved filing also means that historic data on the patients do not go missing, for example if the old file cannot be found.

The centre is also able to report to donors more effectively. The doctor believed that the success in getting a new donor for the maternity unit was partly related to being better at compiling and presenting data since the system was introduced. Finally, she believed that job satisfaction amongst staff had improved and that levels of stress had been reduced.
4.6 Other observations – areas for improvement

Across both sites, staff expressed a need for training and capacity building in basic computer literacy to support them to use any new system. Furthermore, problems with supporting infrastructure such as power shortages should be addressed to ensure proper implementation of the new system and to maximize its usefulness.

In Hargeisa, there are a few issues that could be followed-up to ensure the ongoing efficiency of the system. One is the appointments system, which essentially is absent at the clinic. It remains difficult for staff to monitor which patients should be returning to the clinic for follow-up appointments, and which have been coming on a regular basis previously. The SMS reminder system that was part of the EMR has not been implemented and this is a potential benefit that could be explored further. It is also not entirely clear whether the EMR has had an impact on patients visiting the clinic – whether it has shortened waiting times, for instance. It was clear from observations during the week of the evaluation that some patients were waiting a very long time – several hours – particularly for lab results, and at times were visibly impatient or frustrated. It would be good to understand what was causing these long waits, whether efficiencies from the system were being maximised and whether an increase in patient numbers required more additional staff resource. In Entebbe, they told us that donor reports were a challenge because they had not yet been refined to the Ugandan format, so they are still doing that manually but they think it will improve next year.

The research in Mbalymayo was marred by the fact that the clinic closure had been announced and staff morale was very low. As discussed earlier, this undermines some of the findings and potentially explains some contradictory results. In addition, staff highlighted several problems with how the system was working:

1. The staff felt they lacked sufficient training in how to use the system. The trainers were English-speaking and staff now have no helpdesk support for the system roll-out.

2. The system is still rather unstable and freezes over frequently, thereby slowing down the work of the clinic.

3. There has been reluctance of the patients to accept electronic records, given that they have a history of dealing with the doctor’s handwritten notes and receipts, with stamps and signatures, which they feel are more authentic.

4. The system currently works and supports outpatient clients who pay cash. However, it does not currently handle corporate clients, who still have to be managed manually, thereby slowing down the work of the staff of the clinic.

5. Related to the above issue is the fact that there is no way to differentiate the patients coming from outside SOS Village, the community and corporate clients. This makes it difficult to produce disaggregated statistics for reporting purposes and forces the staff to resort to both manual and electronic patient management system, with all the risks for errors, time delays.

The data we gathered from Mbalymayo would suggest that staff are spending less time on administrative tasks and that the patient journey is faster. Nonetheless, for a system to work well it needs to be acceptable to patients and staff using it and this is certainly a lesson for future roll out. Given the closure of the clinic, it may not be cost effective to resolve these issues at Mbalymayo. However, it is recommended that they be taken on board when migrating the system to another site.

To conclude, there are clear differences in how different clinics are responding to, and using the system. The scale of difficulty seems to relate to the clinic capacity to use and manage the system in the first place. A tentative conclusion from this might be that the clinics that are more efficient to begin with are best placed to take advantage of the benefits of the EMR. This is very relevant for the system migration, as the choice of clinic should be one that does not have wider capacity issues in the first place. Rather than the greatest gains being achieved from giving the system to the neediest clinic, it appears that the time and skill required to make a success of the system are more likely to be present in the more sophisticated clinics.
5.0 The value of the EMR to the health centres

The final research question relates to the value for money implications of the investment in the centre. In this section, we consider how some of the outcomes relate to clinic efficiencies, or cost savings. Many of the benefits are quite diffuse and it is difficult to attach monetary values to them (see Table 11 for a list of non-monetised benefits).

Others lend themselves more easily to monetisation. Data for this section has been inferred from the research findings described earlier. Financial data has been requested from the accountants in the medical centres. Due to the lack of data in some areas it has only been possible to do this analysis for two centres. Tables 9 and 10 set out these calculations. All figures are expressed in Purchasing Power Parity (PPP). PPP converts the amount into international dollars (i.e. the number of units of a country’s currency required to buy the same amounts of goods and services in the domestic market as U.S. dollar would buy in the United States). PPP rates have been sourced from the World Bank and are based on Kenyan PPPs, as no conversation rate is available for Somalia.

Table 9: The value of EMR to Eldoret

<table>
<thead>
<tr>
<th>Increase in patient registration</th>
<th>Increase in turnover</th>
<th>Proportion attributable to EMR</th>
<th>Savings on stationary</th>
<th>Value of additional investment leveraged</th>
<th>Total value attributable to EMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,200 new patients</td>
<td>$20,000</td>
<td>50%</td>
<td>$1,000</td>
<td>TBC</td>
<td>$11,000</td>
</tr>
</tbody>
</table>

Total value: attributable to the centre: $11,000
Total value in 2015 PPP: $25,850

Table 10: The value of EMR to Hargeisa

<table>
<thead>
<tr>
<th>Increase in patient attendance</th>
<th>Proportion attributable to EMR</th>
<th>Savings on cashier/admin</th>
<th>Savings to clinician</th>
<th>Time savings to pharmacy</th>
<th>Time savings to lab</th>
<th>Productivity of lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>+150 per week</td>
<td>50% (based on Eldoret assumption)</td>
<td>3.2 hours per day ($246 per annum)</td>
<td>3.5 hours per day ($3148 per annum)</td>
<td>2 hours per day ($1,040)</td>
<td>4 hours per day ($2319 per annum)</td>
<td>+475 tests per week</td>
</tr>
</tbody>
</table>

Total value: attributable to the centre: $6,753
Total value in 2015 PPP: $15,869
The results show a ‘value’ to the clinics of between $6,753 and $11,000 ($15,869-$25,850 in PPP). However, this underestimates the full value as the productivity increases in Hargeisa and the value of the leveraged funds in Eldoret have not been included. See Table 11 for a list of additional non-monetized benefits.

We can also calculate some environmental benefits from using the system. First, it reduces the amount of paper used by the clinics. In Eldoret, the estimated amount of paper saved was 200 reams of paper per year, or 1,00,000 sheets of paper. A key environmental saving comes from reduced air and car travel as a result of having internet access. The Connecting Africa initiative provided internet access to some of the villages through the VSAT technology. Table 12 sets out some of the associated benefits and the monetary values associated with them. BT is not responsible for internet access in every village but it is illustrative of the kinds of benefits that could be achieved. The total value estimated from professional development, online procurement and online communications is $2899 ($6,812 in PPP). Although this is not the full range of benefits and therefore underestimates the overall contribution, it is indicative of the kinds of benefits that are being achieved. The total value to Eldoret of ICT investment is therefore a minimum of $13899 ($32,662 in PPP). The environmental saving from fewer flights and car trips is $619 per year (1,452 in PPP). The total discounted value\(^6\) of these benefits in PPPs over five years is $71,649 for Hargeisa and $154,056 for Eldoret or $225,675 in total.

### Table 11: Non-monetised benefits

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Beneficiary</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Better attendance at clinic appointments</td>
<td>Existing patients</td>
<td>Eldoret</td>
</tr>
<tr>
<td>Time savings from not having to travel to another clinic</td>
<td>New patients</td>
<td>Eldoret and Hargeisa</td>
</tr>
<tr>
<td>Time savings from faster appointment</td>
<td>New and existing patients</td>
<td>Eldoret and Hargeisa</td>
</tr>
<tr>
<td>Reduced risk of clinical error</td>
<td>New and existing patients</td>
<td>All locations</td>
</tr>
<tr>
<td>Increased revenues from improved billing</td>
<td>Clinic</td>
<td>All locations</td>
</tr>
</tbody>
</table>

\(^6\) Based on 3.5% discount rate.
Table 12: Non-monetised benefits

<table>
<thead>
<tr>
<th>Beneficiary</th>
<th>Number of beneficiaries</th>
<th>Measure</th>
<th>Outcome</th>
<th>Measure</th>
<th>Value per person</th>
<th>Total value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional development</td>
<td>63</td>
<td>Total number of doctors (20) and teachers (280)</td>
<td>Improvement in quality of professional service</td>
<td>Value of one CPD course per year (data from SOS Eldoret)</td>
<td>$336 (doctors), $287 (teachers)</td>
<td>$386</td>
</tr>
<tr>
<td>Online procurement</td>
<td>1 pharmacist, lab staff member, administrator and driver per village (80)</td>
<td>Number of hours saved from procuring medical supplies online</td>
<td>Staff time and costs saved</td>
<td>Value of time saved from online procurement</td>
<td>Pharmacist: 24 days per year ($286), Lab: 12 days per year ($106), Driver: 16 days per year (£68), Administrator: 12 days per year (£22)</td>
<td>$720 per year</td>
</tr>
<tr>
<td>Online communication</td>
<td>Finance and management staff</td>
<td>Number of hours saved from not having to travel</td>
<td>Staff time and costs saved</td>
<td>Value of time saved from travelling to central office and associated costs</td>
<td>30 days of staff time per location ($238) plus 4.27 trips per month ($9,862)</td>
<td>$1793 per year</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$2899</td>
<td></td>
</tr>
<tr>
<td>Value in PPP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$6812</td>
<td></td>
</tr>
<tr>
<td>Environmental</td>
<td>Flights generating 11.73 tonnes of carbon7</td>
<td></td>
<td></td>
<td></td>
<td>$434</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Car trips generating 8000 miles per year or about 5 tonnes of carbon</td>
<td></td>
<td></td>
<td></td>
<td>$185</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$619</td>
<td></td>
</tr>
<tr>
<td>Value in PPP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$1452</td>
<td></td>
</tr>
<tr>
<td>Total value in PPP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$8264</td>
<td></td>
</tr>
</tbody>
</table>

7 Calculated using https://co2.myclimate.org based on 4.27 domestic flights per month, the central estimate for the Social Cost of Carbon (SCC) http://costofcarbon.org/faq. This is the monetised benefit of the damage caused by one tonne of emissions per year.
6.0 Conclusions

In this report, we have described the findings from a 12-month evaluation of BT’s investment in medical centres attached to SOS Children’s Villages in Africa. We presented the theory of change for the project and the outcomes and indicators that were measured. The results of both the qualitative and quantitative research suggests that significant time savings are being achieved by the clinic, particularly in relation to the administrative functions. The total discounted value\(^8\) of these benefits in PPPs over five years is $71,649 for Hargeisa and $154,056 for Eldoret or $225,675 in total.

With any new technology teething problems are to be expected. Nonetheless, in three of the clinics involved – Hargeisa, Entebbe and Eldoret - the results of both the qualitative and quantitative research suggests that significant time savings are being achieved by the clinic, particularly in relation to the administrative functions. We have qualitative evidence that there are increased efficiencies in the lab and pharmacy. Substantial time and efficiencies savings were also found in Mbalmayo, however perceptions of the system by staff were less positive. However, findings from this centre should be seen in light of the impending closure. In the other centres staff appear to have understood how the system operates with very few challenges. Some of the challenges they have experienced have been dealt with promptly by the installation team, either during the training or via Skype.

Significant productivity gains have been observed at Eldoret. This is a particularly well-run clinic that was at an inflection point at the time of investment i.e. it was able to grow and make good use of the technology. As a case study, it is therefore an exemplar of how the EMR can add value. Eldoret is the only centre to have introduced in the SMS system and is now achieving 100% attendance at these clinics. If gains in clinic attendance achieved in Eldoret could be matched in those locations, there would be substantial impacts on postnatal care and attendance for serious conditions like HIV and hypertension.

For future investments of this kind, the capacity of the clinic to make best use of the technology should be considered. Investments to do IT capacity building need to be considered, as well as the time it takes included in the implementation plan. The training provided by the EMR service provider (softcom) has not been enough for the clinic staff in some locations. Follow up training on ICT provided by SOS is highly advisable.

As with other forms of technology, a system like this can only facilitate the effective working of the clinic. Those clinics that were better endowed in terms of productivity, skills, management capacity and funding, appear to be in a better position to exploit the technology. It is therefore not the case that the neediest clinics are the ones that would benefit most, in fact the return on investment may be greatest in the most sophisticated clinics with the highest level of IT skills.

\(^8\) Based on 3.5% discount rate.
References


Williams, F. and Boren, S., 2008. The role of the electronic medical record (EMR) in care delivery development in developing countries:
## Appendix 1

<table>
<thead>
<tr>
<th>Activity</th>
<th>Outcome</th>
<th>Project example</th>
<th>Cost saving</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>SME appointment reminders</td>
<td>Fewer missed appointments</td>
<td>Cost of time wasted</td>
<td>Change in non-attendance was 34% of the baseline non-attendance rate (systematic review) (Hasvold and Wootton, 2011)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lower rates of attrition HIV/TB</td>
<td>Asha Programme, India</td>
<td>53% of participants receiving weekly SMS reminders achieved adherence of at least 90% during the 48 weeks of the study, compared with 40% of participants in the control group (Pop-Eleches et al., 2011). Asha programme decreased attrition from TB treatment from 60% to less than 3% (Lewis et al., 2012).</td>
<td></td>
</tr>
<tr>
<td>Digitisation</td>
<td>Less administration</td>
<td>Mosoriot Electronic Medical Record, Kenya</td>
<td>Saving on administration</td>
<td>Prior to 2001, creating patient records required a half time clerk, but with MEMR (new system) it took less than an hour (Rotich et al., 2003)</td>
</tr>
<tr>
<td></td>
<td>Fingerprint scanning and barcode systems</td>
<td>Mosoriot Electronic Medical Record, Kenya</td>
<td>Time saving</td>
<td>Time to locate records 7 seconds using fingerprint method compared to 27 seconds using traditional method. Difference of 2.9 minutes and 0.09 minutes for barcode system (ibid.).</td>
</tr>
<tr>
<td></td>
<td>Patients seen more quickly</td>
<td>Mosoriot Electronic Medical Record, Kenya</td>
<td>Value of time saving</td>
<td>Patient visits were 22% shorter, provider time per patient was reduced by 58%, and patients spent 38% less time waiting in the clinic (ibid). Clinic personnel spent 50% less time interacting with patients, two-thirds less time interacting with each other, and more time in personal activities</td>
</tr>
<tr>
<td></td>
<td>More patients seen</td>
<td>PIH-EMR, Peru</td>
<td>Number of additional patients seen at no cost</td>
<td>The clinic doubled the number of patients without any additional clinical or admin staff (ibid.). Reduced transfer times for some data from 1 to 3 months to only 2 minutes (Lewis et al., 2012).</td>
</tr>
<tr>
<td></td>
<td>Reduced time to access data</td>
<td>Rapid SMS Malawi</td>
<td>Time saving</td>
<td>A reduction of 17 minutes per employee per working day (28%) – largely due to reduction in dictation (ibid.)</td>
</tr>
<tr>
<td></td>
<td>Less time spent transferring information between records</td>
<td>Mosoriot Electronic Medical Record, Kenya</td>
<td>Staff time</td>
<td>The electronic medication order entry system was shown to produce significantly fewer errors than the previous paper and spreadsheet approach - 17.4% to 3.3%. 20.5% less time taken to order prescriptions</td>
</tr>
<tr>
<td>Electronic prescriptions</td>
<td>Fewer errors Faster processing times</td>
<td>PIH-EMR, Peru</td>
<td>Cost saving and better outcomes time saving</td>
<td>The electronic medication order entry system was shown to produce significantly fewer errors than the previous paper and spreadsheet approach - 17.4% to 3.3%. 20.5% less time taken to order prescriptions</td>
</tr>
<tr>
<td>Automation of laboratory</td>
<td>Faster processing time</td>
<td>US data</td>
<td>Cost and time saving</td>
<td>Decrease of 50% in transportation costs of samples (Rotich et al., 2003). Annual laboratory revenue increased 4 times, from 55,000 to 220,000 euro per month (ibid.). 41% increase in the number of patients and 28% increase in the number of tests performed (ibid.). Reduction of 30% in turnaround times (ibid.).</td>
</tr>
</tbody>
</table>