

# Early infant diagnosis of HIV infection in Zambia through mobile phone texting of blood test results

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**Objective** To see if, in the diagnosis of infant infection with human immunodeficiency virus (HIV) in Zambia, turnaround times could be reduced by using an automated notification system based on mobile phone texting.

**Methods** In Zambia's Southern province, dried samples of blood from infants are sent to regional laboratories to be tested for HIV with polymerase chain reaction (PCR). Turnaround times for the postal notification of the results of such tests to 10 health facilities over 19 months were evaluated by retrospective data collection. These baseline data were used to determine how turnaround times were affected by customized software built to deliver the test results automatically and directly from the processing laboratory to the health facility of sample origin via short message service (SMS) texts. SMS system data were collected over a 7.5-month period for all infant dried blood samples used for HIV testing in the 10 study facilities.

**Findings** Mean turnaround time for result notification to a health facility fell from 44.2 days pre-implementation to 26.7 days post-implementation. The reduction in turnaround time was statistically significant in nine (90%) facilities. The mean time to notification of a caregiver also fell significantly, from 66.8 days pre-implementation to 35.0 days post-implementation. Only 0.5% of the texted reports investigated differed from the corresponding paper reports.

**Conclusion** The texting of the results of infant HIV tests significantly shortened the times between sample collection and results notification to the relevant health facilities and caregivers.

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## Introduction

Despite over three decades of related research and intervention, the global epidemic of human immunodeficiency virus (HIV) infection continues to afflict more than 33 million people worldwide.<sup>1</sup> In Zambia, where the estimated prevalence of HIV infection is 14.3%, mother-to-child transmission accounts for 21% of all HIV infections.<sup>2</sup> Although the use of anti-retroviral therapy (ART) for the prevention of mother-to-child transmission (PMTCT) is essential, effective programmes to achieve early infant diagnosis are critical when that prevention fails. There is strong evidence that the early initiation of ART in HIV-infected children can substantially reduce HIV-related morbidity and mortality.<sup>3–6</sup> In the guidelines it published in 2010, the World Health Organization (WHO) recommended the immediate initiation of ART upon diagnosis of HIV infection in infants and older children, irrespective of the children's CD4+ T-lymphocyte counts.<sup>7</sup>

The early initiation of ART in infants requires reliable early infant diagnosis. This is usually based on the testing of blood samples, collected from infants at least 6 weeks old, using a polymerase chain reaction (PCR) test for the detection of HIV deoxyribonucleic acid (DNA). For convenience, blood samples are usually spotted onto filter paper and allowed to dry before being sent to a laboratory for testing. In a resource-limited setting such as Zambia, the establishment of an efficient and robust system for the early diagnosis of HIV infection in infants is beset with difficulties including; the effective training

of health workers in the testing of dried blood spots, the reliable transport of dried blood spots to the often distant regional laboratories or “hubs” for PCR-based testing, and the good management of the necessary supply chain. One component of the diagnostic process that could be made substantially quicker is the transmission of the test results from the regional laboratory to the tested infant's point-of-care health facility. If transmitted on paper via a courier service, laboratory results can take several weeks to arrive or can be lost in transit. After the test results have been physically transported to the relevant health facility, the infant's caregivers must return to the facility to receive the results, adding further, critical delays.

In this setting, mobile health (m-health) technology offers a reliable and sustainable solution to the slow transmission of test results. By using text (i.e. short message service [SMS]) to deliver test results to health facilities well ahead of traditional paper copies, unnecessary delays can be eliminated. Their expanding use and the extension of mobile phone network coverage to non-urban areas make mobile phones a potentially powerful public health tool in Zambia.<sup>8</sup> The mobile phone platform is increasingly being used across sub-Saharan Africa for functions other than conversations, including the dissemination of information about weather trends and commodity market prices to farmers, the provision of electronic food vouchers from the World Food Programme, and monetary transactions.<sup>9–16</sup>

Increasingly, mobile phone technology is also providing measurable benefit in programmes for HIV prevention and

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(Submitted: 20 November 2011 – Revised version received: 15 March 2012 – Accepted: 15 March 2012)

treatment, particularly in improving ART adherence through reminder calls and/or SMS messages to patients. In southern India nearly 75% of survey respondents stated that weekly automated voice reminders to patients' mobile phones for maintaining medication adherence would be acceptable.<sup>17</sup> In Kenya, weekly SMS messages from a clinic nurse significantly improved ART adherence and rates of viral suppression.<sup>18</sup> Despite the increasing number of anecdotal reports of the use of m-health interventions in the delivery of HIV services, there is little rigorous evidence of the efficacy of such inputs.

This report describes the design, implementation and evaluation of Project Mwana, a pilot project in Zambia's rural Southern Province. The main aim of this project was to reduce the time between blood sampling for the detection of infant HIV infection and notification of the test results to the relevant point-of-care health facility by using an SMS-based system. An overview of the system's architecture is given below, along with a quantitative analysis of the project's effectiveness and a discussion of the problems encountered in the project's deployment.

## Methods

### Zambia and its Southern Province

Although Zambia has one of the world's highest burdens of acquired immunodeficiency syndrome (AIDS) and approximately one million people living with HIV infection,<sup>2</sup> the Zambian government's programmes for the care and treatment of HIV-positive individuals are among the most successful in sub-Saharan Africa. Free services for HIV care and treatment have been provided for Zambians since April 2004, and these government programmes have rapidly expanded, from an estimated 15 000 adults receiving care in 2004 to over 250 000 in late 2011 (unpublished data from the Zambian Ministry of Health). Universal free access to PMTCT services is also provided in government-supported health facilities, where, in recent years, routine HIV screening and an "opt-out" approach have resulted in more than 90% of pregnant women being checked antenatally for HIV infection.<sup>19</sup>

Since 2006, the Zambia Center for Applied Health Research and Develop-

ment (ZCAHRD) – a local nongovernmental organization affiliated with Boston University – has been supporting several programmes for the early diagnosis of HIV infection in infants and PMTCT interventions in the Southern Province. Approximately 1.6 million people live in this province, mostly in rural communities with widely dispersed health facilities. Distances from district health facilities to regional or "hub" laboratories, where blood samples can be checked for HIV DNA, range from 10 to about 600 km. These long distances lead to slow transport times, a problem compounded by poor road conditions, particularly during the rainy season, and by unreliable courier systems. Baseline evaluations over the last five years have revealed several barriers to the delivery of good health care in the Southern Province. These barriers include long delays between the collection of blood samples from infants for HIV testing at a regional laboratory and the arrival of the corresponding test results at the relevant point-of-care health facility; the loss of such results before arrival at a health facility; and the limited uptake of paediatric HIV services because of delayed diagnosis. In addition, mechanical problems with vehicles, fuel shortages and prohibitive transport costs, especially in rural areas, hamper the conveyance of dried blood samples from the health facilities where they are collected to the regional hubs where they undergo testing.

To overcome the observed delays in the delivery of infant HIV test results, the Zambian Ministry of Health, in conjunction with implementing partners, designed an innovative, automated SMS message system for reporting the results directly from regional laboratories back to the point-of-care while ensuring accuracy and confidentiality. The system's secondary goals (reported elsewhere) were to increase the uptake of services for the early infant diagnosis of HIV infection in health facilities using the SMS-based system; to increase the proportion of HIV-infected children who were successfully referred to appropriate care, and to reduce the time between the diagnosis of HIV infection and ART initiation.

### System architecture

The SMS-based system for result delivery was designed to enhance and work seamlessly within the current Zambian

framework for the early diagnosis of HIV infection in infants, which is based on the Results160 software package. This customized software was built by the United Nations Children's Fund's Innovation Team using the free and open source software known as the RapidSMS programming framework. Results160 quickly delivers the results of HIV testing from the regional processing laboratories back to the facilities where the tested blood samples were collected, thereby eliminating the delays in the delivery of the results on paper. Detailed descriptions of the delivery system, its architecture and its support system are given in Appendix A (available at: [http://www.bu.edu/cghd/?attachment\\_id=11923](http://www.bu.edu/cghd/?attachment_id=11923)).

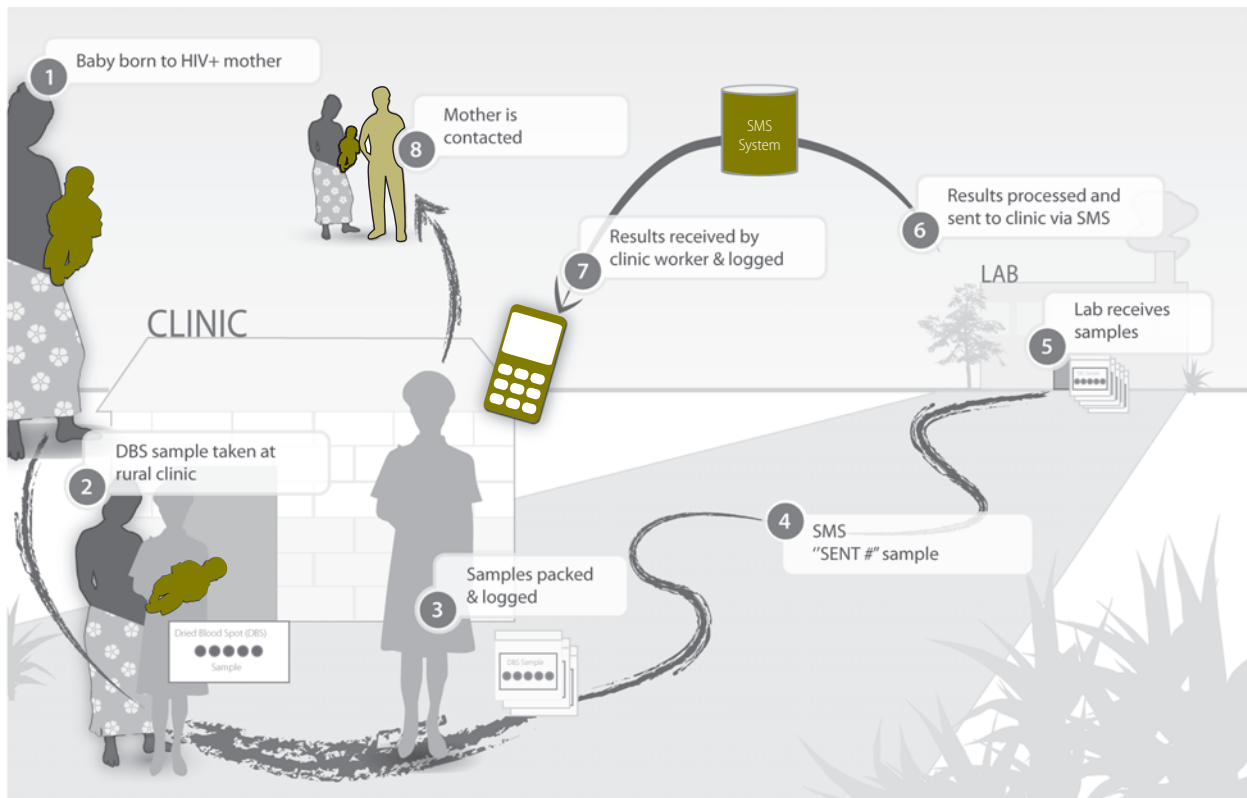
Fig. 1 illustrates the components of the SMS-based system and Fig. 2 illustrates all the steps in the delivery pathway for the results of the HIV tests.

### Pilot sites

Ten public health facilities within two districts in Zambia's Southern Province were purposively selected for inclusion in the pilot SMS project (Table 1). Five were located in Mazabuka district and the other five in Monze district. Sites with varied characteristics were selected to increase the generalizability of the results of the study. Five of the selected facilities were categorized as urban/periurban and the other five as rural. Catchment populations ranged from roughly 5000 to almost 40 000 people. Although no formal statistics exist to show the percentage of Zambian patients attending urban health facilities, Zambia does have one of the most urban populations within sub-Saharan Africa. An estimated 40% of the population lives in an urban area.<sup>20</sup> In the absence or near absence of data that could be used to identify those health facilities and catchment populations most likely to benefit from an SMS-based system for the delivery of HIV test results, we felt that the inclusion of health facilities with a variety of characteristics was the best option for a pilot evaluation.

After blood samples were collected from infants for HIV testing, the infants' caregivers were asked to return to the health facility at 4-week intervals, at least until they had been given the test results. This request was made in case the caregiver could not be traced when the result arrived at the health facility. In most cases, these follow-up visits

Fig. 1. Mobile-phone-based system for infant HIV test result notification, Zambia, 2008–2011



DBS, dried blood spot; HIV+, positive for human immunodeficiency virus; SMS, short message service. Image reproduced with permission from Frog Design (San Francisco, USA) for the United Nations Children's Fund.

coincided with routine infant immunization visits. Once the HIV test result reached a point-of-care health facility, a staff member tried to trace at least one of the infant's caregivers to request that he or she visit the health facility as soon as possible to receive the infant's test result and undergo counselling. Results were not sent directly to caregivers who had

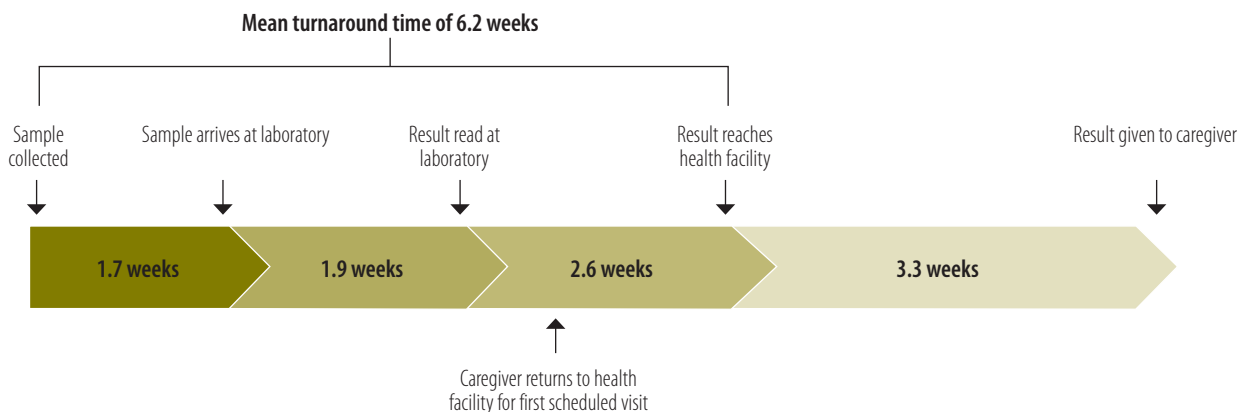
access to a mobile phone because of the need to provide counselling and ensure confidentiality.

**Training and follow-up**

At least two staff members from each study facility attended a half-day training session. The attendees were either the intended primary users of the

SMS-based system or their managers. Training consisted of an interactive PowerPoint (Microsoft, Redmond, United States of America) presentation on the existing Zambian programme for the early diagnosis of HIV infection in infants and instruction on how to use the SMS-based system to retrieve test results. Trainees used their own

Fig. 2. Pathway for infant HIV test result notification, Zambia, 2008–2011



HIV, human immunodeficiency virus. Note: Times shown are mean values for the delivery of test results on paper.

Table 1. **Baseline characteristics of 10 health facilities in study of early diagnosis of HIV infection in infants through mobile phone texting of test results, Southern Province, Zambia, 2009**

Facility	District	Area	Catchment population	Km from facility to lab/hub	Main sample transport to lab/hub	Road type	Frequency of sample transport to lab/hub	Mobile phone network provider	HIV	
									Prevalence (%) <sup>a</sup>	Exposure <sup>b</sup>
Monre urban	Monze	Urban/periurban	17 962	0.5	Walking	Graded gravel	Weekly	Zain	12.5	191.16
Manungu	Monze	Urban/periurban	16 511	2.5	Walking	Tarmac	Weekly	Zain	21.2	173.27
Keemba RCHC	Monze	Rural	14 827	30	Motorbike	Ungraded gravel	Weekly	MTN	10.1	74.13
Luyaba	Monze	Rural	9 530	22	Public transport	Ungraded gravel	Weekly	Zain	22.4	105.67
Rusangu RCHC	Monze	Urban/periurban	8 678	15	Motorbike	Ungraded gravel	Weekly	Zain	10.4	44.67
Nakambala urban	Mazabuka	Urban/periurban	36 697	2	Public transport	Ungraded gravel	Twice monthly	MTN and Zain	23.0	417.80
Mazabuka HAHC	Mazabuka	Urban/periurban	10 895	5	Walking	Tarmac	Weekly	MTN and Zain	18.0	97.07
Mbaya	Mazabuka	Rural	12 299	70	Vehicle	Ungraded gravel	Weekly	MTN and Zain	22.6	137.59
Nameembo RCHC	Mazabuka	Rural	8 009	65	Motorbike	Ungraded gravel	As needed	MTN and Zain	17.6	69.77
Nega Nega	Mazabuka	Rural	4 902	37	Motorbike	Graded gravel	Weekly	MTN and Zain	19.7	47.80

HAHC, hospital-affiliated health centre; RCHC, reproductive and child health clinic.

<sup>a</sup> Prevalence of HIV infection among women attending antenatal clinics as collected from each facility and reported to the Zambian Health Management Information System.

<sup>b</sup> Exposed liveborns per year (expected value).

mobile phones to interact with the system, participated in a discussion of the system's possible benefits, and reviewed case studies to ensure a thorough understanding of the system's intended use. The training concluded with a 10-question quiz and issue of certificates.

A support visit was made to each study facility one and two months after the initial training and system launch. Such support visits, which were subsequently conducted on an ad hoc basis, were used to troubleshoot problems, receive feedback from site staff, and observe staff using the SMS system. Representatives of the relevant District Health Management Team were involved in conducting initial trainings, accompanied ZCAHRD staff during all follow-up visits to the study sites, and were involved in follow-up management of the SMS system.

### Programme hardware

Mobile phones were originally procured and provided for each of the 10 health facilities involved in the pilot project. However, after some early difficulties with the maintenance of these facility-

specific phones, the health-care providers who were using the SMS system were able to register their personal mobile phones onto the system securely, with the full approval of the national Ministry of Health.

A server was procured and centrally placed at the offices of the Ministry of Health in Lusaka to support the software, the flow of data from the regional laboratories that were testing the dried blood samples, and the SMS messages going to and from the study health facilities. Web-based reports and real-time updates for the system were made available, through secure access, to individuals who had received the approval of the national Ministry of Health (Appendix A).

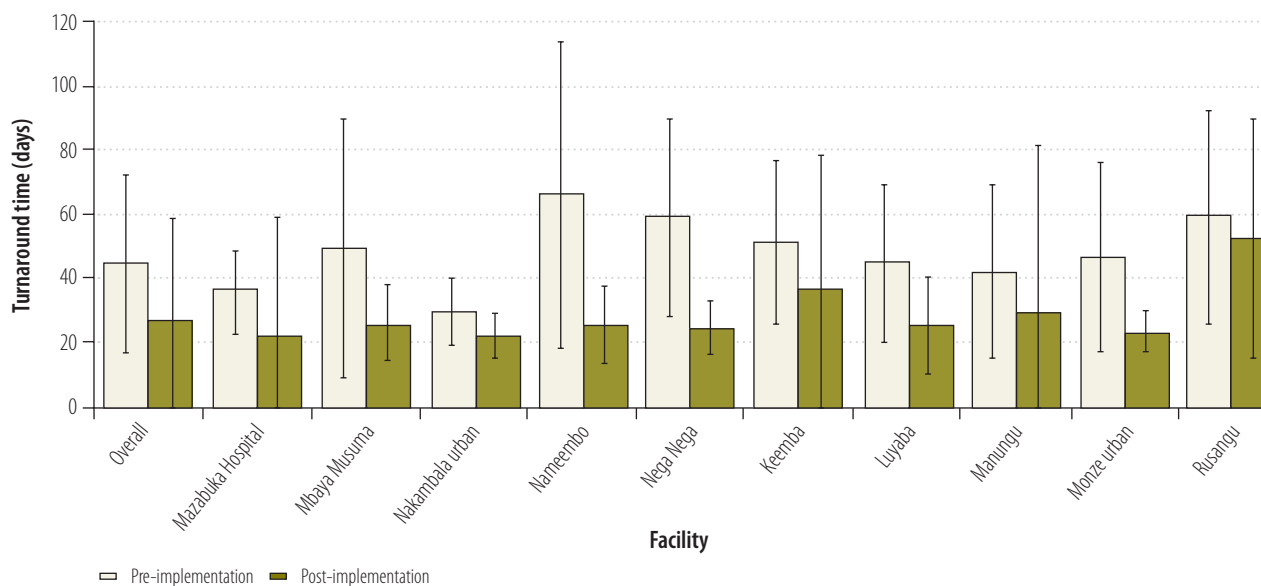
### Data collection and analysis

To provide a baseline, anonymized data on infant dried blood sample HIV results were collected from the routine registers of each of the 10 study health facilities for the 19-month period before the SMS system was implemented (i.e. from 1 December 2008 to 30 June 2010). To facilitate their comparison with post-

implementation data, these pre-implementation data were expanded into the specialized SMS registers (Appendix A). The data from the study facilities were supplemented with relevant data from the central PCR laboratory database at the University Teaching Hospital in Lusaka. Pre-implementation data were entered into a database created using the Census and Survey Processing System (CSPRO) package (United States Census Bureau, Washington, USA) for tabulation of turnaround times from sample collection to result delivery before SMS system implementation. Samples for which turnaround times could not be calculated because of missing data were excluded.

Two sources of post-implementation data were used, both to assist in service delivery and to allow for effective monitoring and evaluation. Data on turnaround times were collected monthly from the project register at each study facility and entered into a CSPRO database. The relevant results of HIV testing stored at the University Teaching Hospital in Lusaka were entered into an Access (Microsoft) database. Most infant

Fig. 3. Mean turnaround times for infant HIV test result notification to health facility, before and after implementation of mobile-phone-based notification system, Zambia, 2008–2011



HIV, human immunodeficiency virus.

Note: Times shown are from blood sampling until delivery of test result to the health facility. Error bars indicate one standard deviation above and below the mean. For all study sites combined and for each site except Rusangu, mean post-implementation turnaround time was significantly shorter than mean pre-implementation turnaround time ( $P < 0.01$ ).

blood samples collected for HIV testing at any of the study facilities between 1 July 2010 and 15 February 2011 were included in the analysis. Only samples for which turnaround times could not be calculated because of missing data were excluded.

The data were analysed using SAS version 9.1.3 (SAS Institute, Cary, USA). The main outcomes of interest were mean turnaround time (i.e. time from sample collection to the delivery of the test result to either the relevant point-of-care health facility or a caregiver of the tested infant) and result error rate (i.e. per cent discordance between the results recorded on paper, which were assumed to be correct for this study, and the corresponding results sent by SMS). Mean turnaround times pre- and post-implementation of the SMS system were compared by means of Student's *t*-tests.

## Results

Overall, 1009 dried blood samples were collected from infants for HIV testing in the 10 study sites over the 19 months before the SMS system was implemented. In the 7.5 months after implementation, 406 such samples were collected at the same sites (Fig. 3). The mean turnaround time for delivery of a test result to the relevant health

facility fell from 44.2 days (standard deviation, SD: 28.0) pre-implementation to 26.7 days (SD: 31.8) post-implementation. Every study facility experienced a substantial reduction in turnaround time following the introduction of the SMS system (Fig. 3) and this reduction was statistically significant ( $P < 0.01$ ) in all study facilities except one (the Rusangu health centre). During the post-implementation period, staff turnover hampered the effective adoption of the SMS system at Rusangu.

The mean turnaround times for delivery of a test result to a caregiver of the tested infant, as calculated from a subset of 623 baseline and 293 post-implementation samples (Fig. 4), were 66.8 days (SD: 38.8) pre-implementation and 35.0 days (SD: 31.2) post-implementation. Again, the reduction was significant ( $P < 0.01$ ) in all study facilities except Rusangu health centre.

During the post-implementation study period, we recorded both the hard copy (paper) and the SMS-transmitted test results for 336 blood samples. Only two discrepancies occurred, for an error rate of only 0.5%. In one case the SMS-reported result was positive when the corresponding hard copy result was negative, and in the other the opposite occurred. Both errors were noticed during routine management of the SMS

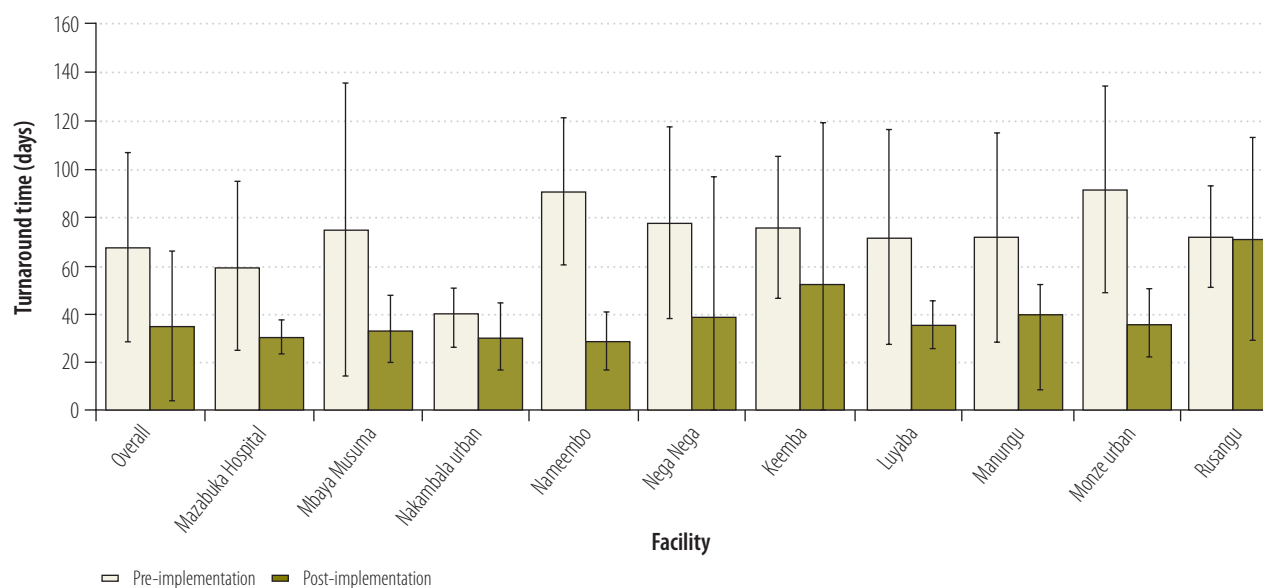
system and promptly corrected before the test results were given to the relevant caregivers.

## Discussion

Our study demonstrated that in Zambia, particularly in rural areas, mobile phone texting can overcome the logistical and distance barriers that can impede the early diagnosis of HIV infection in infants. An automated SMS allowed the results of PCR testing of infant dried blood samples to be reported to the relevant point-of-care health facility or infant caregivers much faster than would have been possible by using a courier to deliver the results on paper to the relevant health facility. In addition, the results delivered through SMS texting were highly accurate by comparison with the results recorded on paper.

After an HIV test result was texted to a health facility, it took, on average, another 8 days for it to reach the tested infant's caregiver. This was because health-facility staff often had difficulty contacting caregivers, especially if they lived very far away. Caregivers who could not be traced were given the test results when they returned to the health facility for the routine follow-up visit they had been requested to make when the infant's blood sample was collected.

Fig. 4. Mean turnaround times for infant HIV test result notification to caregiver, before and after implementation of mobile-phone-based notification system, Zambia, 2008–2011



HIV, human immunodeficiency virus.

Note: Times shown are from blood sampling until delivery of test result to caregiver. Error bars indicate one standard deviation above and below the mean. For all study sites combined and for each site except Rusangu, mean post-implementation turnaround time was significantly shorter than mean pre-implementation turnaround time ( $P < 0.01$ ).

In future, the SMS-based system for result delivery could be altered to automatically notify caregivers with access to mobile phones that their infants' test results are ready to be picked up at the health facility. In the case of caregivers without direct access to a mobile phone, community volunteers or lay counsellors living close to them and with access to mobile phones could be sent similar automated SMS reminders so that they could, in turn, contact caregivers and encourage them to return promptly to their health facility to retrieve their infants' test results.

The present study has several limitations. It compared pre-implementation data collected routinely before the study began with post-implementation data collected for the study. Thus, unrecognized secular trends and confounding factors may account for at least some of the apparent benefits of the SMS-based system for result delivery. For example, outcomes could have been affected by observer expectancy or a "Hawthorne effect" resulting from project personnel's frequent visits to the study health facilities during implementation of the system. A more rigorous scientific design, such as a cluster randomized trial or a study based on the step-wedge introduction of the intervention, would have been preferable. However, the program-

matic nature of the work involved limited our options to a "before and after" study design. We know of no major improvements in HIV diagnosis that could have affected the outcomes measured during the post-implementation phase of this study except for the SMS system. Any increases in the general efficiency and reliability of sample transport would have been slight. In fact, courier service for transporting blood samples between regional hubs and the national PCR laboratory at the University Teaching Hospital was particularly unreliable after the SMS notification system was implemented. Thus, the benefits of the SMS system may have been underestimated.

There are numerous advantages to a reliable and more timely system for the notification of infant HIV tests, such as the one presented here. The foremost advantage is more rapid initiation of appropriate care, which is critically important considering that HIV infection acquired perinatally progresses very quickly. In rural areas, health facility staff usually find it easier to ask caregivers to keep returning to the facility until the test results have arrived than to trace caregivers when the results are ready. Under these circumstances, caregivers often struggle to visit a health facility only to be told one or more times that the results are not yet available. Such

"wasted" visits make caregivers reluctant to return to the health facility. Setting up an SMS-based system for test result notification involves some initial fixed costs (e.g. for training, a server and supervision), but the elimination of courier transport of results on paper leads to savings. Once the SMS system is established at reference laboratories, little additional investment is required and national scale-up should be relatively cost-efficient. The central server and management of the system are designed to be low cost, locally owned and scalable. Only one server, located at the Ministry of Health's headquarters in Lusaka, is required for system implementation. This platform could be easily scaled up to cover all HIV-exposed children born in Zambia. Server maintenance is minimal and could be included in the Ministry of Health's information technology infrastructure. In addition, the use of a web-based management tool allows for complete decentralization of system support and management, which should ideally be taken up by individual, district or provincial health offices, since they are best equipped to identify and resolve local challenges to the system's efficiency. Finally, the capacity of the server and web-based management tool to accommodate very large volumes of traffic without any additional inputs

should allow economies of scale to be attained as the system's coverage expands.

The SMS-based system for the notification of test results has shown great promise during its pilot phase in Zambia. It could be expanded and improved. The Government of Zambia has now committed to undertake a national scale-up of the system, to cover,

by the year 2014, all 587 health facilities currently offering the HIV testing of infants in Zambia. The results of the present evaluation suggest that an SMS-based system can overcome some of the challenges inherent in the delivery of test results in a resource-constrained context such as Zambia. Despite some remaining challenges and the need

for continued research on the impact of mobile-phone-based health interventions, the simple, sustainable SMS system described in this paper has great potential in Zambia and elsewhere. ■

**Competing interests:** None declared.

## ملخص

### تشخيص عدوى فيروس العوز المناعي البشري (HIV) في الرضع في مرحلة مبكرة في زامبيا من خلال الإخطار بنتائج فحوصات الدم باستخدام الرسائل النصية عن طريق الهواتف المحمولة

القصيرة على مدى فترة سبعة أشهر ونصف لجميع عينات الدم المجففة للرضع المستخدمة في فحص فيروس العوز المناعي البشري في مرافق الدراسة العشرة.

النتائج انخفض متوسط مهلة التنفيذ لإخطار المرفق الصحي بالنتائج من 44.2 يومًا قبل التنفيذ إلى 26.7 يومًا بعد التنفيذ. وكان الانخفاض في مهلة التنفيذ كبيرًا من الناحية الإحصائية في تسعة مرافق (90%). كما انخفض أيضًا متوسط الوقت اللازم لإخطار مقدم الرعاية بشكل كبير من 66.8 يومًا قبل التنفيذ إلى 35 يومًا بعد التنفيذ. ولم تشهد التقارير المفحوصة التي تم إرسالها عن طريق الرسائل النصية اختلافًا سوى بنسبة 5.0% عن التقارير الورقية المناظرة.

الاستنتاج أدى إرسال نتائج فحوصات فيروس العوز المناعي البشري في الرضع عن طريق الرسائل النصية إلى تقصير الفترات التي تتخلل جمع العينات وإخطار المرافق الصحية ومقدمي الرعاية ذوي الصلة بالنتائج بشكل كبير.

الغرض دراسة إمكانية خفض مهلة التنفيذ - عند تشخيص عدوى فيروس العوز المناعي البشري (HIV) في الرضع في مرحلة مبكرة (HIV) في زامبيا - باستخدام نظام إخطار آلي يعتمد على الرسائل النصية عن طريق الهواتف المحمولة.

الطريقة في المقاطعة الجنوبية في زامبيا، تم إرسال عينات دم مجففة من الرضع إلى المختبرات الإقليمية لفحصها للتأكد من الإصابة بفيروس العوز المناعي البشري باستخدام تفاعل البوليميراز التسلسلي (PCR). وتم تقييم مهلة التنفيذ الخاصة بالإخطار بنتائج مثل هذه الفحوص عن طريق البريد في 10 مرافق صحية على مدار 19 شهرًا من خلال جمع البيانات الاستيعادية. وتم استخدام هذه البيانات المرجعية لتحديد مدى تأثير مهلة التنفيذ بالبرمجيات المخصصة المصممة لتوصيل نتائج الفحوصات تلقائيًا ومباشرةً من المختبر الذي يقوم بإجراء الفحص إلى المرفق الصحي الذي يحتوي على العينة الأصلية عن طريق خدمة الرسائل النصية القصيرة (SMS). وتم جمع بيانات نظام خدمة الرسائل النصية

## 摘要

### 感染早期诊断使用手机短信通知血样检测结果

目的 在赞比亚的婴儿艾滋病(HIV)感染的诊断方面，观察使用基于手机短信的自动通知系统是否能够缩短处理时间。

方法 在赞比亚的南部省份，将婴儿干血样送往地区实验室，利用聚合酶链反应(PCR)进行 HIV 检测。在超过 19 个月的时间内，通过收集回顾性数据，对 10 个卫生机构该类检测结果的邮政通知处理时间进行评价。使用这些基线数据来确定将检测结果直接从处理实验室通过短信服务(SMS)文本自动发送到样品来源的卫生机构而定制的软件对处理时间有什么样的影响。针对 10 个研究机构中用

于 HIV 检测的所有婴儿干血样，对 SMS 系统数据进行为期 7.5 个月的采集。

结果 卫生机构获得结果通知的平均处理时间从实施前的 44.2 天缩短到实施后的 26.7 天。在统计上，有 9 个机构(90%)的处理时间显著缩短。照顾者得到通知的平均时间也显著缩短，从实施前的 66.8 天缩短到实施后的 35.0 天。所调查的短信报告只有 0.5% 与对应的纸质报告不同。

结论 婴儿 HIV 检测的短信通知显著缩短了样本收集与相关卫生机构和照顾者收到结果通知之间的时间。

## Résumé

### Dépistage précoce du VIH chez les nourrissons en Zambie au moyen de la transmission par SMS des résultats des analyses de sang

Objectif Vérifier si l'utilisation d'un système automatique de notification basé sur l'envoi de SMS permettrait de réduire les délais de dépistage du virus de l'immunodéficience humaine (VIH) chez les nourrissons en Zambie.

Méthodes Dans la province méridionale de la Zambie, les échantillons séchés de sang de nourrissons sont envoyés aux laboratoires régionaux pour le test du VIH par réaction en chaîne à la polymérase (RCP). Les délais de notification par la poste des résultats de ces tests à 10 centres de santé sur 19 mois ont été évalués au moyen d'une collecte de

données rétrospectives. Ces données de base ont été utilisées pour déterminer comment les délais étaient affectés par l'utilisation d'un logiciel personnalisé, conçu pour envoyer par SMS les examens de sang automatiquement et directement depuis le laboratoire d'analyse vers le centre de santé d'où proviennent les échantillons. Les données du système SMS ont été collectées sur une période de 7,5 mois pour tous les échantillons séchés de sang de nourrissons pour le dépistage du VIH dans les 10 centres de santé.

**Résultats** Le délai moyen pour la notification des résultats à une clinique est passé de 44,2 jours pré-implémentation à 26,7 jours post-implémentation. La réduction du délai était significative du point de vue statistique dans 9 centres de santé (90%). Le délai moyen de notification d'un soignant a également considérablement diminué, passant de 66,8 jours pré-implémentation à 35 jours post-implémentation. Seuls

0,5% des rapports analysés envoyés par SMS différaient des rapports papier correspondants.

**Conclusion** L'envoi par SMS des résultats des tests VIH chez les nourrissons a considérablement raccourci les délais entre la collecte des échantillons et la notification des résultats aux centres de santé et aux soignants concernés.

## Резюме

### Ранняя диагностика ВИЧ-инфекции у детей в Замбии с передачей результатов анализов крови текстовыми сообщениями по мобильной связи

**Цель** Выяснить, можно ли сократить длительность цикла при диагностике инфицирования детей вирусом иммунодефицита человека (ВИЧ) в Замбии с помощью автоматизированной системы уведомления текстовыми сообщениями по мобильной связи.

**Методы** В южных районах Замбии высушенные пробы крови детей отправляются в региональные лаборатории для анализа на ВИЧ с помощью полимеразной цепной реакции (ПЦР). Время, затраченное на сообщение результатов подобных анализов по почте 10 медицинским учреждениям в течение 19 месяцев, было оценено с помощью ретроспективного сбора данных. Данные базовые показатели использовались, чтобы установить, как на длительность цикла диагностики влияет применение специального программного обеспечения, созданного для автоматической доставки результатов анализов непосредственно из лаборатории в медицинское учреждение, где была взята

проба, с помощью службы коротких текстовых сообщений (SMS). В течение 7,5 месяцев собирались данные системы SMS по всем высушенным пробам крови детей, которые использовались для анализа на ВИЧ в 10 исследуемых учреждениях.

**Результаты** Среднее время сообщения результата медицинскому учреждению сократилось с 44,2 дней перед внедрением до 26,7 дней после него. Данное сокращение времени было статистически значимым в девяти (90%) учреждениях. Среднее время уведомления опекуна также существенно сократилось: с 66,8 дней перед внедрением до 35,0 дней после него. Только 0,5% участвовавших в исследовании сообщений содержали отчеты, не соответствующие их бумажным аналогам.

**Вывод** Отправка результатов проверки детей на ВИЧ текстовыми сообщениями существенно сократила время от сбора пробы до сообщения результата соответствующим медицинским учреждениям и опекунам.

## Resumen

### Diagnóstico temprano de la infección por VIH en lactantes en Zambia mediante el envío de los resultados del análisis de sangre a través de mensajes de texto

**Objetivo** Observar si se puede reducir el tiempo de diagnóstico de la infección por el virus de la inmunodeficiencia humana (VIH) en lactantes en Zambia mediante un sistema de notificación automática a través de mensajes de texto a teléfonos móviles.

**Métodos** Se enviaron muestras de sangre seca de lactantes procedentes de la provincia meridional de Zambia a laboratorios regionales para realizar la prueba del VIH con la reacción en cadena de la polimerasa (PCR). A través de una recopilación de datos retrospectivos se evaluaron los plazos de notificación postal de los resultados de dichas pruebas a 10 centros sanitarios durante más de 19 meses. Esos datos de referencia se emplearon para determinar cómo podían verse afectados los plazos por la aplicación de un *software* adaptado que transmitiera los resultados de las pruebas de forma automática y directa desde el laboratorio de procesado al centro sanitario origen de las muestras mediante un servicio de mensajería de texto (SMS). Durante un periodo de 7 meses

y medio se recopilaron los datos del sistema de SMS para todas las muestras de sangre desecada a las que se realizó la prueba del VIH en los 10 centros de estudio.

**Resultados** El plazo medio para la notificación de los resultados a un centro sanitario bajó de 44,2 días antes de la implementación a 26,7 después de ésta. La reducción de los plazos fue estadísticamente significativa en 9 (90%) de los centros. El plazo medio de notificación de un cuidador también disminuyó apreciablemente: de 66,8 días antes de la implementación a 35,0 días después de ésta. Sólo el 0,5% de los informes enviados como mensaje de texto difirió de los informes por escrito correspondientes.

**Conclusión** El envío mediante mensajes de texto de los resultados de las pruebas del VIH en lactantes redujo de manera significativa los plazos entre la recogida de las muestras y la notificación de los resultados a los centros sanitarios y a los cuidadores pertinentes.

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