Patient identification and hospital information management systems in sub-Saharan Africa: a field study in Rwanda and Burundi

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Abstract

For many sub-Saharan health facilities, accurate patient identification remains a challenge. Poor national person identification systems, inefficient identification procedures, the use of weak search criteria and sometimes fraudulent practices constitute some underlying causes.
In this study, patient identification effectiveness (PIE) was first assessed for a group of 27 sub-Saharan hospitals which were using purely paper based procedures. Six of these health facilities implemented a hospital information management system at later stage enabling pre- and post-implementation comparison of PIE. Based on a simple metric, results show a significant ($p<0.001$) PIE improvement reducing identification errors from 64.6% before to 2.3% after information system implementation in the sample of 1 private and 5 public hospitals in Rwanda and Burundi.

Keywords

Patient identification systems, Africa, Hospital information systems

Introduction

Accurate identification of patients remains not less than a headache in many countries in the sub-Saharan region. Still, correct patient identification remains a cornerstone of safe and high quality healthcare. Several reasons explain the defective patient identification procedures in Sub-Saharan hospitals:

Decentralized patient administration is common in larger hospitals where the implementation of financial and managerial autonomy of clinical departments has promoted the multiplication of administrative patient management systems (every department wanting to take care of it's own bookkeeping). As a result, patients end up with multiple department-specific medical records and ID numbers. Added to this, the absence of a master patient index (MPI) [3] is a general rule: no central patient identification table referring to the different existing departmental patient records, exists.

Also, encounter-centered instead of patient-centered filing systems are being found in many hospitals, meaning that patient files are arranged based on the last encounter date. If a patient can't remember the date of the last encounter, it becomes very hard to retrieve his file.

Very often, weak patient identifiers are in use: the most used identification elements are the patient's names, the date of birth or internal department-specific medical record numbers. Different problems exist with this kind of identifiers:

- Many patients do not know their exact date of birth. Even the year of birth can be an approximate.
- Patient names are not stable: newborns may get a temporary name that changes at a later stage. Some patients do not even know the exact spelling of their name.
- As explained above, one patient can have many medical record numbers within one and the same health facility. It is often not feasible for the patient to memorize all of these record numbers or even to keep track of them.

National person identification instruments could surely significantly improve unique patient identification practices in Sub-Saharan health facilities. Unfortunately, very few countries have been able to implement accurate and comprehensive person-identification procedures guaranteeing the unambiguous identification of their citizens from the day they are born. In many places though, fragmentary identification systems enabling the coverage of at least part of the population can be found:

- At the age of 16, Rwandans receive a national ID card [1] integrating machine readable identification codes that could easily be used for health record identification purposes. Nevertheless, children under 16 years old, who are not being covered by this procedure, still make up a very important portion of the patient population.

- A similar situation exists in the Democratic Republic of the Congo [2] where all adults that are eligible to participate in political voting, get a unique identification number in the form of a *voting card*. Here again, children and other non-eligible citizens such as immigrants, displaced people, military and mentally handicapped persons are being left out.

Sometimes, patients will also voluntarily provide erroneous identification data to the health facility, such as when they want to take the identity of another person who benefits from a health insurance coverage plan or if they still have outstanding hospital bills and want to avoid to pay for these before getting access to new healthcare services. Others may have judicial reasons for not being identified. These situations are not uncommon in a number of countries and therefore also constitute a real problem.

The inability of health facilities to correctly re-identify patients with existing health records leads to creation of duplicate patient files and frequently results in information loss. A survey conducted in 30 health facilities in Rwanda, Burundi, Mali, Ivory Coast and the Democratic Republic of the Congo showed that 28 (93%) of the hospital management teams recognized that patient identification was problematic in their facility.

Electronic hospital information systems (HIS) have been reported several times to bring significant improvements to many inefficiencies that exist in hospitals in developing countries [5,6,7,8,9]. This study aimed to evaluate to what extent the advent of HIS in sub-Saharan health facilities could also bring relief to the patient identification issue.

Materials and methods

Purpose of the study

The purpose of the study was to evaluate the effect of HIS implementation on patient identification effectiveness (PIE) in a set of sub-Saharan health facilities.

Study concept

This is a comparative study evaluating PIE based on a simple output metric.

Materials

Patient identification metrics calculation was based on pre- and post HIS implementation datasets from out-patient consultations in public and private hospitals in Rwanda and Burundi. A total of 7 public hospitals and 20 private health facilities were studied in the pre-implementation phase and 6 of them also provided post-implementation data after introducing software based health information management tools in their institution.

Methods

Step 1: develop a PIE metric enabling the evaluation of paper-based and software-supported patient identification activity.

Step 2: Apply the patient identification metric to a sample of out-patient visits in hospitals and clinics which have no access to a HIS.

Step 3: Apply the same metric to a sample of out-patient visits in a subset of these hospitals after they have implemented a HIS and compare the results to what was obtained in step 2.

Results

Step 1: development of a patient identification metric

For every out-patient that visited the hospital on the days of the survey, a maximum of 3 questions were asked at the moment the patient left the registration desk:

1. Is this your first visit to this health facility?
2. If it isn't your first visit, did the registration staff manage to retrieve your existing medical and/or administrative record?
3. If your record wasn't found, did the registration staff try to find it?

Based on these simple questions, the following 4 possible results could be produced for every encounter:

1. The patient had never visited the hospital before and therefore no medical record existed.
2. The patient had already visited the hospital before and his existing patient file was found.
3. The patient had already visited the hospital before and a new file was created because the existing patient file could not be found although the receptionist tried to find it.
4. The patient had already visited the hospital before and a new file was created because the receptionist did not even try to find the existing one.

The complete process diagram of the survey is summarized in Figure 1.

The most interesting data were being provided by Result 2 (which is called a **patient identification success**) and Results 3 and 4 (which are called **patient identification failures**), as cases producing Result 1 were irrelevant for measuring PIE.

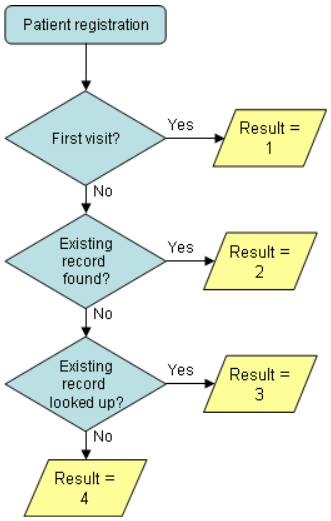

Figure 1 - Patient identification survey process diagram

Step 2: perform a pre-implementation patient identification survey

An initial pre-implementation survey was conducted in 2007 in 7 Rwandan public hospitals evaluating patient identification results for all patient encounters that took place on 3 randomly selected different days of the week (in order to eliminate staff-related or day-of-week related bias). In 2011, the same data was also collected for a large public hospital in Burundi. All hospitals had a paper based out-patient registration/identification system. The survey produced the results shown in Table 1.

Table 1 - Paper based patient identification results for 7 Rwandan public hospitals

Facility	CHK	NYA	RUT	MUH	KIB	HMK	RWA	CHB	Mean
n	355	271	279	384	104	25	298	85	1801
Result 1	41%	41%	29%	43%	68%	68%	29%	40%	45% (+-13%)
Result 2	17%	16%	11%	12%	22%	28%	24%	38%	21% (+-7%)
Result 3	8%	22%	36%	29%	6%	0%	37%	21%	20% (+-12%)
Result 4	34%	20%	24%	16%	4%	4%	10%	1%	14% (+-9%)

A surprising element was the fact that in 14% of the encounters, the registration clerk did not even try to look up the existing paper record. Very often this was due to the reception staff getting so frustrated after numerous failing file retrieval attempts, that they abandoned the procedure of file retrieval whenever they had the opportunity.
Reducing the results to patient identification successes and failures produced the results shown in Table 2, whereby:

- The Result 1 cases were omitted.
- The Result 2 cases represented successes.
- The sum of Result 3 and Result 4 cases represented the number of failures.

Table 2 - Paper based patient identification success and failure for 7 Rwandan public hospitals

Facility	CHK	NYA	RUT	MUH	KIB	HMK	RWA	CHB	Mean
n	210	159	198	220	33	8	212	51	548
Success	29%	28%	16%	21%	70%	88%	34%	63%	43% (+-22%)
Failure	71%	72%	84%	79%	30%	13%	66%	37%	57% (+-22%)

The results demonstrate that on average, in the group of public hospitals that participated in the survey, only 43% of the existing patient records could be retrieved, which was a disappointing score (although some facilities performed much better than others).

During interviews with hospital managers, it also became clear that many of them expected the problem to be worse in public hospitals compared to the private health sector. In order to evaluate this, PIE was also analyzed in 20 private health facilities using the same method. All private facilities also used a paper based patient identification and administration system. The results clearly confirmed that the situation was much better in the sample of private hospitals (only 3% non-lookups), but still for 24% of the out-patients, identification procedures failed (Figure 2). Statistically, 3 of the evaluated facilities were to be considered outliers (blue marks in Figure 2). Nevertheless, their results being assignable to extremely inefficient or non-existent identification procedures and not to data collection error, it was decided to keep them included in the data set.

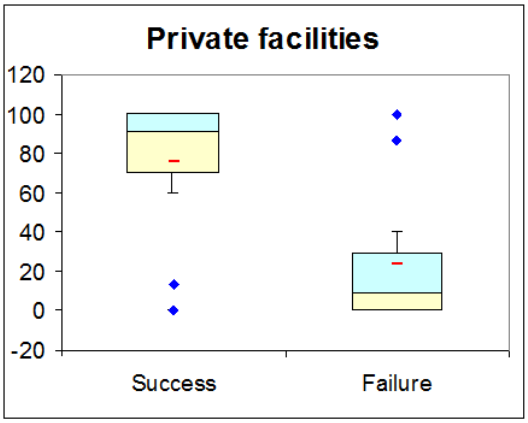

Figure 2 - Pre-implementation patient identification results in a sample of 20 private hospitals

Step 3: apply the patient identification metric to a sample of post HIS-implementation hospitals

Six of the pre-implementation health facilities had started HIS implementation at a later stage enabling

pre- and post-implementation comparison. They all made use of the open source OpenClinic HIS software [10], in which our patient identification metric had been implemented for automatic generation of the required measurements. Post-implementation metric calculation was performed as follows:

- Newly created patients without an existing match between a *patient identifier set* and the list of known patients in the HIS database were considered *New patients (result 1)*. The *patient identifier set* included the following elements:
  1. Exact combination of last name, first name, full date of birth (except for the first of January of each year) and gender. The first of January was excluded because the majority of patients that didn't exactly knew their date of birth (e.g. they only knew the year of birth) had been entered in the system with a date of birth on January 1st.
  2. Exact combination of last name, first name, gender and cellphone number
  3. National ID number
  4. Health insurance ID number

  As soon as 1 of these 4 elements already existed in the database at the moment of creation of the new patient record, the record was considered being a duplicate of an existing patient record generating *result 3* or *result 4*, depending on the patient record creation being preceded by a search attempt or not (all search attempts had also been logged by the OpenClinic software)
- Searched and retrieved patient records returned *result 2.*

Clearly, the above procedure represented a slight simplification of the paper-based algorithm, potentially leading to an overestimation of *result 3* and *result 4* frequencies (failures) when handling records of patients born on the 1st of January or really sharing the same last name, first name, date of birth and gender with another person.

The pre- and post-implementation comparison of the patient identification metric for 4 Rwandan and 2 Burundian health facilities in March 2012 produced the results shown in Figure 3.

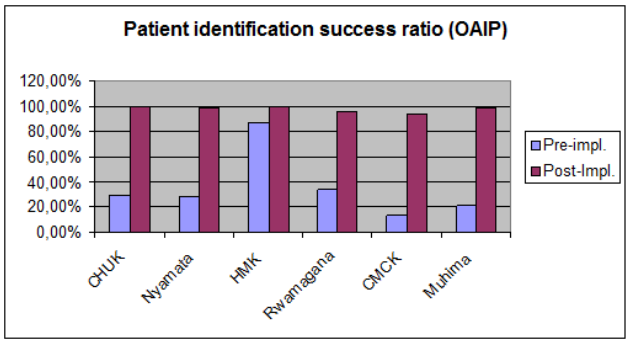

Figure 3 - Pre- and post HIS implementation patient identification success ratios for 4 hospitals in Rwanda and 2 in Burundi

Figure 3 shows a sharp improvement of patient identification success rates for all facilities, except for the Military Hospital of Kamenge (HMK) which already obtained a relatively high score in the baseline assessment. The overall success rate improved from 35,42% to 97,68% (p=0,00019, ANOVA single factor). The very high *result 1* scores for most of the health facilities are explained by the fact that many of them had to build up an electronic patient database from scratch (no existing patient identification data that could be imported in the HIS database was available). Consequently, most of the patients were declared *new patients* in the early phase of HIS implementation.

Discussion

Most if not all analyzed health facilities had serious trouble to reliably identify their patients in the pre-implementation phase. Also, none of them used a unique facility-wide patient record. Patient identification took place at different clinical departments of the hospitals, resulting in patients having their health information scattered over sometimes up to 10 different health records in one and the same institution. Moreover, different filing logic was used in separate hospital departments, which pretty much excluded practical solutions for merging health information from patient files stored in different locations.

Post-implementation evaluation demonstrated that HIS implementation brought a number of significant advantages in terms of PIE. Different reasons have been identified:

First of all, a unique facility wide identification number was generated for every patient visiting the hospital. Electronic or paper based data capture of administrative, financial and clinical information was then systematically linked to this unique number. Consequently, the functional value of the unique ID had significantly increased.

One of the participating hospitals (the University Teaching Hospital of Kigali) had produced barcoded patient identification cards (Figure 4). By the end of 2011, some 106.000 patient ID cards had been printed by the hospital information management system. These identification cards only contained basic identification information such as:

- Names of the patient
- Date of birth
- Gender
- A maximum 5-letter code referring to the paper based archiving system
- A barcode representing the unique sequential identification number of the patient in the HIS database

Figure 4 -Sample patient ID card at CHUK

When patients came to the hospital for the first time, an identification card was generated at the reception desk for free. Patients were then supposed to bring their ID card to subsequent visits in order to enable quicker and more accurate identification and consequently faster retrieval of their file. For patients who forgot to bring their ID card or lost it, a new one was printed against a small printing fee (400 Rwandan francs, equivalent to 65 dollarcents). A 2010 survey covering 1.052 out-patients that presented at the CHUK in the course of 2 consecutive days, suggested that the small fee constituded an effective motivator: almost 95% of the patients that already had received an ID card at a previous encounter, carried it with them when coming back for a new consultation, as is shown in the following table:

Table 3 - Usage of patient ID cards at the Kigali University Teaching Hospital

Total patients	1052	
New patients	319	30,32%
Known patients	733	69,68%
Known patients with ID card	694	94,68%
Known patients without ID card	39	5,32%

The multi-criteria search engine that was built into the HIS also provided a significant improvement compared to prevailing paper based patient identification practices. Although the majority of patients were retrieved using the unique record identifier (almost 59% of the searches), patient names (27,2%), national ID card number (8.6%), date of birth (4.1%) and family relationships (1.1%) also contributed to the improved identification accuracy.

Biometric identification instruments which were supported by the HIS have also been tested. Fingerprint registration and recognition was first introduced in CHUK by the end of 2007 using standard Microsoft Fingerprint Readers which costed less than 50 USD (Figure 5). After some trial and error testing with different fingerprint recognition thresholds, acceptable results could be obtained in a field study on 342 out-patients producing fingerprint refusal rates (FRR) of less than 1 false rejection in 342 and fingerprint acceptance rates (FAR) of less than 1 false acceptance in 300.000 (the last figure being provided by Griaule Biometrics [4] who supplied the fingerprint recognition libraries, because a false acceptance was never detected in the field tests)

Figure 5 - Fingerprint reader used at CHUK

Fingerprint recognition had initially been integrated with 2 purposes in mind: patient identification and user authentication. In the end, although the results where technically satisfying, neither of these processes have been put in production for a number of reasons:

- Patient acceptance of fingerprint enrollment appeared to be low and many patients worried about possible consequences of having their fingerprints stored in a government-owned hospital database (some of them explicitly asked if they had done something wrong).
- With many of the agricultural workers, fingerprint identification showed to be not successful due to multiple small skin lesions covering the fingertips.
- With young children, fingerprint recognition was only effective during a 6 to 12 months period after enrollment, fingerprint vectors having changed too much at later times.
- Many patients needed a lot of assistance during fingerprint enrollment making it a lengthy process causing longer waiting queues in front of the registration desks.
- Other identification methods (such as patient ID cards) had proven to be more effective and more efficient alternatives to fingerprint recognition.

It was concluded that HIS implementation had significantly improved PIE in the studied hospitals. Today, the developed identification metric continues to be used in 22 health facilities in Rwanda, Burundi and the Democratic Republic of the Congo.

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References

[1] Rwanda National ID Project. Available from: http://nid.gov.rw

[2] Loi portant organisation des elections presidentielles, legislatives, provinciales, urbaines, municipales et locales. République Démocratique du Congo; 2006. Available from: http://www.congonline.com/documents/Loi_Electorale_fevrier2006.pdf

[3] Lenson C. Building a successful enterprise master patient index: a case study. Top Health Inf Manage. 1998 Aug;19(1):66–71.

[4] Griaule Biometrics. Available from: http://www.griaulebiometrics.com/

[5] Verbeke F, De Pauw F, Tran Ngoc C, Karara G, Gasakure E, Nyssen M. Evaluating the relevance of disability weights for adjusting disease-cost and comorbidity calculations at the Kigali University Teaching Hospital. Studies in health technology and informatics. 2010;160(Pt 1):769–73.

[6] Hategekimana T, Tran Ngoc C, Porignon D, De Jonge M, Verbeke F, Van Bastelaere S. Monitoring of clinical activities and performances by using international classifications ICD-10 and ICPC-2. Three years experience of the Kigali University Teaching Hospital, Rwanda. electronic Journal of Health Informatics. 2010;5(1):e8.

[7] Umulisa L. La rationalisation des coûts basée sur la structuration électronique des données des prestations de soins dans un hôpital d'un pays en développement. Cas du Centre Hospitalier Universitaire de Kigali (CHUK). [Brussels]: Université Libre de Bruxelles; 2010.

[8] 1 year of OpenClinic experience at the Military Hospital of Kamenge. Bujumbura; 2012.

[9] Zere E, World Institute for Development Economics Research. Hospital efficiency in Sub-Saharan Africa. Helsinki: United Nations University, World Institute for Development Economics Research; 2000.

[10] OpenClinic GA. Available from: http://sourceforge.net/projects/open-clinic/

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