Open Source HMIS Enabled Evaluation of Financial Burden of Disease and Patient Coverage in Three University Hospitals in Great Lakes Africa

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Abstract

Since the eighties, case mix evaluation methods based on diagnosis-related groups (DRG) were gradually introduced in developed countries. These methods of assessing the costs of diseases to measure the productivity of the hospital have been introduced in management softwares that are not accessible to low-income countries. In this study, the authors applied these methods to an open source hospital management information system (HMIS) implemented in three university hospitals in Great Lakes Africa. A comparative study of the financial burden of five major diseases, monitored as part of a universal health coverage (UHC) analysis, was carried out. The level of coverage of patients in the hospitals was evaluated and the impact of UHC policies demonstrated. Although the financial protection of patients treated in the three hospitals had improved, HIV and tuberculosis treatments that ought to be free, remained a considerable financial burden for the patient.

Keywords

Diagnosis-Related Groups; Hospitals, University; Africa

Introduction

Knowing the financial burden of disease remains a challenge in sub-Saharan countries. In this study we focused on three countries in the Great Lakes region: Rwanda, Burundi and DRC. WHO and the WB [1] evaluated the coverage of the population for the treatment or prevention of tracer health services and Boema et al. [2] estimated coverage for five diseases as a metric for the UHC progress in countries. The evaluation mainly used household surveys from the Demographic and Health Survey (DHS). The indicators of health coverage focused on maternal and newborn care, the traitement of HIV infection, hypertension, tuberculosis (TB) and diabetes. Health coverage diminishes when household income is lower [3; 4]

Tuberculosis treatment was highly covered in Rwanda, Burundi and DRC (between 80 and 90%) thanks to the national TB programs. ARV therapy was accessible to 67%, 40% and 20% of population with advanced HIV infection in Rwanda, Burundi and DRC respectively. But values for diabetes coverage remained particularly low in the three countries (<10%). The evaluation focused on the general framework of health services accessibility and coverage, without zooming in on the individual patient's financial situation in health facilities. Questions such as "What is the patient's financial coverage for the treatment of these diseases monitored in the context of the UHC?", "What is the patient's ability to pay for the treatment?", "What role does health insurance play?" remained unanswered.

According to the DHS [5], UHC policies in the three countries in the Great Lakes region are very different. Rwanda opted for a community based health insurance (Mutuelle de santé) which covers more than 90% of the population. Burundi has strengthened its UHC policy with free healthcare for pregnant women and children under five years old, reaching coverage of 23-30% of the population. In the DRC, we observe a low level of population health coverage (2%). In DRC, patients nearly pay for the full costs of health services they consume.

Alternative methods, based on health facility data, have been developed with the same purpose of measuring financial burden of diseases and to promote better quality of care. These methods are at the basis of the case mix concept introduced in the USA around the 1980s [6] This concept is based on DRGs (Diagnosis Related Groups), and was developped by a team of researchers at the Yale University and consequently introduced in the MEDICARE prospective payment system [7]. The DRG is defined as the first "health management tool" to group patients in clinically meaningful categories with homogeneous resources consumption [6]. The DRG-based payment systems have been introduced in Europe in the mid-nineties [8]. The first evaluation of the use of the case mix tool in Africa is found in private health facilities in South Africa in the early 2000s [9] . These were pilot experiments introduced in 3M software which used the ICD-10 classification for diagnostics and CPT for medical procedures in service pricing. The challenge in sub-Saharan health facilities remained to find affordable tools that integrated these international standards, were easy to use and better adapted to the local context.

In 2009, we worked out a set of disease grouping codes in an attempt to enable efficient evaluation of clinical activity in a typical sub-Saharan health facility [10]. This classification was called the KHIRI Pathology Grouping Set (KPGS). KPGS is a bi-classified grouping system, based on ICD-10 and ICPC-2 classification standards. The KPGS classification aimed to be a simplified sub-Saharan implementation of DRG codes, addressing clinical conditions that better matched local sub-Saharan health management reality [11]. We introduced this classification in an open source hospital management information system (HMIS) called OpenClinic GA [10; 12]. OpenClinic GA-HMIS was developed by a research team of the Vrije Universiteit Brussel (VUB) and has been put in the public domain (https://sourceforge.net/projects/open-clinic/). The first implementation was at the university hospital of Kigali (CHUK), where the KHIRI (Kigali Health Informatics Research Institute) was established [13]. At a later stage, a data warehouse enabling fully automatic extraction of KPGS coded health indicators from OpenClinic GA hospital databases worldwide, named the Global Health Barometer (GHB, http://www.globalhealthbarometer.net), was added to the project.

This study attempts to use the KPGS classification to provide case mix evaluation extracted from OpenClinic GA databases for estimating the financial burden of diseases and the level of patient coverage provided by health insurance schemes.

Methods

The study was conducted during a 6-year period from 2010 to 2016 in three university hospitals of Rwanda, Burundi and DRC by collecting data through *the OpenClinic GA* software. Data related to patient identification, ADT (admission, discharge, transfer), patient- and insurance invoicing, diagnostics and other clinical medical records content.

The following hospitals participated in the study:

- The University Teaching Hospital of Kigali (CHUK) in Rwanda where the first implementations of OpenClinic GA started in 2007.
- The University Teaching Hospital of Kamenge (CHURK) in Burundi where the OpenClinic GA implementation started in 2014, and
- The Provincial General Reference Hospital of Bukavu (HPGRB) in DRC where the OpenClinic GA implementation started in 2011.

The process of *OpenClinic GA* implementation included the setup and configuration of the software, staff training, follow-up, quality control, monitoring and evaluation.

In each of the hospitals, we analysed and compared:

- The main disease groups encountered in the hospitals. Data were extracted from the GHB data warehouse. We focused on the five disease groups monitored within the framework of UHC: Maternal and new-born health, diabetes, hypertension, tuberculosis and HIV.
- 2. The financial burden was calculated in terms of care costs generated by each of the five disease groups and split up into patient out-of-pocket and health insurance payments. This information was directly extracted from the hospital OpenClinic GA databases. Disease cost factors have been furthermore identified using the CALCO method. This approach takes into account the amounts of health services consumed and, the disability and mortality weight factors of a disease group compared to associated pathologies (comorbidity) recorded during one and the same encounter [11] [14]. Care deliveries and medical procedures had been registered using local coding schemes. Diagnoses were coded using ICD-10 and ICPC-2 and have been mapped onto the KPGS classification.
- 3. Levels of patient coverage were derived from average amounts paid by patients and reimbursed by insurer schemes. We calculated the patient health service payment rate (PHSP) by dividing the patient out-of-pocket payment (POOP) by the total amount of health services consumed. The PHSP defines the level of the patient share in the health services consumed and should, in the light of UHC, not exceed 25% of the total cost of health services consumed. To avoid ruinous expenses for the patient, the POOP should also not exceed 25% of the GDP per capita in the country.

Results

Main KPGS-disease groups monitored

Table 1 shows the top 10 of disease groups registered in the three university hospitals during the year 2016. These disease groups represent respectively 58%, 66% and 59% of all cases at CHUK, CHURK and HPGRB. At CHUK in Rwanda, the first

in-patient disease group is related to the complications of pregnancy, childbirth and the puerperium (1679 cases). This disease group (KPGS code 15B) covered 13% of all cases in 2016 at CHUK and was also found in the top 10 of disease groups at CHURK (10th group, 2.1%) and HPGRB (3rd group, 8.1%). Genitourinary system diseases (KPGS code 140) constituted another disease group that found its way to the top 10 disease groups recorded in each of the three university teaching hospitals.

Malaria (KPGS code 1V) was the first disease group encountered at CHURK in Burundi. This pathology group did not appear in the top 10 pathologies group encountered either at CHUK or HPGRB.

Figure 1 presents the disease group overlap for the top 10 disease groups (KPGS codes) in the three hospitals.



Figure 1- Top 10 KPGS codes overlap in three university hospitals of Rwanda, Burundi and DRC (2016)

If we focus on the five disease groups monitored as indicators of UHC progress, we see that:

- 1. 15B (Other complications of the pregnancy, childbirth and the puerperium) is found in the top 10 of pathologies in the three hospitals.
- 04B (Diabetes mellitus) is encountered in the top 10 of diseases at CHUK of Rwanda and CHURK of Burundi.
- 3. 09C (Hypertensive diseases) is encountered in the top 10 of diseases at CHUK (Rwanda) and HPGRB (DRC).
- 4. 01B (Tuberculosis) is encountered in the top 10 of pathologies treated at CHURK in Burundi only.

HIV, the fifth treatment intervention monitored by the health coverage at global level was not among the top 10 disease groups in any of the three hospitals in 2016. In 2010, HIV still represented a morbidity rate of 4.5% (1594 in-patient cases, ranked at the third place) at CHUK in Rwanda.

Financial burden per pathology group

Table 2 shows the disease weight scores used from the CALCO method and the number of in-patient cases related to the five disease groups monitored in the framework of health coverage analysis during the period of study.

The data analysis period was different in the three hospitals. For each hospital, we only took into account the period during which financial information and diagnostics have been recorded in the *OpenClinic GA* system.

Figure 2 illustrates a graph of financial burden by disease group. It also shows a table of the POOP and the health insurance share in disease treatment costs. We have expressed the money values in the three countries in international dollars for the sake of consistency and comparability.

Top 10 of pathologies (CHUK)				Top 10 of pathologies (CHURK)			Top 10 of pathologies (HPGRB)				
		#				#				#	
Code	Pathology	Cases	%	Code	Pathology	Cases	%	Code	Pathology	Cases	%
15B	OTHER COMPLICATIONS OF THE PREGNANCY, CHILDBIRTH AND			01V	MALARIA	444	20.7%	140	DISEASES OF THE GENITOURINARY SYSTEM	499	16.3%
140	DISEASES OF THE	1679	13.1%	19A	CERTAIN	224	10.4%	10A	ACUTE UPPER	248	8.1%
140	GENITOURINARY SYSTEM	1515	11.8%		CONDITIONS			<u> </u>	OTHER COMPLICATIONS OF		<u> </u>
19A	FRACTURES	1429	11.1%	160	ORIGINATING IN				THE RECOMPLICATIONS OF		
160	CERTAIN CONDITIONS ORIGINATING IN THE PERINATAL	676	4.50		THE PERINATAL PERIOD	185	8.6%	15B	CHILDBIRTH AND THE PUERPERIUM	248	8.1%
	OTHER IN HERV, DOLSONING AND	5/5	4.5%		DISEASES OF THE				PERSONS ENCOUNTERING		
100	CERTAIN OTHER CONSECUENCES			140	GENITOURINARY	440	5 40/		HEALTH SERVICES IN		
130	OF EXTERNAL CAUSES	554	4.3%	<u> </u>	DIADETEO	110	5.1%	210	CIRCUMSTANCES RELATED	220	7.50
09C	HYPERTENSIVE DISEASES	512	4.00	04B	MELLITUS	105	4.9%		TO REPRODUCTION	230	/.5%
	PERSONS ENCOUNTERING	512	4.0%	10C	PNEUMONIA	82	3.8%	09C	HYPERTENSIVE DISEASES	147	4.8%
21A	HEALTH SERVICES FOR EXAMINATION AND		2.6%	11D	HERNIA	74	3.5%	12B	DERMATITIS AND ECZEMA	125	4.1%
	INVESTIGATION	335			INTESTINAL		0.070	01A	INTESTINAL INFECTIOUS	88	2.9%
	MALIGNANT NEOPLASMS, STATED			01A 01B	INFECTIOUS				DISEASES		2.070
02A	OF SPECIEIED SITES EXCEPT OF				DISEASES	74	3.5%		DISORDERS OF THE EARS		
	LYMPHOID. HAEMATOPOIETIC AND				TUBERCULOSIS	64	3.0%	80	AND PROCESSUS	84	2.7%
	RELATED TISSUE	308	2.4%	<u> </u>	OTHER		0.070	<u> </u>	MASTOIDEUS		
04B	DIABETES MELLITUS	302	2.4%		COMPLICATIONS OF			400	SYMPTOMS AND SIGNS		
	CONGENITAL MALFORMATIONS,	302	2.470	15B	THE PREGNANCY,			108	SYSTEM AND ABDOMEN	77	2.5%
170	CHROMOSOMAL ABNORMALITIES	264	2.1%		THE PUERPERIUM	44	2.1%	02F	BENIGN NEOPLASMS	76	2.5%
		7473	58.2%			1406	65.6%			1822	59.4%

Table 1- Top 10 of disease groups in three university hospitals of Rwanda, Burundi and DRC (2016)

Table 2- Number of in-patient cases and weight score in five disease groups at CHUK, CHURK and HPGRB during the period of study

Codo	Dathology group	Weight-	CHUK	CHURK	HGPRB
coue	Pathology group	Score	(2010-2016)	(2014-2016)	(2014-2016)
01B	Tuberculosis	271	1140	421	10
01M	HIV Disease	135	2618	112	15
04B	Diabetes Mellitus	175	6118	267	158
09C	Hypertensive Diseases	246	4332	35	460
15B	Other complications of pregnancy	50	13075	498	311





The financial burden for treating diabetes, tuberculosis and hypertension are the highest in CHURK. Treatment of HIV is most expensive in HPGRB (Intl\$394), three times the cost of CHUK (Intl\$123). In contrast, the treatment of "other

complications of pregnancy" is twice as high in the CHUK (Intl\$295) compared to the two other teaching hospitals. There is not much difference in the financial burden of tuberculosis treatment in the three university hospitals. The average treatment costs vary between Intl\$355 and Intl\$405.

The patient share (POOP) for tuberculosis treatment (Intl\$352) and HIV disease (Intl\$293) are the highest at HPGRB and represent respectively 95.8% and 74.5% of the total amount of treatment costs. POOPs for the treatment of diabetes (Intl\$ 251) and hypertension (Intl\$152) are the highest in CHURK and represent respectively 52.3% and 65.1% of the total financial burden for treatment. The POOP for "other pregnancy complications" (Intl\$68) is the highest at CHUK, while it is around zero at CHURK thanks to the free health care policy applied in Burundi for children under five years and pregnant women.

Health services coverage per disease group in the three hospitals

Figure 3 illustrates the average level of health service coverage for each disease group in the three university hospitals.

At CHUK, the financial health service coverage of the studied disease groups varies between 63.1% (for HIV) and 86.8% (for tuberculosis). In CHURK, this coverage is close to 100% for "other complications of pregnancy" and remains low (34.9%) for hypertensive diseases. Finally, in HPGRB, the treatment costs of tuberculosis seem to remain predominantly uncovered (only 4.2% coverage) for the patient, and also other groups of diseases have a low coverage rate (between 25.5% and 48.8%) compared to the two other sites.

Discussion

Our study of the financial burden of diseases showed that the situation of case mix in the three university hospitals in the Great Lakes region was not homogeneous both for disease costs and for patient coverage. For tuberculosis for example, the health coverage varied between 87% at CHUK and only 4% at HPGRB.

The patient's financial burden (PHSP) depends on the cost of the health services consumed on the one hand and the level of health coverage on the other hand. It varied between 37% (for HIV) and 13% (for tuberculosis) in CHUK, 65% (for hypertensive diseases) and 0% (for other complications of pregnancy) in CHURK. It was very high in HPGRB (between 96% for tuberculosis and 51% for other complications of pregnancy). Even if the patient share in the health service costs (PHSP) is low in CHUK, it still exceeds the 25%-threshold of health services consumed for the HIV treatment. HIV treatment is not well covered in the CHUK and HPGRB in spite of the free ARVs treatment. The PHSP remains above the 25%-threshold for all disease groups studied in HPGRB



Code	Pathology group	сник	CHURK	HPGRB
01B	Tuberculosis	86.8%	59.8%	4.2%
01M	HIV Disease	63.1%	77.5%	25.7%
04B	Diabetes Mellitus	82.1%	47.7%	38.5%
09C	Hypertensive Diseases	83.1%	34.9%	46.3%
15B	Other complications of pregnancy	77.0%	99.9%	48.8%

Figure 3- Health care coverage for five disease groups in CHUK, CHURK and HPGRB

and CHURK, expect for other complications of pregnancy where the PHSP was 0% in CHURK thanks to the policy of free healthcare for pregnant women. Patients may be pushed into poverty if they have to be treated for these diseases not well covered by health insurance schemes.

Treatment of tuberculosis and HIV is supposed to be "free" for the patient, thanks to the specific health programs set up in the countries to fight against these diseases. However, there always remain uncovered costs associated to these treatments. Our findings match the results of several studies that have also found sometimes high associated costs of health care for patients receiving 'free' HIV and tuberculosis treatment [15] [16; 17]. There are indirect costs related to transport, food and waiting time; direct costs due to the treatment of opportunistic infections, self-medication, extra medical exams and traditional healers' services. Chimbindi estimated annually expenditures to USD200 for patients suffering from tuberculosis and USD270 for HIV patients receiving public care in rural KwaZulu-Natal [15] while Laokri estimated tuberculosis associated costs to USD101 in six rural districts of Burkina Faso [16]. On our side, the average POOP associated to these two pathologies varied between USD20 and USD217 for tuberculosis treatment and between USD19 and USD182 for HIV treatment in the three university hospitals of the Great Lakes region. In the HPGRB in DRC, the POOP is more than 50% of the GDP per capita, which could financially ruin the treated patient.

POOPs are related to the treatment of the main disease plus comorbidities that increase the financial burden and add up their disability and mortality weight factors. We have not included the costs of external factors, such as transportation, unproductivity due to time-loss, treatment in the private sector... that may furthermore increase the POOP for the studied diseases.

Although we have noted the important role of health insurance in the coverage of health expenditures in Burundi and Rwanda, appropriate policies should further ensure the management of comorbidities of HIV and tuberculosis to reduce the financial burden for patients and reach total coverage for the two pathologies.

Conclusions

KPGS codes derived from ICD-10 and ICPC-2 classifications integrated into the HMIS software enabled comparison of financial burden and coverage of five disease groups in three university teaching hospitals (CHUK, CHURK and HPGRB) in Great Lakes Africa. Coverage for these diseases is used to monitor UHC progress in countries. The evaluation using case mix methods shows that the situation is quite different in the three hospitals, in terms of total financial burden of disease as well as financial patient coverage.

Our analysis method allowed to detect effects of the free health care policy for pregnant women applied in Burundi in covering pregnancy related problems and the role of CBHI in health services coverage in Rwanda. The method also enabled measuring the financial burden of comorbidity related to treatments for diseases such as HIV and tuberculosis. The same method could also be applied in other low-income countries through an implementation of adequate ICT infrastructure for health information management. Additional broader studies involving more health facilities are needed in order to further evaluate the role of health insurance in covering the financial burden of diseases.

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