Journal of Health Science 5 (2017) 215-226
doi: 10.17265/2328-7136/2017.05.001

ICT-Enabled Universal Health Coverage Monitoring and Evaluation in Sub-Saharan Health Facilities: Study in 8 Reference Hospitals of Rwanda, Burundi, the Democratic Republic of Congo and Mali

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Abstract: UHC (Universal Health Coverage) is at the center of the Sustainable Development Agenda. In this study, the authors made an evaluation of the indicators allowing quantification of the impact of health coverage schemes on patients, applied in 4 sub-Saharan Africa countries: Rwanda, Burundi, the DRC (Democratic Republic of Congo) and Mali. After an analysis of potential health coverage indicators, the most relevant ones were calculated on the basis of patient administrative and health insurance data, collected via OpenClinic GA, an HIMS (health information management system) used in 8 sub-Saharan hospitals during the period 2010-2016. The results show that the PHSC (patient health services coverage) rate is highest (81.5%-92.7%) in the 2 hospitals of Rwanda and in 2 hospitals of Burundi (37.7%-77.7%). The PHSP (patient health service payment) rate as the proportion of costs paid by the patient versus total health service costs is below the 25% threshold recommended by WHO only for the 2 hospitals in Rwanda. The POOP (patient out-of-pocket) payment is below the threshold of 180USD per patient per year for all hospitals. The HIEXs (health insurance expenditures) are funded by the university private insurance (86% of expenses covered) in 2 university teaching hospitals in DRC, by CBHI (community based health insurance) (69%) in 2 hospitals in Rwanda, by the free care policy (77%) in 2 hospitals in Burundi and by the SHI **(**social health insurance) (100%) in the 2 hospitals in Mali. PHSC in the 8 reference hospitals reflects the national trend towards UHC in each country. With this study, we demonstrate the possibility to assess the degree of UHC in developing countries, by a methodology based on indicators calculated via information extraction from routine data in electronic health records.

Key words: UHC, health insurance schemes, patient health coverage indicators, sub-Saharan reference hospitals.

1. Introduction

Since the 58th World Health Assembly resolution in May 2005, UHC (Universal Health Coverage) has become a major point of attention, gradually integrated into health policies of countries [1-3]. UHC means that all citizens receive the essential quality health services they need without being exposed to financial hardship [1, 2].

Sub-Saharan African countries are moving towards UHC through the establishment of health insurance systems with an aim to cover all citizens.

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Generally, three types of health insurance schemes are observed [4].

- National, public or SHI (social health insurance) based on individuals' mandatory enrolment. SHI schemes are initiated by the governments in the context of social security programs and funded through national NHIF (health insurance funds). These schemes are a privilege of the public agents in the formal public sector;
- CBHI (community-based health insurance) schemes, now available in many African countries, are initiated mostly by community leaders (village committee, churches, etc.) or corporate associations in the informal sector. These types of schemes cover a

large majority of the population and the informal economy. CBHI schemes are often put forward as health financing mechanisms that can specifically benefit the poor;

- PHIs (Private health insurances) are most often initiated by commercial health insurance companies in the formal sector. PHI schemes are voluntary insurance mechanisms.

These health insurance schemes can cover the patient's health expenditures by means of different insurance plans offered by the public health insurance programs of the country or by private insurance companies.

The UHC monitoring framework defined by WHO and the World Bank Group in 2013 highlighted two major components to assess [1]: effective health services coverage and financial protection coverage. Health services include prevention, promotion, treatment, rehabilitation and palliative care and these services must be sufficient to meet health needs, both in quantity and in quality. The need for financial risk protection is determined by the proportion of costs that individuals must themselves cover by making direct and immediate cash (out-of-pocket) payments [1, 5]. Under UHC, there would be no OOP (out-of-pocket) payments that exceed a given level of affordability. People in developing countries should not spend 25% or more of their total health expenditure or a maximum of 40% of 1.25USD per capita per day (i.e. 180USD per year) as OOP (set at zero for the poorest and most disadvantaged people) to avoid the impoverishment [6, 7].

Establishing monitoring indicators on UHC still remains a challenge. Basically, the primary information on UHC comes from household surveys and health facility data. For most indicators, effective household-based surveys are the preferred data source compared to health facility data obtained through the HIMSs (health information management systems). HIMS data present a number of weaknesses due to incomplete, inaccurate and delayed reporting especially in developing countries [8-10].

Several studies conclude that it is difficult to effectively monitor UHC without relying on ICT (Information and Communication Technology) [11-13]. ICT innovations in health or e-Health are key enablers for achieving and measuring UHC. The ICT revolution brings opportunities to sub-Saharan African countries in their efforts to strengthen the quality of HIMS data [12, 14].

Few studies analyzed the UHC in health facilities of developing countries using the indicators advocated by the WHO. This study attempts to prove that UHC can be adequately evaluated in sub-Saharan health facilities using ICT-enabled monitoring and evaluation methods, based on structured patient administrative and financial data. The study analyzed data from 8 national reference hospitals in 4 sub-Saharan Africa countries: Rwanda, Burundi, DRC (Democratic Republic of Congo) and Mali. Those hospitals are all equipped with a comprehensive technical and medical platform that provides the continuum of health services that people need. Those 8 hospitals joined several years ago a project named ICT4Development initiated by the authors at the VUB (Vrije Universiteit Brussel) to improve health information management using ICT methods. An open-source integrated hospital information management system, OpenClinic GA, was developed by the VUB for this purpose and put in the public domain [15]. The system covers management of administrative, financial, clinical, lab, x-ray, pharmacy data, and includes an extensive statistical and reporting module. OpenClinic GA was developed in Java connecting over JDBC to the most popular ANSI SQL 92 compliant database servers (such as MySQL and MS SQL Server) and offers an easy way to use web interface facilitating HIMS deployment in often challenging technological settings commonly found in developing countries [12, 15].

2. Materials and Methods

The study was conducted during the period

2010-2016. Initially, an analysis of the UHC situation in Rwanda, Burundi, DRC and Mali has been performed. We used health financial data from the 2015 World Health Statistics [16], the 2014 World Bank Report [17] and the national health statistics to frame health insurance schemes in a national picture of health protection financing. The second step concerned the analysis of patient information collected in OpenClinic GA related to a series of UHC indicators in the 8 hospitals of:

- Rwanda: the University Teaching Hospital of Kigali (CHUK) and the Neuro-Psychiatric Hospital Cares-Ndera (NPH-CN);
- Burundi: the University Teaching Hospital (CHURK) and the Military Hospital of Kamenge (HMK);
- DRC: the University Teaching Hospital of Lubumbashi (CUL) and the Provincial Reference Hospital of Bukavu (HPGRB). HPGRB is also a university teaching hospital.
- Mali: the African Institute of Tropical Ophthalmology (IOTA) and the Nianankoro Fomba Hospital of Segou (HNFS). IOTA is a university teaching hospital and the HNFS a provincial reference hospital.

Rwandan hospitals were amongst the first to integrate the ICT4Development project starting with the CHUK in 2007. It has become our main center for research and development of OpenClinic GA software. The NPH-CN joined the project in 2011. The hospitals HMK in Burundi and HPGRB in DRC followed in 2013. The other 4 hospitals have joined the project in 2014. We set up the OpenClinic GA software and configured the financial module by standardizing health insurance formats and health service components for all hospitals to facilitate the extraction of UHC indicators. We then collected and analysed UHC-related data from the 8 reference hospitals in the period between 1/1/2010 and 30/06/2016.

The most essential UHC indicators we used, were:

- The PHIC (patient health insurance coverage) by evaluating patient health insurance data and the use of health insurance schemes in hospitals;
- The PHSC (patient health service coverage) by evaluating patient's health services consumed and coverage of these services by health insurance schemes;
- The patient financial risk protection using data related to patient's health service payments and insurance health service reimbursements.

The PHIC is determined by the health insurance schemes that are most used by patients in the hospital. The more often a health insurance scheme is used by patients, the more this health insurance scheme participates in the UHC. We applied PHIC metrics to out-patient and in-patient encounters to deduce the proportion coverage in health insurance schemes. Five types of health insurance schemes were distinguished: (1) FREE (Free health services) where the patient did not pay anything, (2) SHI, (3) CBHI, (4) PHI and (5) PATIENT (No health insurance) where the patient paid the total of health service expenditures.

For the measurement of the PHSC, we identified two categories of patients: (1) insured patients for whom the OOP did not exceed 25% of the health services costs and (2) uninsured patients who covered 75% or more of the total consumed health services with OOP. The higher the percentage of insured patients, the more the hospital is involved in UHC. We separately calculated the same metric for out-patient and in-patient encounters.

The measurement of the patient financial risk protection was done by extracting from OpenClinic GA's hospital financial reports the amounts paid by patients and by insurers. Therefore, we evaluated: (1) the PHSP (patient health service payment) rate as the proportion of amounts paid by the patient for uncovered health services divided by total amounts of health services consumed; (2) the POOP (patient out-of-pocket) payment as average amount paid directly by the patient for health services not (fully) covered by the health insurance plan; (3) the evolution

of HIEX (health insurance expenditure) to estimate the burden of health insurance financing in the 8 hospitals. For the patient financial risk protection, we considered the PHSP not exceeding 25% of total health services consumption and the POOP not exceeding 40% of 1.25USD per day (i.e. 180USD per year). We separately calculated these metrics for out-patient and in-patients' encounters.

Comparative Chi² testing was applied to compare the coverage rate of different health insurance schemes within the hospital and between different hospitals. The correlation analyses were applied to compare the distribution of health insurance schemes for out- and in-patient encounters and the relation between insured and uninsured patient statuses. Regression tests were used to analyse health insurer expenditures per in- and out-patient over time. Finally, means of health insurance expenditures over the study period were analysed using the ANOVA test.

3. Results

3.1 UHC Situation in Studied Countries

Table 1 represents the official situation of UHC in health expenditure and health coverage in the 4 countries of our study: Rwanda, Burundi, DRC and Mali.

According to the report of the Rwandan Ministry of health (2012), the population health coverage surpassed 90% [18] through the public, community and private health insurance schemes.

The Demographic and Health Survey conducted in Burundi (2010) and in Mali (2012/2013) showed a health insurance coverage respectively of 22.5% and 4.6% [19, 20]. The health coverage in Burundi has increased substantially following the introduction in 2006 of a "Free Healthcare" policy for pregnant women and children under 5 years.

For the DRC, at the end of 2013, 54 health zones had initiated a CBHI scheme [21] but the nationwide enrolment remained at a very low level (2% of the population) [22].

In 2012, the total health expenditure per capita was highest in Rwanda (70USD) compared to other countries. The DRC (15USD) had the lowest public health expenditure per capita. Health expenditures are funded both by the public and the private revenues. Burundian and Rwandan governments funded their health expenditures respectively at 61.9% and 58.6%. The weakness of the Malian government in public health funding (only 38.1%) is offset by the private sector (61.9%) and essentially through the direct expenditure of households (99.6%).

Private health expenditure includes direct household (OOP) spending, private and CBHI, and charitable donations. As part of UHC national policy, the OOP health spending should not exceed 25% of total health expenditures. Mali and the DRC reach respectively 61.7% and 31.2%. The fact of relying on households for the financing of their health needs is responsible for the low health coverage seen in the DRC (< 2% of households with health insurance) and

Table 1 Health services expenditure and coverage.

Health expenditure*	Rwanda	Burundi	DRC	Mali
Total health expenditure per capita	70USD	21USD	15USD	42USD
Government health expenditure per capita	41USD	13USD	8USD	16USD
(as % of total expenditure on health)	(58.6%)	(61.9%)	(53.3%)	(38.1%)
Private health expenditure per capita	29USD	8USD	7USD	26USD
(as % of total expenditure on health)	(41.4%)	(38.1%)	(46.7%)	(61.9%)
OOP expenditure	13.22USD	4.39USD	4.68USD	25.90USD
(as % of private expenditure on health)	(45.6%)	(54.9%)	(66.9%)	(99.6%)
OOP expenditure as % of total expenditure on health	18.9%	20.9%	31.2%	61.7%
% population health coverage**	> 90%	23-30%	< 2%	< 10%

* WB and WHO statistics reports (2014-2015); ** National health statistics reports.

in Mali (< 10% of households with health insurance). Conversely, the more governments are involved in the financing of health, the higher is the coverage of the population for health services. This is demonstrated in Burundi (30%) and Rwanda (> 90%).

3.2 PHIC

In this part, we analysed more than 1.4 million electronic patient records created and updated in the course of our 6 years' study in the 8 national reference hospitals. The distribution of out- and in-patients and their encounters is shown in Table 2.

The database of the HMK in Burundi contained the highest absolute number of outpatients (41.8% of the total number of outpatient encounters in the study). The CHUK in Rwanda had the highest number of admissions (33.4% of the total number of admissions in the study).

For each out- and in-patient encounter, part of the health service costs is paid by the health insurer and the remainder by the patient, according to the patient's health services coverage plan.

Therefore, we analysed the health insurance schemes that have been used by patients for each encounter. For some encounters, patients may have used 1, 2 or more different health insurance schemes. The OpenClinic GA system was configured to apply, whenever possible, the health insurance scheme with the lowest patient contribution in case of availability of different eligible schemes. Fig. 1 shows the PHIC used for inpatient encounters in the 8 hospitals.

The direct contribution by the patient (PATIENT) to the health services payments was higher ($p < 0.001$) in the 4 hospitals of DRC (CUL, HPGRB) and Mali (IOTA, HNFS) than in the other hospitals. In those hospitals, patients had self-payment for health services in over 70% of inpatient encounters. At the IOTA hospital, the PATIENT scheme was even used in more than 80.3% of the inpatient encounters.

The SHI was the second most frequently used scheme by patients in the 8 reference hospitals. At HMK in Burundi, SHI schemes were used ($p < 0.0001$) in 45.9% of inpatient encounters. The most used SHI scheme in the hospital of Burundi was the MFP (Mutuelle de la Fonction publique). The SHI scheme was also important in Malian hospitals through the AMO (Assurance Maladie Obligatoire). In the 2 University teaching hospitals of DRC, the SHI was essentially constituted by the University health insurance covering staffs' and students' health services. In Rwandan hospitals, the SHI schemes include the RSSB (Rwanda Social Security Board) and the MMI (Military Medical Insurance) which cover all government employees.

CBHI schemes were most frequently used in Rwandan hospitals. CBHI schemes covered 54.1% and 37.2% of inpatient encounters respectively in CHUK and NHP-CN.

FREE schemes were often encountered in Burundian hospitals, especially at CHURK where they were seen in almost 31.9% of inpatient encounters.

Table 2 Distribution of patients and encounters.

Country	Hospital	Out-patients	In-patients	Out-patient encounters	In-patient encounters
Rwanda	CHUK	330,485	56,792	609,258	71,940
	NPH-CN	45,800	10,754	161,920	13,378
Burundi	CHURK	126,042	25,939	208,717	45,789
	HMK	586,905	48,487	734,260	48,581
DRC	CUL	33,714	2,928	50,401	3,025
	HPGRB	35,610	16,104	57,016	17,159
Mali	IOTA	101,249	8,124	153,857	8,516
	HNFS	143,340	935	173,396	981
Total		1,403,145	170,063	2,148,825	209,369

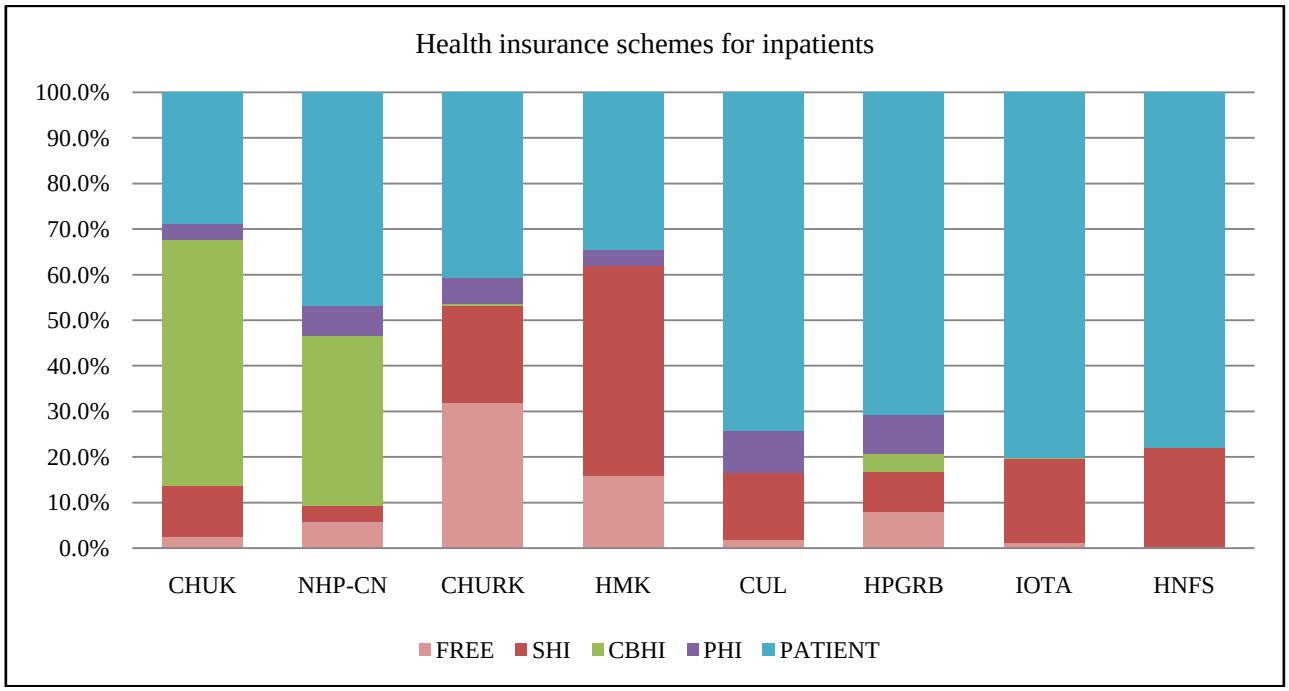

Fig. 1 Health insurance schemes for inpatient encounters.

Finally, PHI schemes were rarely used in all hospitals except for Malian hospitals. In DRC hospitals, the PHI schemes have been used in 9.2% and 8.5% of inpatient encounters at CUL and HPGRB respectively.

Out-patients' coverage schemes followed a similar distribution than in-patients' coverage schemes. A strong correlation between out- and in-patient coverage was observed at NHP-CN and IOTA (r > 0.99). This high correlation may be due to the specificity of patients treated in these two highly specialized hospitals.

3.3 PHSC

Table 3 shows the health services coverage situation for out- and in-patients during the study period.

Globally, the health services coverage rate was higher for in-patients (50.2%) than for out-patients (41.3%) but this difference was not statistically significant due to the opposite situation in the 2 university hospitals of DRC (CUL and HPGB) and the HMK in Burundi.

The variations observed for health services coverage between in-patients and out-patients were statistically significant (p < 0.0001). The 2 Rwandan hospitals showed a better coverage of health services for outpatients (> 81.0%) as well as for inpatients (> 88.0%). This high coverage demonstrates the role of health insurance schemes in this country where 90% of the population is supposed to be covered by at least one health insurance scheme. Health services coverage was also high for in-patients in the 2 Burundian hospitals (> 69.0%) and at the HMK for out-patients (77.7%).

We noticed high correlation in the proportion of insured (r = 0.89) and uninsured (r = 0.94) in- and out-patients in all hospitals.

Many insured inpatients benefited from the full health services coverage in the 2 Burundian hospitals (CHURK: 45.7% and HMK: 61.5% of the patients) financed by the public authority (pregnant women, children under 5 and public servants) and NGOs (prisoners and indigents).

The level of health services coverage for out-patients in Malian hospitals remained low: 3.3% in IOTA and 4.1% in HNFS. On the other hand, in-patients' health services coverage was significantly higher in the 2 hospitals of Mali (IOTA: +16.7%

and HNFS: +32.8%). This difference between out- and

Table 3 Out- and in-patient health services coverage.

Country	Hospital	Outpatient		Inpatient		Statistical significance*
		Insured* (POOP ≤ 25%)	Un-insured* (POOP ≥ 75%)	Insured (POOP ≤ 25%) (difference)	Un-insured (POOP ≥ 75%) (difference)	
Rwanda	CHUK	81.5%	14.8%	88.0% (+6.5%)	7.0% (-7.8%)	$P < 0.001$
	NPH-CN	92.0%	5.0%	92.7% (+0.6%)	3.7% (-1.3%)	$P < 0.001$
Burundi	CHURK	37.7%	43.0%	70.1% (+32.4%)	20.2% (-22.8%)	$P < 0.001$
	HMK	77.7%	17.0%	69.2% (-8.5%)	23.6% (+6.6%)	$P < 0.001$
DRC	CUL	9.4%	88.7%	6.5% (-2.9%)	92.4% (+3.6%)	$P < 0.001$
	HPGRB	24.4%	71.6%	17.9% (-6.4%)	75.5% (+3.9%)	$P < 0.001$
Mali	IOTA	3.3%	81.9%	20.0% (+16.7%)	79.0% (-2.9%)	$P < 0.001$
	HNFS	4.1%	81.4%	36.9% (+32.8%)	61.2% (-20.3%)	$P < 0.001$
Mean		41.3%	50.4%	50.2% (+9.2%)	45.3% (-5.1%)	$P < 0.001$
Correlation analysis**				$r = 0.89$	$r = 0.94$	

* Proportion comparison Chi² test comparing health services coverage between in- and outpatients for each hospital;
** Pearson correlation coefficient between distribution of health services coverage of in- and outpatients for all hospitals.

in-patient coverage was mainly due to the important role of the AMO in the health services coverage for inpatients.

3.4 PHSP Rate

Fig. 2 presents the patient health services payment rate (PHSP) in the 8 hospitals for in- and out-patients during the period of study.

The first indicator to evaluate the patient's financial risk protection in the hospital is the proportion of amounts paid by the patient for uncovered health services divided by total amounts of health services consumed. This proportion should not exceed 25%.

PHSP indicators were above 25% for in- and out-patients in all studied hospitals except in Rwanda. In hospitals of Mali and DRC, the PHSPs were above 50% and up to 96.3% for in-patients in the CUL hospital.

This finding at CUL was coherent with the fact that only 6.5% of the in-patients were insured. Similarly, the 2 hospitals of Mali (IOTA and HNFS) showed an out-patient PHSP rate of more than 80%. Indeed, in these hospitals, insured out-patients only represented between 3.3% and 4.1% of the total number of admitted patients.

3.5 POOP

The second indicator concerning the financial risk protection for patients in the 8 hospitals is the POOP. The POOP averages for inpatients in the 8 hospitals are represented in Fig. 3.

The global average of out-patient OOP was 14.01USD (7.23USD-29.27USD) and 86.14USD (12.00USD-149.65USD) for in-patient OOP. The POOP was higher for inpatients ($p = 0.002$).

The POOP for out-patients was highest in the 2 university teaching hospitals of DRC (> 24USD) and lowest in the 2 hospitals of Mali (< 10USD). The DRC hospitals had also the highest in-patient OOP (around 150USD) and HNFS of Mali the lowest (12USD). The POOP depends on health services costs and health services coverage. The hospitals studied in DRC combine high health services costs and low coverage of these services.

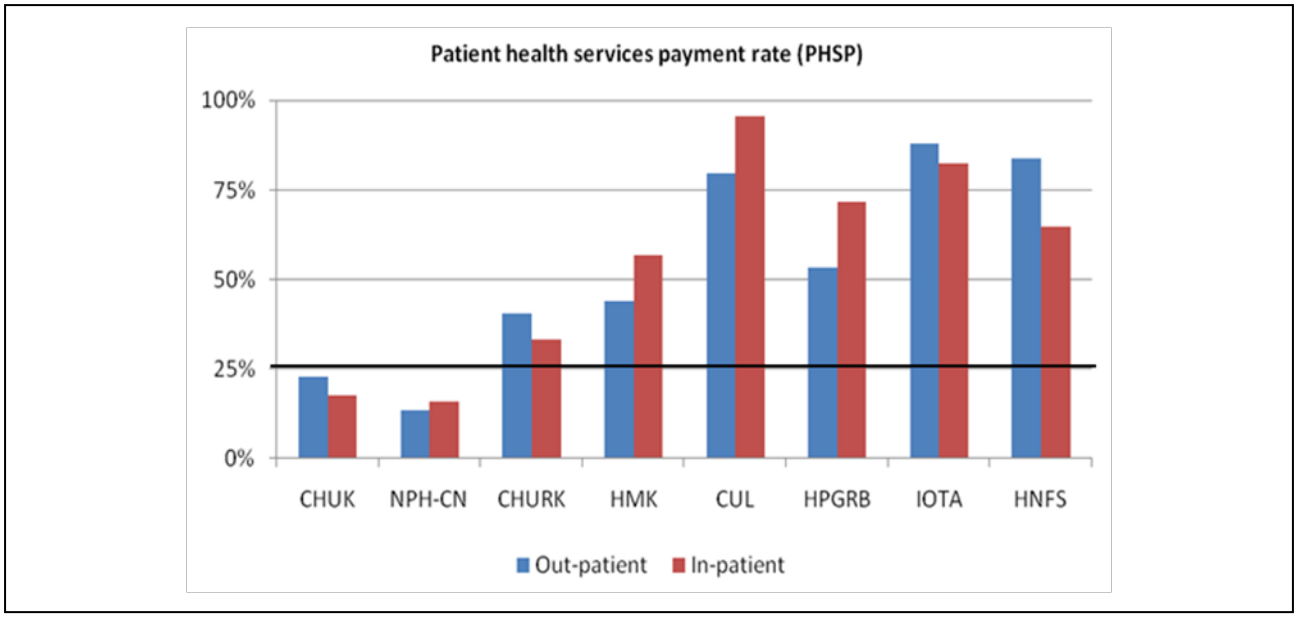

Fig. 2 PHSP during the period of study.

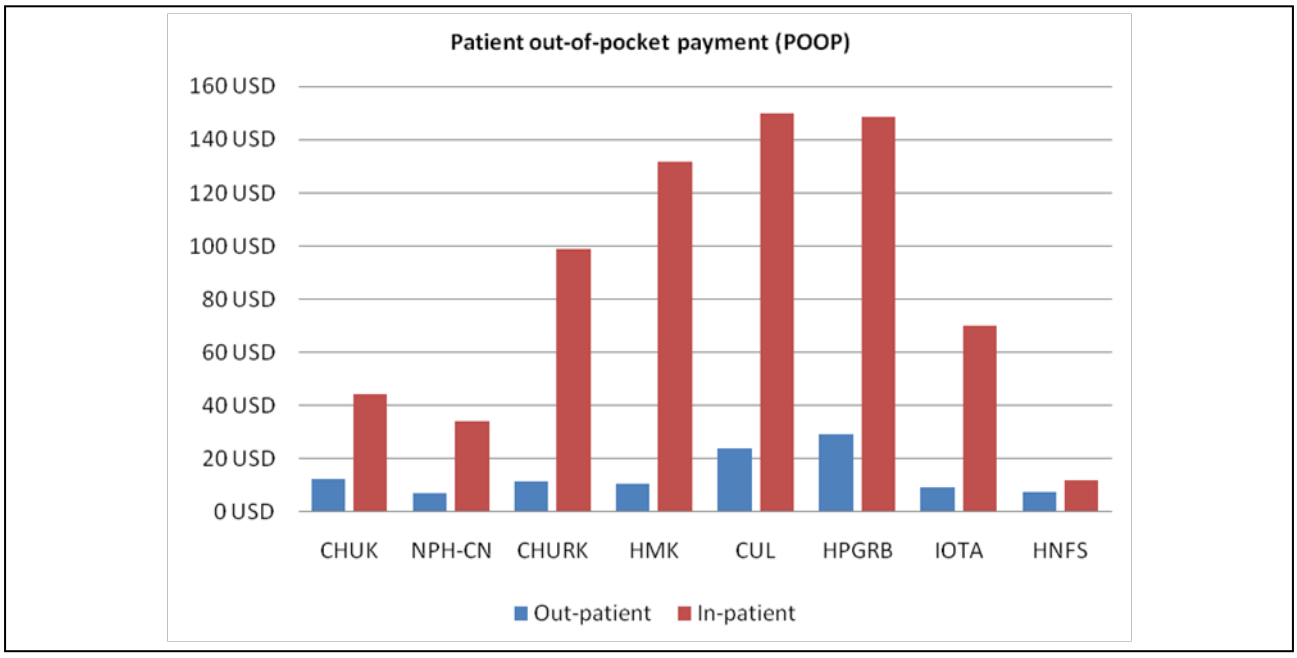

Fig. 3 POOP during the period of study.

3.6 Evolution of Average HIEX per Patient

Table 4 presents the HIEX during the first 4 years of health services coverage monitoring.

After a year of implementation, we observed a statistically significant (p = 0.048) difference between the averages of HIEX of in-patients and out-patients. The in-patient HIEX was significantly higher than out-patient HIEX (+137% in average) in all hospitals, except for HNFS in Mali where it was erroneously low because almost all patients had been managed as out-patients in the system. HIEX per out- and in-patients was highest at HPGRB (126USD, 310USD) of DRC due to the higher costs of health services in this hospital.

We noticed an important difference between in-patient

Table 4 HIEX per patient Y1 (base) of implementation.

Country	Hospital	HIEX per outpatient	HIEX per inpatient	Difference
Rwanda	CHUK	56.82USD	191.23USD	+ 237%
	NPH-CN	82.55USD	104.28USD	+ 26%
Burundi	CHURK	63.19USD	178.08USD	+ 182%
	HMK	9.47USD	62.41USD	+ 559%
DRC	CUL	46.63USD	113.92USD	+ 144%
	HPGRB	125.99USD	309.63USD	+ 146%
Mali	IOTA	34.09USD	73.46USD	+ 115%
	HNFS	24.72USD	17.67USD	- 29%
Mean		55.43USD	131.33USD	+ 137%
Statistical significance*				$p = 0.0483$

* Single factor ANOVA test between averages of health insurance expenditures per out- and in-patient.

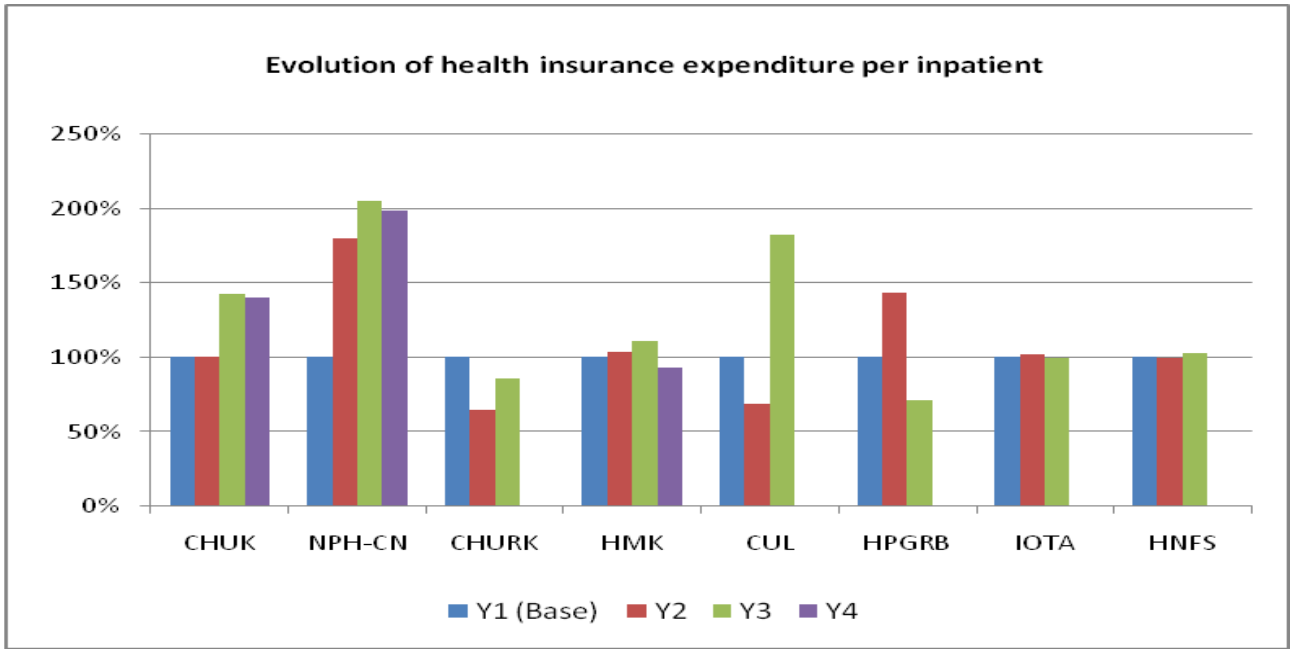

Fig. 4 Evolution of HIEX per inpatient during the period of study.

and out-patient HIEX at HMK (559% higher for in-patients) and CHUK (237% higher for in-patients). The difference at HMK was mainly explained by the highest costs of drugs, laboratory tests and consumables for orthopaedics and surgery. In CHUK, medical procedures, drugs and consumables were the most expensive in-patient health services.

The HIEXs for inpatients were reimbursed to a large extent (85.4%-86.3%) by university and private company insurances to HPGRB (265USD) and to CUL (98USD). In Rwandan hospitals, 81% (84USD) and 57% (109USD) of HIEX for inpatients were reimbursed by CBHI at NHP-CN and CHUK respectively. In Burundian hospitals, 89% (56USD) and 65% (116USD) of inpatient HIEX were funded by the Free healthcare policy (Government) to HMK and CHURK respectively. In Malian hospitals, the total amount of HIEX per in-patient was directly paid by the SHI essentially the AMO.

The evolution of HIEX during the first 4 years of health services coverage monitoring for each hospital is shown in Fig. 4. The first year was the baseline (100%) of comparison, and the HIEX per inpatient for each year was compared to the first year.

We did not observe any statistically significant change of health insurance expenses per inpatient and per outpatient during the 4 monitored years, although we observed an increase of HIEX per in-patient in certain hospitals (CHUK, NPH-CN, CUL and HPGRB). At CHUK and CHURK, we found a statistically significant correlation between averages of HIEX per in-patient and out-patient of $r = 0.96$ ($p = 0.034$) and $r = 0.99$ ($p = 0.021$) respectively, during the first 4-monitoring years. This high correlation was due to the stability of funding by the large health insurance schemes such as CBHI and Free healthcare respectively at CHUK and CHURK and stability in evolution of insured outpatients and inpatients during the period of study. In other hospitals the trend of HIEX during the study period did not follow the same evolution for in-patients and out-patients.

4. Discussion

This study focused on the health coverage monitoring by using HIMS data collected and analysed using ICT methods implemented in 8 reference hospitals in Rwanda, Burundi, DRC and Mali. The results showed that PHSC was highest in the 2 Rwandan hospitals (81.5%-92.7%) followed by the 2 Burundian hospitals (37.7%-77.7%). This high level of PHSC has been greatly facilitated by the intervention of health insurance schemes oriented towards FREE and SHI schemes in Burundi, CBHI and SHI schemes in Rwanda. The PHSC in hospitals of DRC (6.5%-24%) and Mali (3.3%-36.9%) was significantly lower. The important role of “mutuelles de santé” (CBHI) and SHI schemes (RSSB and MMI) in health coverage was also demonstrated by a previous study conducted in 6 public and private hospitals of Rwanda [23].

The results found in the studied hospitals are more or less in accordance with the reality at national level where the population health coverage is higher in Rwanda (> 90%) and Burundi (23%-30%) than in Mali (< 10%) and DRC (< 2%).

For the patient financial risk protection, we found that only the PHSP rate in Rwandan hospitals remained under the 25% threshold recommended by WHO. This result fits with national level data also demonstrating that only Rwanda had an OOP expenditure of less than 20%.

Bearing in mind that the hospitals studied were at the third referral level, the POOP payment was expectedly higher than the national average. Although POOP was below the threshold of 180USD per patient per year in all hospitals, it remained high for DRC hospitals (around 150USD). The patient still consumes other health services outside the hospital and therefore in certain cases the patient’s impoverishment threshold could be quickly reached.

Looking at health cost financing in each country, the HIEXs are supported by different health insurance schemes [4, 24, 25]. In the monitored hospitals, the intervention of health insurance was oriented to PHI schemes in DRC, CBHI schemes in Rwanda, FREE scheme in Burundi and to SHI scheme in Mali with average proportions respectively of 86% (182USD), 69% (97USD), 77% (86USD) and 100% (46USD) for in-patient costs. The trend of health insurance schemes financing for out-patients was the same, but with on average 57.8% less costs than for in-patients.

5. Conclusions

The implementation of an ICT-HIMS has enabled the monitoring and evaluation of UHC in 8 reference hospitals in 4 sub-Saharan countries. The used methods allowed extraction of routinely collected patient data for secondary use in this health insurance coverage study. The study showed that DRC and Mali hospitals have a level of PHSC lower than hospitals in Rwanda and Burundi, where the patient was covered by more solidarity-based health insurance schemes. This study also showed that more efforts are needed to achieve good patient financial risk protection in hospitals. Only the 2 hospitals in Rwanda had reached the indicators recommended by WHO thanks to the

high reimbursement rates of CBHI schemes.

This study also managed to estimate average costs of HIEX per patient in the studied hospitals. Additional broader studies involving more health facilities are needed in order to draw further conclusions on the role of health insurance schemes in UHC in sub-Saharan health facilities.

With our study, we mainly demonstrated the feasibility of assessing the level of UHC in sub-Saharan health facilities using ICT-HIMS routine patient data. Consistent application of the same method over time will enable us to evaluate evolutions in health coverage, based on objective data, recorded by the health facilities themselves. Although we targeted reference hospitals, the same methods could also be applied to other health facilities through implementation of an adequate ICT infrastructure for health information management.

6. Statement on Conflicts of Interest

None.

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