MEDINFO 2017: Precision Healthcare through Informatics
A.V. Gundlapalli et al. (Eds.)

doi:10.3233/978-1-61499-830-3-738

OpenClinic GA Open Source Hospital Information System Enabled Universal Health Coverage Monitoring and Evaluation in Burundian Hospitals

Gustave Karara[a, b], Frank Verbeke[a, b], Evelyne Ndabaniwe[b], Etienne Mugisho[c], Marc Nyssen[a]

[a] Department of Public Health, Biostatistics and Medical Informatics, Vrije Universiteit Brussel, Brussels, Belgium
[b] Burundi Health Informatics Association, Bujumbura, Burundi
[c] Belgium Technical Cooperation, Bujumbura, Burundi

Abstract

The Universal Health Coverage (UHC) is at the center of the 2030 Sustainable Development Goals agenda. In this study, the authors made an evaluation of the patient health coverage indicators in eight Burundian hospitals from 2011 to 2016. The relevant UHC indicators were calculated on the basis of patient administrative and health insurance data, collected via OpenClinic GA, an information and communication techiniolgy (ICT) supported helath management informaiton system (HMIS). The results show that the patient health services coverage rate was 70.8% for inpatients and 46.0% for outpatients. The patient health services payment rate as the proportion of total health service costs was above the 25% threshold recommended by WHO for inpatients (30.2%) and for outpatients (43.1%). The patient out-of-pocket payment was below the threshold of 180USD per patient per year for public hospitals. This study demonstrated the possibility to assess the degree of UHC in developing countries, by using routine data extracted automatically from the electronic HMIS.

Keywords

Universal Coverage; Insurance, Health; Health Expenditure; Developing Countries

Introduction

The Universal Health Coverage (UHC) has become at the center of 2015-2030 Agenda for Sustainable Development Goals (SDGs) and has gradually integrated into health policies of countries [1-6]. Under UHC framework, there would be no patient out-of-pocket payment (POOP) that exceeds a given level of affordability for the patient financial risk protection. According to WHO, people in developing countries should not spend in average of 25% or more of their total health expenditure and a maximum of 40% of 1.25USD per capita per day (i.e. 180USD per year) as POOP (set at zero for the poorest and most disadvantaged people) to avoid the impoverishment [7, 8, 21].

Some sub-Saharan Africa countries have made remarkable efforts to move towards UHC. In Ghana, a tax-funded national health insurance system covers 95% of diseases that affect Ghanaians, enabling financial protection and expanding coverage [6]. By implementing ambitious reforms that started in 2000, with the goal of UHC, Rwanda currently sustains one of the most elaborate health insurance schemes: the Community Based Health Insurance Scheme (CBHI), which covers over 90% of the population [9].

The Burundian government's effort to spread a scheme similar to CBHI preceded the Rwandan state-driven approach by a decade and a half, but was far less successful [10]. Currently, small CBHI plans cover less than 1% of the population specifically among local associations (farmers, bicycle drivers, etc.). Four types of health insurance plans are currently observed in Burundi:

- CAM insurance plan (*Carte d'Assurance Maladie*). This is a national program, with revenue collection and management at the community level similar to CBHI. According to the Ministry of Health, in 2014, 23% of the population had adhered to the CAM.
- MFP (*Mutuelle de Fonction Publique*) insurance plan provides health insurance for public employees. This public insurance plan covers 3% of the population [43].
- Private health insurance plans initiated by commercial health insurance companies in the formal sector. The classic private insurance plans (*ASCOMA, JUBILEE, SOCABU and SONAVIE*) cover almost 2% of population.
- Free health services insurance plan initiated by the Government for all children under 5 years and pregnant women.

According to the "Demographic and Health Survey" conducted in Burundi in 2010, 22.5% of the population reported to have at least one health insurance coverage scheme [11]. The health coverage in Burundi has increased (23-30%) substantially following the integration of "Free healthcare" policy for pregnant women and children under 5 years in 2006. The World Bank and WHO statistics (2014-2015) reported in Burundi a POOP of 4.39USD per year representing 20.9% of total expenditure on health [21, 22].

Monitoring health coverage indicators on UHC remains a challenge because the primary information of UHC comes from household surveys and health facility data but not health services data. Although most countries have functioning health facility-based health management information systems (HMIS), the HMIS data continue having a number of weaknesses, including incompleteness, inaccuracy and untimeliness, and therefore are not often used [12-14]. Appropriate application of Information and Communication Technology (ICT) can improve data quality by the computerization of the HMIS data [15, 16].

The introduction of open source ICT solutions for hospital management in several sub-Saharan health facilities prove that sub-Saharan countries move towards ICT development in health facilities [16, 17]. *OpenClinic GA* implementations are recorded in several health facilities over the world, and

monitored in more than fifty health facilities both public and private in sub-Saharan Africa [16, 18, 20]. *OpenClinic GA* is an open source integrated hospital information system developed by the project *ICT4Development* of *Vrije Universiteit Brussel* (VUB) and put in the public domain [19, 20]. The system covers management of administrative, financial and clinical patient records; lab, x-ray, and 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 MS SQL and MySQL Server). It offers an easy to use web interface facilitating HMIS deployment in often challenging technological settings commonly found in developing countries [16, 19].

This study attempts to show that UHC has been adequately evaluated in Burundian health facilities using *OpenClinic GA*-HMIS based on structured patient administrative and financial data (patient identification, type of encounter, insurance information, health services invoicing, etc.). The study analyzed data from eight hospitals among which district and national reference hospitals. Those hospitals joined the *OpenClinic GA* implementation projects since 2011. Most of them have been funded by the PAISS program (*Programme d'appui institutionnel au secteur de la santé*) of the Belgium Cooperation to start their ICT development [25].

Methods

The study was conducted during a 5-year period from 2011 to 2016. The process of *OpenClinic GA* implementation was applied and included (1) project management team set up, (2) *OpenClinic GA* software installation and configuration including security of the system, (3) users training and follow up; and (4) quality control, monitoring and evaluation. The implementation period was followed by a period of maintenance and assistance according to the needs of the hospital. The hospitals included in this study were:

- Four National reference hospitals (NRH): Military hospital of Kamenge (HMK, 2012), University teaching hospital of Kamenge (CHURK, 2014), Prince Louis Rwagasore clinic (CPLR, 2013) and Prince Regent Charles hospital (HPRC, 2015)
- Three District hospitals (DH): Ngozi regional hospital (NGORH), Muramvya (MUDH) and Kirundo (KIDH) district hospitals, all started implementation in 2015.
- One Private hospital (PH): Centre medico-chirurgical of Kinindo (CMCK, 2011)

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 analyzed UHC-related data from the 8 hospitals in the period between 1/1/2013 and 30/06/2016.

The analysis of the collected patient information was performed in the *OpenClinic GA* statistics module. The pertinent indicators on UHC were centralized on the *Global Health Barometer* (GHB), a data warehouse installed on our servers at the VUB [20].

The most essential UHC indicators were:

- The patient health insurance coverage (PHIC) by evaluating patient health insurance data and the use of health insurance schemes in hospitals. We distinguished five types of health insurance schemes: (1) Free health services (FREE) where the patient did not pay anything, (2) Social health insurance (SHI) represented by the MFP plan, (3) Community based health insurance (CBHI) including the CAM plan, (4) Private health insurance (PHI), and (5) No health insurance (PATIENT) where the patient paid the total of his health service expenditures.
- The patient health services coverage (PHSC) by evaluating patient's health services consumed and coverage of these services by health insurance schemes. We identified two categories of patients: (1) Insured patients for whom the POOP 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 POOP.
- The patient health services payments rate (PHSP) as the proportion of amounts paid by the patient for uncovered health services divided by total amounts of health services consumed.
- The patient out-of-pocket payment (POOP) as average amount paid directly by the patient for health services not (fully) covered by the health insurance scheme.

We separately calculated these metrics for out-patient and in-patient encounters. Comparative Chi Square 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 examine the relationship between insured and uninsured patient statuses. Finally, the UHC indicators' means were compared using the ANOVA test.

Results

Patient health insurance coverage (PHIC)

We analyzed more than 1.1 million electronic patient records in the course of our 4 years' study. The distribution of out and in-patients and their encounters is shown in table 1.

Table 1: Distribution of patients and encounters

Hospitals		Out-patients	In-patients	Out-patient encounters	In-patient encounters
NRH	HMK	586 905	48 487	734 260	48 581
	CPLR	113 146	18 043	215 196	19 139
	CHURK	126 042	25 939	208 717	45 789
	HPRC	50 395	12 287	77 969	77 969
DH	NGORH	27 454	13 452	51 471	18 700
	MUDH	10 164	2 691	14 311	3 095
	KIDH	9 778	5 469	16 197	6 053
PH	CMCK	82 228	2 619	90 807	2 619
Total		**1 006 112**	**128 987**	**1 408 928**	**221 945**

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. We analyzed the health insurance schemes that have been used by patients for each encounter. Figures 1 shows the health insurance schemes coverage used for outpatient encounters in the eight hospitals.

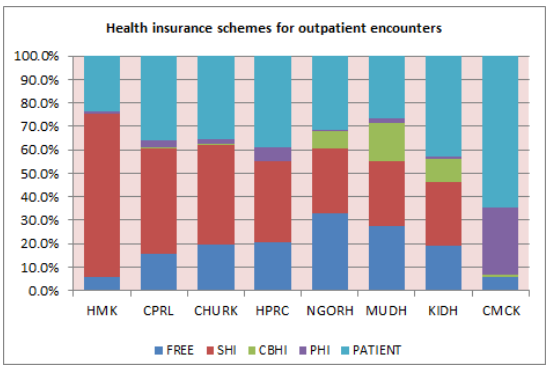

Figure 1 – Health insurance schemes for outpatient encounters

Free health services (FREE) and social health insurance (SHI) were the most frequently used schemes by outpatients. In district hospitals, FREE scheme was more frequently used ($p<0.0001$) in 18.9% to 32.7% outpatient encounters. The SHI scheme was more frequently (34.3%-69.1%) used ($p<0.0001$) in reference hospitals and especially in HMK (69.1%). The Community based health insurance (CBHI) scheme was mainly encountered (7.5%-16.1%) in district hospitals. This scheme was almost non-existent in other hospitals. The PATIENT scheme use was highest (64.8%) at the CMCK, the private hospital. In this hospital, private health insurance (PHI) plans were also mostly applied (28.4%) to outpatient encounters. For inpatient encounters, health insurance coverage schemes followed the similar distribution.

Patient health services coverage (PHSC)

Table 2 shows the health services coverage situation for out- and in-patients in the 8 hospitals during the study period.

Table 2 – Out- and In-patient health services coverage

Hospitals	Outpatient		Inpatient		Statistical significance *(Chi² test)*
	Insured *(POOP <=25%)*	Un-insured *(POOP >=75%)*	Insured (difference)	Un-insured (difference)	
HMK	77.7%	17.0%	69.2% (-8.5%)	23.6% (+6.6%)	P<0.001
CPRL	39.7%	39.9%	76.2% (+36.5%)	18.3% (-21.6%)	P<0.001
CHURK	37.7%	43.0%	70.1% (+32.4%)	20.2% (-22.8%)	P<0.001
HPRC	39.7%	47.0%	73.5% (+33.8%)	18.2% (-28.7%)	P<0.001
NGORH	54.7%	34.8%	69.5% (+14.7%)	19.9% (-14.9%)	P<0.001
MUDH	60.7%	22.0%	86.5% (+25.8%)	10.7% (-11.3%)	P<0.001
KIDH	29.6%	48.4%	77.5% (+47.9%)	13.2% (-35.2%)	P<0.001
CMCK	28.2%	70.3%	43.8% (+15.7%)	54.1% (-16.2%)	P<0.001
Mean	**46.0%**	**40.3%**	**70.8% (+24.8%)**	**22.3% (-18.0%)**	P<0.001
Statistical significance *(ANOVA test)*			**p=0.005**	**p=0.032**	

The proportion of inpatients insured was higher (+24.8%) than that for outpatients and this difference was statistical significant ($p=0.005$). The difference observed on the PHSC in each hospital between in- and out-patients were statistically significant ($p<0.001$). The overall picture of the PHSC in Burundian hospitals was that inpatients (70.8%) were covered better for health services than outpatients (46.0%).

Patient health services payment rate (PHSP)

The PHSP in the eight hospitals is represented in Table 3.

Table 3 - Out- and In-patient health services payment rate

Hospitals		Out-patients	In-patients	Difference
NRH	**CHURK**	40.5%	33.2%	-7.3%
	HPRC	41.2%	29.5%	-11.7%
	CPLR	46.3%	11.5%	-34.8%
	HMK	48.1%	56.7%	8.6%
DH	**MUDH**	25.2%	13.2%	-12.0%
	NGODH	36.8%	29.5%	-7.3%
	KIDH	47.4%	20.9%	-26.5%
PH	**CMCK**	59.3%	47.4%	-11.9%
Mean		**43.1%**	**30.2%**	**-12.9%**
Statistical significance *(ANOVA test)*				**NS**

The highest PHSP was found in the private hospital CMCK (59.3%) for outpatients and in the military hospital HMK (56.7%) for inpatients due to the high costs of health services in these hospitals that offer a high quality of healthcare compared to other hospitals in the country. The PHSP was normally lower in district hospitals (27.5%) than in national reference hospitals (35.4%). Averages of PHSP for outpatients (43.1%) and inpatients (30.1%) were above the threshold of 25% of the total amount of health services consumed by patients recommended by WHO.

Patient out-of-pocket payment (POOP)

The POOP in Burundian hospitals is shown in table 4.

Table 4 – Out and In-patient out-of-pocket payment

Hospitals		Out-patients	In-patients	Difference
NRH	**CHURK**	11.54 USD	98.98 USD	+758%
	HPRC	10.47 USD	93.68 USD	+795%
	CPLR	9.39 USD	40.51 USD	+332%
	HMK	10.84 USD	131.50 USD	+1113%
DH	**MUDH**	3.12 USD	2.10 USD	-33%
	NGODH	6.58 USD	24.71 USD	+276%
	KIDH	5.67 USD	12.22 USD	+115%
PH	**CMCK**	13.52 USD	393.42 USD	+2809%
Mean		**8.89 USD**	**99.64 USD**	**+1021%**
Statistical significance *(ANOVA test)*				**p=0.064**

The POOP's were higher in the private hospital CMCK and in the three national reference hospitals (HMK, CHURK and HPRC) than in district hospitals. They exceeded 90USD for inpatients in the first hospitals where health service tariffs applied were highest. Although the tariff of health services was almost the same in district hospitals of Burundi, the POOP was different in the 3 studied hospitals following to the level of health services coverage. The POOP average for inpatients (99.64USD) was significantly higher than the outpatient POOP (8.89USD). The largest differences of POOP between in- and outpatients were observed at CMCK and HMK. As seen above, the two hospitals offer health services that are expensive because of their (private) status and the quality of services they provide to the patient. The inpatient POOP's for the two hospitals were the highest and exceeded the threshold of 180USD for inpatients at CMCK.

Discussion

This study focused on the health services coverage monitoring by collecting and analysing data using *OpenClinic GA*-HMIS implemented in eight Burundian hospitals. The results showed that patient health services coverage (PHSC) was globally

70.8% for inpatients and 46.0% for outpatients. It was higher in the public hospitals compared to the private hospitals due to the important intervention of health insurance coverage plans oriented towards FREE (6.0%-55.6%) and SHI (5.8%-69.1%) schemes. We noted the intervention of CBHI (7.5%-26.0%) schemes in district hospitals especially for outpatient encounters. The CBHI scheme was predominantly based on the use of the CAM insurance plan. The results of health coverage found in the studied hospitals are higher than those in the reality at national level where the population health coverage is between 23-30%. The group of patients in the population is apparently better assured than the general population. This likely resulted from the adverse selection observed in certain health insurance contexts [23, 24] causing high costs for health insurance. Bearing in mind that the hospitals studied were at the second and third reference level, the PHSP remained globally above the 25%-threshold both for inpatients (30.2%) and for outpatients (43.1%) due to health services not covered by certain health insurance plans at those levels. This situation has been also observed in Rwanda [18, 24]. The POOP was also higher in these hospitals (8.89-99.64USD) than the national average (4.39USD) as could be expected. Although POOP was below the threshold of 180USD per year in all hospitals, it remained high for inpatients in private hospitals due to the high costs of health services in those health facilities. An effort is still needed for Burundian health insurance schemes to reach the patient financial risk protection in the framework of UHC.

Conclusions

In this study, we have demonstrated the feasibility of evaluating the UHC level in developing countries using ICT-HMIS routine patient data recorded by the health facilities themselves. Specifically, the implementation of an ICT-HMIS has enabled the monitoring and evaluation of UHC in eight hospitals of Burundi. The methods used allowed extraction of routinely collected patient data for secondary use in this health insurance coverage study. The study showed that the level of patient health services coverage was significantly higher for inpatients than outpatients. It was also high in hospitals where the patients were covered by more solidarity-based health insurance schemes especially by Free health services and social health insurance plans. We suggest that more efforts are needed to achieve good patient financial risk protection in Burundian hospitals since none of the hospitals involved in the study has reached all the thresholds recommended by WHO.

References

[1] WHO, The World Health Report 2013, Research for Universal Health Coverage. Available from: http://www.who.int/universal_health_coverage/en/ [accessed 14 December 2016]

[2] WHO, What is universal health coverage? Online Q&A, October 2012. Available from: http://www.who.int/features/qa/universal_health_coverage/en/ [accessed 14 December 2016]

[3] WHA Resolution 58.33 2005. Social health insurance: sustainable health financing, universal coverage and social health insurance. Available from: http://apps.who.int/iris/bitstream/10665/20383/1/WHA58_33-en.pdf?ua=1 [accessed 14 December 2016]

[4] UNDP, Sustainable Development Goals (SDGs), http://www.undp.org/content/undp/en/home/sdgoverview/post-2015-development-agenda.html [accessed 14 December 2016]

[5] UNDP, SDGs, Goal3 tragets, http://www.un.org/sustainabledevelopment/health/ [accessed 14 December 2016]

[6] Matshidiso M, Toward Universal Coverage in Africa, http://www.afro.who.int/en/rdo/articles/4823-toward-universal-health-coverage-in-africa.html[accessed 14 December 2016]

[7] WHO & WB, Tracking universal health coverage, First global monitoring report, 2015. Available from: http://apps.who.int/iris/bitstream/10665/174536/1/9789241564977_eng.pdf [accessed 14 December 2016]

[8] Boerma T, Abou Zahr C, Evans T, Monitoring Intervention Coverage in the Context of Universal Health Coverage, PLoS Med 11(9): e1001728 doi:10.1371/journal.pmed.1001728. Available from: http://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1001728 [accessed 14 December 2016]

[9] MoH, Rwanda Community based health Insurance policy, Kigali, April 2010. Available from: http://www.moh.gov.rw/fileadmin/templates/Docs/Mutual_policy_document_final1.pdf [accessed 16 December 2016]

[10] Soors, W, Devadasan, N, Durairaj, V, Criel, B, Community Health Insurance and Universal Coverage: Multiple paths, many rivers to cross. World Health Report (2010). Background Paper, 48. Available from: http://www.who.int/healthsystems/topics/financing/healthreport/48_CHI.pdf [accessed 16 December 2016]

[11] ISTEEBU, MFPDE, INSP, MSPLS, Enquête Démographique et de Santé (EDS 2010) au Burundi, Rapport Final Mai 2012. Available from: https://dhsprogram.com/pubs/pdf/FR253/FR253.pdf [accessed 16 December 2016]

[12] WHO and Health Metrics Network (2011) Country health information systems. A review of the current situation and trends. Geneva: WHO. Available from: http://www.who.int/healthmetrics/news/chis_report.pdf?ua=1 [accessed 16 December 2016]

[13] Aqil A, Lippeveld T, Hozumi D. PRISM framework: a paradigm shift for designing, strengthening and evaluating routine health information systems. Health Policy and Planning, 2009:1–12. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2670976/ [accessed 16 December 2016]

[14] Health information systems in developing countries. A landscape analysis. California, Vital Wave Consulting, 2009. Available from: http://www.minsa.gob.pe/ogei/conferenciaops/recursos/43.pdf [accessed 16 December 2016]

[15] Simba O Daudi, Application of ICT in strengthening health information systems in developing countries in the wake of globalisation, Afr Health Sci. 2004 Dec; 4(3): 194–198. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2688333/ [accessed 16 December 2016]

[16] Verbeke F, ICT-based health information management methods in sub-Sahara hospitals, A field study in Rwanda, Burundi, Mali, Ivory Coast and the Democratic Republic of the Congo, Thesis, VUB-BISI 2012.

[17] Braa J, Heywood A, Sahay S (2012) Improving quality and use of data through data-use workshops: Zanzibar, United Republic of Tanzania. Bull World Health Organ 90: 379–384. doi: 10.2471/blt.11.99580. Available from: http://www.who.int/bulletin/volumes/90/5/11-099580.pdf [accessed 16 December 2016]

[18] Karara G, Frank V, Nyssen M, The Role of Hospital Information Systems in Universal Health Coverage Monitoring in Rwanda, Studies in health technology and informatics 08/2015; 216:193-7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26262037 [accessed 8 September 2016]

[19] Verbeke F, OpenClinic GA. Available from: https://sourceforge.net/projects/open-clinic/ [accessed 16 December 2016]

[20] Vrije Universiteit Brussel, Globalhealthbarometer. Available from: http://www.globalhealthbarometer.net/globalhealthbarometer/datacenter/datacenterHomePublic.jsp [accessed 16 December 2016]

[21] The world health report 2010. Health systems financing: the path to universal coverage. Geneva, World Health Organization, 2010. Available from: http://www.who.int/whr/2010/10_summary_en.pdf?ua=1 [accessed 16 December 2016]

[22] World bank, 2014 World bank report. Available from: http://data.worldbank.org/indicator/NY.GDP.PCAP.CD/countries [accessed 16 December 2016]

[23] Parmar D et al. Adverse selection in a community-based health insurance scheme in rural Africa: Implications for introducing targeted subsidies. BMC Health Serv Res 2012;12:181. 21. Available from: http://bmchealthservres.biomedcentral.com/articles/10.1186/1472-6963-12-181 [accessed 21 December 2016]

[24] WHO, Republic of Rwanda, Health financing system review, Options for universal coverage, Geneva 2008. Available from: http://www.who.int/health_financing/documents/hsfr_e_09-rwanda.pdf [accessed 21 December 2016]

[25] BTC-CTB. Programme d'Appui Institutionnel au Secteur de la Santé (PAISS). Available from : https://open.btcctb.org/fr/BDI/2083/p/programme-d-appui-institutionnel-au-secteur-de-la-sant-paiss.html [accessed 21 December 2016]

Address for correspondence

Gustave Karara, MPH, PhD Candidate
Department of Public Health,
Biostatistics and Medical Informatics
Vrije Universiteit Brussel
Laarbeeklaan 103
B-1080 Brussels - Belgium
gustave.karara@vub.ac.be