Secondary use of electronic health records for measuring the impact of health insurance status on health services consumption and in-hospital mortality

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Abstract

This study evaluates a method for measuring the differences in terms of care consumption and health outcomes between insured and non-insured patients admitted to the University Teaching Hospital of Kigali in the period from January 2009 till September 2012. The studied method relies on secondary use of financial, clinical and health-insurance data that were routinely collected in the health facility's hospital information management system. A total of 15,825 admissions have been analyzed demonstrating a statistically significantly 26% higher consumption of health services and a 19% lower mortality in the insured patients group compared to the uninsured group. The stability of these results over the years in spite of changing health insurance coverage percentages, suggests a causal relationship between health insurance status and health care outcomes.

Keywords

Hospital information systems, health insurance, universal coverage, mortality, quality of care, ICD-10, DRG

Introduction

A lot of research has been published in de past few decades on the presumed relationship between health insurance and health outcomes such as mortality [5,6,10,11,12,13,14,15,16,17,18,19]. The majority of the studies from the mid-1980s until today keep confirming such relationship, despite important changes in medical therapeutics and the demography of the insured and uninsured patients in the past 30 years. Most of the literature covers research in industrialized countries while health outcome analyses which explicitly include health insurance status, remain rather scarce in the sub-Saharan region. Since 2008, the University Teaching Hospital of Kigali (CHUK) routinely registers structured clinical, financial and administrative information on all out-patient encounters and in-patient admissions, including health insurance status and detailed health care expenditures [1,2,3,4] using its open source hospital information management system (OpenClinic [20]). Rwanda also having a high level of health insurance coverage (more than 90% of the population in 2012), the electronic data available at CHUK seemed reasonably appropriate for better documenting the relationship between health insurance, health services consumption and mortality in this 3rd level reference hospital.

Materials and Methods

Study concept

This is a comparative retrospective study in which disease related information is studied including patient health insurance status, in-patient case load, mortality load, cost and quantity of provided health services and diagnostic coding using ICD-10, ICPC-2 and KPGS [2] classifications.

Objectives

In our study, we wanted to evaluate differences in terms of health service consumption and health outcomes between insured and non-insured patients admitted to the CHUK, based on routinely registered and classified electronic patient data.

Methods

In a first step, a list of in-patient contacts had to be produced for the most important DRGs treated at the CHUK in the period January 2009 to September 2012 and for which sufficiently detailed data was available in the hospital information management system. After this, patients had to be classified according to their insurance status at the time of admission. Finally, a quantitative and qualitative analysis of provided health services was to be performed for each insurance status group in order to identify possible differences.

Health insurance coverage

Different kinds of health insurance coverage exist in Rwanda:

Government employees and their dependents are being covered through a compulsory adherence to the RAMA (Rwandaise d'Assurance Maladie) statutory health insurance scheme. RAMA is mainly financed by monthly contributions: 15% of the member's base salary with

7.5% paid by employers and the remaining half by employees. The scheme's benefit package covers all major preventive and curative services. Health care providers are paid on a fee-for-service basis and beneficiaries pay a 15% co-payment upon treatment.

Military and police personnel, which are supposed to be exposed to higher risks, must adhere to MMI (Military Medical Insurance). The package of health services covered by MMI is very similar to RAMA's, with the difference that prostheses are also covered. Excluded are contact lenses and braces as well as plastic surgery for purely aesthetical reasons. To cover health reimbursement risks, MMI receives 22,5% of it's members' base salaries of which the affiliates themselves pay 5% and the government adds 17,5%. When they need health care, beneficiaries contribute a direct out-of-pocket (OOP) co-payment of 15% for services and pharmaceuticals, the remainder being covered by the insurer.

Less than 1% of Rwandans are covered by a private health insurance program, the two main providers being SORAS (Société Rwandaise d'Assurance) and CORAR (Compagnie Rwandaise d'Assurance et de Réassurance). These companies offer different insurance coverage plans.

More than 70% of today's Rwandan population however, is covered by one of the many community based health insurance programs (CBHIP). Rwandan CBHIP cover for standard packages of common health services, many of them excluding pharmaceutical products, prostheses and other elements considered less important. Usually, patients pay a 10% OOP fee upon treatment and the rest of the costs are being covered by the CBHIP. For the poorest 10% of Rwandans as well as for specific categories such as HIV-patients and genocide refugees, OOP fees are waived and covered for by government or NGOs. Affiliates mostly pay an annual flat fee contribution of around 2 USD a year, making health coverage very accessible even to the poorest part of the population. Clearly, these low contributions are totally insufficient to cover for the reimbursement claims and all CBHIP heavily depend on complementary government subsidies.

In our study we wanted to distinguish between encounters for insured and uninsured patients. In an attempt to simplify the rather complex and diverse health coverage implementations in Rwanda, we have defined an *insured patient encounter* as an encounter for which a patient had to make OOP payments not exceeding 25% of the total costs invoiced for the encounter. In case of an *uninsured patient encounter*, the patient's OOP payments accounted for at least 75% of the total encounter cost. *Undecided encounters* with OOP payments between 25% and 75% of the total encounter cost (6.13% of the total number of encounters) have not been considered in our study.

Hospital bound mortality

Hospital bound mortality was the only quality of care metric analyzed in this research. This metric was expressed as the percentage of patients that were treated for a specific clinical condition *x* and eventually died in the hospital (but not necessarily from *x*).

Care consumption

Measuring the amount of care provided to patients, goes through making an inventory of all health services (procedures, drugs, consumables, technical services, medical equipment) delivered within the context of a single encounter. Thereby, every health service should be weighed according to its importance in the global treatment of the disease.

Disease classification

Mortality- and care consumption comparison between insured and uninsured patients had to be performed for different categories of diseases, preferably using international classifications aggregated in the form of DRGs.

Results

DRG classification

In 2009, the Kigali Health Informatics Research Institute (KHIRI), a department of the CHUK, worked out a set of pathology grouping codes in an attempt to enable more efficient evaluation of clinical activity in this typical sub-Saharan hospital. This collection of grouping codes was called the KHIRI Pathology Grouping Set (KPGS [2]) and is a bi-classified grouping system, based on ICD-10 and ICPC-2 classification standards. The code structure has been derived from ICD-10 chapters. To support hospital users with diagnostic coding, a clinical thesaurus mapping local health care terminology to ICD-10 and ICPC-2 classifications was provided [4]. KPGS is somehow similar to the well known concept of Diagnosis Related Groups (DRG), which has proven to be useful for health management mainly in the Western world. However, the usability of these sophisticated, expensive and complex systems in developing countries, more particularly in Central Africa was at least questionable. The KPGS classification therefore must be considered a simplified African implementation of DRGs, addressing clinical conditions that better match local African health management requirements.

In our study, we have evaluated in-patient admissions that belonged to at least one of the following KPGS-groups, representing a number of major clinical conditions for the hospital:

DRG-group	KPGS codes
1. Traumatology & Burns	190,19A and 19B
2. Cancer	02A to 02D
3. Diabetes	04B
4. Tuberculosis	01B
5. HIV/AIDS	01M
6. Cardiovascular diseases	09A to 09R
7. Pneumonia	10C
8. Digestive diseases	11A to 11S
9. Malaria	01V
10. Genital-urinary diseases	140
11. Pregnancy related problems	15A and 15B

Table 1: KPGS codes used per studied DRG-group

Health insurance coverage

For each in-patient admission that occurred in the study period and that was linked to one of the above DRG-groups, all invoiced health services have been analyzed, enabling the classification of the encounter into the *insured encounters* (<25% OOP payments), *uninsured encounters* (>75% OOP payments) or *undecided encounters* (from 25% to 75% OOP payments), the latter being precluded from further analysis. This classification resulted in the following table:

DRG-group	# Insured	# Uninsured
1. Traumatology & Burns	2197	215
2. Cancer	1173	53
3. Diabetes	395	36
4. Tuberculosis	364	31
5. HIV/AIDS	412	40
6. Cardiovascular diseases	1283	77
7. Pneumonia	398	54
8. Digestive diseases	2004	158
9. Malaria	317	53
10. Genital-urinary diseases	1682	145
11. Pregnancy related problems	4088	650
Total	**14313**	**1512**

Table 2: number of insured and uninsured patients per DRG-group

Care consumption

Health care services have been identified as items that were invoiced to the patient and/or the insurer and therefore included medical procedures, products, consumables as well as any other item of care provided. Each type of health care service (e.g. consultation, lab analysis *x*, drug *y*, consumable *z*…) was allocated a clinician-generated weight factor λ between 0 and 1, according to its relative importance for the DRG under consideration. For the purpose of this study, λ values were based on a consensus document provided by a technical team of 12 physicians (4 GPs and 8 specialists) who all individually reviewed the complete set of health services provided for each DRG-group. In the case of admissions for which multiple DRGs applied, health services have been distributed over individual DRGs using the disability weights based CALCO [3] method. For each DRG-group this resulted in an average care consumption score *ε* as shown in equation (1).

$$\varepsilon = \sum_{i=0}^{n} c_i \cdot \lambda_i \qquad (1)$$

where

- ε = care consumption score for a group of DRGs *d* over a period of time *t*
- n = total number of different types of health services provided for *d* over a period of time *t*
- c_i = total number of health services of type *i* provided for *d* over a period of time *t*
- λ_i = clinician generated weight-factor for health service type *i* according to *d*

The care consumption score was calculated separately for insured and uninsured patients, differences between both groups being expressed as Δε in table 3.

DRG-group	ε_i	ε_u	Δε
1. Traumatology & Burns	39,96	27,84	+43,53%
2. Cancer	33,13	29,51	+12,29%
3. Diabetes	37,54	27,31	+37,49%
4. Tuberculosis	40,25	30,32	+32,75%
5. HIV/AIDS	35,68	27,53	+29,63%
6. Cardiovascular diseases	32,78	22,65	+44,72%
7. Pneumonia	29,11	21,74	+33,89%
8. Digestive diseases	38,24	26,53	+44,15%
9. Malaria	29,50	23,32	+26,50%
10. Genital-urinary diseases	35,67	29,01	+22,95%
11. Pregnancy related problems	33,13	29,74	+11,39%
All DRGs	**35,34 n=14313 SD=61,12**	**28,08 n=1512 SD=42,56**	**+25,87% P<0.001**

Table 3: increase in care consumption (Δε) per DRG in 2009-2012
$\varepsilon_i = \varepsilon$ for insured patients, $\varepsilon_u = \varepsilon$ for uninsured patients
$\Delta\varepsilon = (\varepsilon_i - \varepsilon_u)*100/\ \varepsilon_u$

Results showed a statistically significant 25.87% higher health services consumption in the group of insured patients (two tailed p<0.001, single factor ANOVA test). However, when comparing total health care costs per admission, no significant differences could be found between the insured and uninsured groups. This was mainly due to the fact that for many health services (except for drugs), higher tariffs are being applied in the hospital for uninsured patients.

The DRG-specific values of Δε remained remarkably stable over the years during our study period, as is shown in Fig 1.

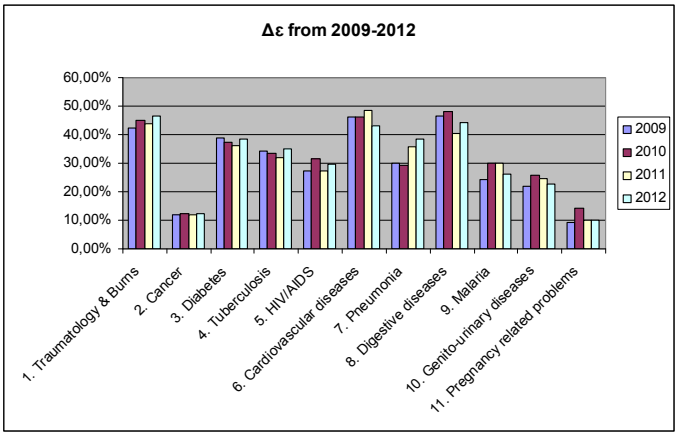

Fig 1: Δε evolution per DRG-group from 2009 to 2012

Hospital bound mortality

Analysis of hospital deaths also showed a statistically significant 19.14% lower mortality in the insured patients group compared to the uninsured group (two tailed p=0.019, Chi-square test with Yates' correction). For 7 of the 11 DRG-groups, mortality was more than 40% lower in the insured group, as is shown in the Δmortality column of Table 4.

DRG-group	Insured			Uninsured			Δmortality	Significance
	Alive	Deceased		Alive	Deceased			
1. Traumatology & Burns	2139	58	2,64%	203	12	5,58%	-52,70%	p=0,0293*
2. Cancer	1002	171	14,58%	39	14	26,42%	-44,81%	p=0,0286*
3. Diabetes	351	44	11,14%	27	9	25,00%	-55,44%	p=0,0289*
4. Tuberculosis	291	73	20,05%	25	6	19,35%	+3,61%	NS*
5. HIV/AIDS	295	117	28,40%	28	12	30,00%	-5,34%	NS*
6. Cardiovascular diseases	1084	199	15,51%	57	20	25,97%	-40,28%	p=0,024*
7. Pneumonia	363	35	8,79%	44	10	18,52%	-52,51%	p=0,0479*
8. Digestive diseases	1854	150	7,49%	136	22	13,92%	-46,24%	p=0,0085*
9. Malaria	303	14	4,42%	50	3	5,66%	-21,98%	NS*
10. Genito-urinary diseases	1579	103	6,12%	129	16	11,03%	-44,50%	p=0,033*
11. Pregnancy related problems	4034	54	1,32%	641	9	1,38%	-4,60%	NS*
All DRGs	**13295**	**1018**	**7,11%**	**1379**	**133**	**8,80%**	**-19,14%**	**p=0,019****

Table 4: mortality differences between insured and uninsured patients
* Fischer's exact test on 2x2 contingency table (alive-deceased / insured–uninsured)
** Chi-square test with Yates' correction NS = statistically not significant

HIV and tuberculosis treatments are normally provided for free in Rwanda, meaning that these are not being invoiced by the hospital (*zero tariff*). Therefore, one might expect that insurance status would be irrelevant for these patients. Still, HIV and tuberculosis can be part of more complex clinical conditions including diseases for which free care does not apply. Also, some complementary treatments are not being covered by the free care policy, resulting in an invoice being produced by the hospital. For that reason, HIV and tuberculosis patients that made out-of-pocket payments covering more than 75% of these extra costs were also considered *uninsured* in our study.

If we apply the DRG-specific mortality rates for uninsured patients to the insured patients group, we can calculate the virtual extra number of patients that would have died if no health insurance would have been in place (Θ also explained as the number of *lives won* due to health insurance), based on the hypothesis that the difference in mortality between insured and uninsured patients exclusively depends on health insurance status and that no other confounding factors exist (see Table 5)

Discussion

Obviously, the health service consumption score ε heavily relays on the weight scores that are allocated to individual health services. Nevertheless, the relative frequencies of provided health services not being significantly different between the insured and uninsured groups, changing individual health service weight scores had little or no influence on Δε.

Mortality reduction was quite impressive for most of the studied disease groups, but only statistically significant for 7 DRG-groups: cancer, cardiovascular diseases, digestive diseases, genital-urinary diseases, traumatology, diabetes and pneumonia. We calculated the number of *lives won* in the insured patient group by comparing actual mortality rates to the number of deaths we would have seen if the mortality rate of the uninsured patients would have applied to the insured patients group. Based on these results, the most important improvement had been achieved for cancer, cardiovascular diseases and digestive diseases with respectively 139, 134 and 129 lives won between January 2009 and September 2012.

DRG-group	# insured	Actual # insured deceased	mortality rate uninsured	Θ	Lives won
1. Traumatology & Burns	2197	58	5,58%	123	65
2. Cancer	1173	171	26,42%	310	139
3. Diabetes	395	44	25,00%	99	55
4. Tuberculosis	364	73	19,35%	70	-3
5. HIV/AIDS	412	117	30,00%	124	7
6. Cardiovascular diseases	1283	199	25,97%	333	134
7. Pneumonia	398	35	18,52%	74	39
8. Digestive diseases	2004	150	13,92%	279	129
9. Malaria	317	14	5,66%	18	4
10. Genito-urinary diseases	1682	103	11,03%	186	83
11. Pregnancy related problems	4088	54	1,38%	57	3
All DRGs	**14313**	**1018**	**8,80%**	**1259**	**241**

Table 5: lives won per DRG-group in the 2009-2012 period
Θ = number of insured patients that would have died when applying mortality rate of uninsured patients to insured patients group

Clearly, the interpretation of these results depends on a supposed causal relationship between care consumption and mortality on the one hand and health insurance status on the other. And although care consumption is significantly higher and mortality is significantly lower for the insured patient admissions, we cannot just reliably conclude that there is such a causal relationship: too many confounding factors existed. For some of them, such as age and gender, we were able to exclude significant differences between the insured and uninsured patient groups. The relevance of many other factors however, could not be evaluated as necessary underlying data was lacking: income, employment status, education, exercise, tobacco and alcohol consumption, body-mass index, marital status, immigration status and other factors have been described in literature to play a potential role in eventual care consumption profiles [10,11,12,13,14,15,16,17,18,19]. Nevertheless, the fact that the observed differences in care consumption and hospital bound mortality appear to remain almost constant for subsequent years in the studied period, in spite of a considerable rise of insured patients from 81% in 2008 to 93% in 2012, suggest that the role of the afore-mentioned confounding factors is probably of secondary importance (otherwise the shift of uninsured patients to the insured group would also have influenced care consumption and mortality). We therefore can assume that health insurance as such also played a role in improving health outcomes for patients admitted to the CHUK in the past 5 years.

Differences in care consumption and mortality between insured and uninsured patients finally showed to be very significant for non-communicable chronic diseases such as cancer, hypertension, stroke and diabetes. The importance of these diseases is rapidly growing in the sub-Saharan region [8,9] and some evidence has been provided in our study results that universal health coverage [6,7] might play a relevant role in fighting this new pandemic in the future.

Conclusions

This study demonstrated the important potential of routinely collected electronic health record data for documenting and monitoring the relationship between health insurance status, in-hospital mortality and care consumption. Analysis of patient admissions in the University Teaching Hospital of Kigali during the 2009-2012 period suggests that health insurance coverage significantly increases care consumption and reduces hospital bound mortality for patients suffering from cancer, cardiovascular diseases, digestive diseases, genital-urinary diseases, trauma & injuries, diabetes and pneumonia.

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