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How to Cover the Medical Costs of Hospitalization: a Theoretical Model Based on the Household Willingness to Pay

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ABSTRACT

Covering medical costs is very important, in order to solve the various financial problems that limit the users' access to health care (patients attending the public hospitals). Designing a new model of financing system by using an additional levy to the local tax revenue is one of the solutions to these problems. This theoretical model optimizes the amount of financial participation of the users or "*pfu*" compared to the direct costs of hospital care starting from the willingness to pay revealed by the household. The criterion of morbidity for predicting the staffing of a part from the tax amount was chosen so that we can handle most of the users of the hospital. Firstly, the model shows that our new system could reduce the direct costs of care paid by users, and secondly, it also helps provide an additional resource in the supplementary budget of hospitals.

1. Introduction

The costs of hospital care are a major problem of accessibility of the household to maintain their health. For the poorest, this problem tends to delay or exclude their use of formal health structures. To pay the medical expenses, they may have to sell their property / goods, and sometimes, their production tools (small-scale artisans, farmers, fishermen etc.). For these disadvantaged social strata, the principle of financial participation of the users is a condition of unequal[1] healthcare delivery, that is to say that a high rate of participation causes a barrier to the use of health services by low income groups and promotes access to health care to groups with a very high income. Thus the search for alternative funding to help these low-income groups to pay the various costs to hospitals must be a major concern. For the costs of care to be accessible, the value of financial participation of the users must be reduced.

For the hospital, the policy of reducing the amount of financial participation of the users requires an additional budget allocation to cover the various costs of care (costs of administrative functioning, expenses of maintenance of medicines stocks and medical consumables). Another problem also arises in the selection or evaluation of the optimal amount of costs to be charged between the two entities (hospital and users). How else can we be funding the hospital to reduce the share of hospital costs paid by its users? As an example, since 1995, Madagascar has adopted a system to cover the health care costs[2] but the political and economic crisis in 2002 forced the country to cancel the financial participation of users in medicines costs (Wholesale District (PHAGDIS) pharmacies and community management pharmacies (PHAGECOM)) causing a shortage of medicines supplies in the health service.

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[1] [...] The many indications that the financial participation of the users and other forms of direct payment are the least progressive forms of financing health care. It has been shown in all the high-income countries for which data are available, that direct payments of the household are decreasing (Van Doorslaer and Wagstaff, 1993; Wagstaff et al., 1999). However, recent studies conducted in countries with low and middle incomes have shown that direct payments may be gradual in these countries if the groups with lower incomes use health services rarely or never (Equitap, 2005). In this context, the term "progressive" can be misleading because it refers to an equitable funding, but to an inequitable supply of health care. So, if everyone has to make direct payments, the higher income groups undoubtedly realize the bulk of expenditure, but they are also the only beneficiaries of services. As the direct payments can represent a heavy financial burden for many households of low-and middle-income (Whitehead et al., 2001, Xu et al. 2003), some households avoid seeking health care.
McIntyre DIANE, Le financement des soins de santé dans les pays à faibles et moyens revenus, Global Forum for Health Research, Genève, Juin 2007, page 94.

[2] Law No. 93-005 of 26 january 1994 on the general policy of decentralization, Law No. 94-007 of 26 april 1995 concerning the authority, skills and resources of decentralized local and Decree No. 96-169 of 06 march 1996 under article 15 of Law 94-007 of 26 april 1995. The financial participation of the users was reinstated by Decree No. 2003-1040 of 14 October 2003 and its implementing Decree No. 5228/2004. The PHAGECOM has changed its name to FANOME (Funding for Non-stop Supply of Essential Drugs): This is a support mechanism for providing health care for the poor. For this purpose, a special fund called "*equity fund*" is established to provide this support.
International Health Partnership (ihp+), Partenariat International pour la Santé et les initiatives connexes (PIS+) : Dispositif d'Harmonisation pour la Santé en Afrique (HSA), Rapport d'inventaire Madagascar, Mars 2008, Lusaka, Zambie, page 6-7.

This led us to propose a theoretical model of financing care of some of the costs of hospital care by applying a levy on the local tax[3] revenue to maintain the stability of funding (financial compensation). In fact, this theoretical model optimizes the options of covering medical costs, the choice of budget allocation and pricing model.

2. Methodology

The model is based on the level of willingness to pay household converted in percentage of their average income[4]. The volume of tax revenue allocated to the hospital is calculated relatively to the population size weighted by the higher morbidity of the hospital tax district and the average or median value of the level of willingness to pay[5] revealed by the household.

Funding will be a periodical allowance of a part from the local tax revenue to the budget appendix of the hospital to support some of the costs in accordance with the following condition: the total direct[6] costs of hospital care to take charge should be less than or equal to the total amount of taxes paid in the budget appendix: it is "*the balance of hospital care costs expected to be payable by the users and the volume of tax receipts to pay*".

The value of financial participation of the users varies because of a test condition of the average direct costs of the hospital care as it follows:

- *If the tax levy < Annual average total direct cost of care:* the level of care = (Total amount of support from the average total annual direct cost - the levy tax) / Total amount of support;
- *If the tax to be levied = Annual direct average total cost of health care:* the rate of support is equal to 100%;
- *If the tax levy > Annual direct average total cost of health care:* the rate of support is equal to 100% and we forecast a surplus. This surplus is the difference between the tax levy and the estimated total amount of support the annual direct average total cost.

The rational models are those where we can calculate the value of financial participation of the users in relation to options for assignments and budget allocations set by the decision maker of the hospital (investment, considering another source of funding and treatment of the remaining period[7] to another budget year).

3. The funding model based on willingness to pay

The model is based on the model of tax financing system BEVERIDGE[8], decentralized management and state-run (case of co-payments[9] in the mixed health system such as in France) and universal coverage (without differentiation of social stratum).

- ***The model variables:***

t: the base year for calculating the level of willingness to pay
n: number of population in the period *t*
rm: average income of the household for the period *t*
m^t : prediction of the tax revenue (ex ante perspective)
DAP_i : Willingness to pay of each individual p_i^t. p_i^t is the number of individual respondents in their willingness to pay for a sampling of some of the tax revenue is made, and $1-p_i^t$ those who have not given their level of willingness to pay
dap_{ma}^t : the average willingness to pay of $\boldsymbol{p}_i^t$, obtained relatively to the average income,

$$dap_{ma}^t = \left(\left(\frac{\sum_{i=1}^{\infty} DAP_i}{p_i^t} \right) / rm \right) \times 100$$

or median willingness to pay according to the dispersion of the variable *dap*.

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[3] [...] The establishment of a redistribution system based solely on tax is often cited as an optimal measure that would guarantee equitable access to health care for all the populations (Atkinson and Stiglitz, 1976). This policy is intended to limit government intervention in the health sector and improve their impact.
Mohamed Lamine DOUMBOUYA, Accessibilité des services de santé en Afrique de l'Ouest : le cas de la Guinée, Laboratoire d'Économie de la Firme et des Institutions, Université Lumière Lyon 2, Working paper n° 2008, Janvier 2008, France, page 5.

[4] The ability to contribute to the household health expenditure depends on their income and according to Tshinko et al. the value of willingness to pay to pre-funding health is positively correlated to income ratio and confidence in the health sector.
Tshinko B. Ilunga, Andre-Pierre Contandriopoulos, Pierre Fournier, Plan de paiement anticipe des soins de santé de Bwamanda (Zaïre) comment a-t-il été mis en place?, *Social Science et Medicine*, Volume 40, Issue 8, pages 1041-1052.

[5] The choice between mean and median WTP depends on the dispersion or concentration of willingness to pay by calculating the Gini index.

[6] Costs paid directly by the patients and their household (or users) to the hospital.

[7] The annual period is due to the annual nature of the law of public finance.

[8] This system is based on universal access to care and on the taxation of health spending. It is based on three principles, called the three "U": - *Universality*: every citizen is protected against all the social risks regardless of the employment status; – *Unit*: a single administration handles each type of risk; – *Uniformity* : each individual has services according to the needs and regardless of income.

[9] Co-payments (user of the health sector and state) or users participation on a base rate set by the health system and social security.

tma^t : the highest morbidity in hospital (an ex post perspective)

nb_{ma}^t : number of morbid population at period *t*, $nb_{ma}^t = tma^t$ x n

$CTMD$: estimated direct total average cost for care in population hospital

$Ctmd = CTMD$ x nb_{ma}^t : average total direct cost of the morbid

er : forecast error in percent

pfu : financial participation of the users as a percentage of the cost of care

- ***The funding model based on willingness to pay:***

The tax package for the management of hospital costs is (∂^t),

$\partial^t = dap_{ma}^t$ x m^t .

In ex ante perspective, the morbidity might be different than in ex post. To avoid this problem, we add a margin of error according to a forecast level of confidence chosen. The model is then

$$\partial^t = \left(\text{dap}_{\text{ma}}^{\text{t}} \text{ x m}^{\text{t}}\right) \times \left(1 + \frac{\text{er}}{100}\right) \quad (1)$$

and the value of the effective management of the users in hospital (or the sum of the actual support) includes $\partial_{réelle}$

$$\partial_{réelle} = \left(1 - \frac{pfu}{100}\right) \times Ctmd \text{ with a rate of effective support } \text{t}\partial_{\text{réelle}} = \left(1 - \frac{\text{pfu}}{100}\right)$$

4. Rationalization of the amount of financial participation of the users

Let's write our balance between care costs paid by users and the volume of tax revenue:

$$\left(\partial_{réelle} = \sum_{i=1}^{nb_{ma}^t} pfu_i \times Ctmd\right) \leq \partial^t \qquad (2)$$

We must obtain a rate of the value of financial participation of the users that achieves a balance between the direct average total cost of the care taken into consideration and the volume of tax revenue allocated, that is to say the remainder of the budget appendix is closer to zero. In our model, the rationalization policy of financial participation of the users and support depends on the fiscal envelope. It is not enough to seek to find more resources, but also to improve the efficiency of health expenses (investment for a good quality of care, funding for prevention to reduce morbidity etc.). Indeed, a high level of financial participation of the users causes a barrier to using health services[10].

Thus, we bring to the fore the following two cases:

- liquidation of the budget to support the hospital *r*, $r = \partial^t - \partial_{réelle} = 0$;
- and having a hangover r>0, $\partial^{\text{t}} - \partial_{\text{réelle}} > 0$ by considering another source of funding (*fin*) where $(\partial^t + fin) - \partial_{réelle} = r$.

From the equilibrium equation, the calculation of the value of financial participation of the users depends on the value of support $\partial_{réelle}$ in an ex-post perspective.

Case 1: Liquidation of the overall budget balance $r = 0$ with $\partial^t \geq (Ctmd \times pfu)$

$\partial_{réelle} \leq \partial^t (1 + er)$, to simplify the formula, we set $pfu = \frac{pfu}{100}$ and $er = \frac{er}{100}$

However, the sum of costs of care paid by users $\left(\sum_{\text{i=0}}^{\text{nb}_{\text{ma}}^{\text{t}}} pfu_i \times Ctmd\right)$ and some of the costs of care ($\partial_{réelle}$) must be less than or equal to the volume of tax revenue (∂^{t}) allocated: $\left(\sum_{\text{i=0}}^{\text{nb}_{\text{ma}}^{\text{t}}} \text{pfu}_{\text{i}} \times \text{Ctmd}\right) + \partial_{\text{réelle}} \leq \partial^{\text{t}}(1 + \text{er})$

[10] [...] Case of the Democratic Republic of Congo in 1999, when government subsidies were plummeting and caused frequent increases of the flat rate financial participation of the users and made hospital care increasingly unaffordable.
DIANE McIntyre, Le financement des soins de santé dans les pays à faibles et moyens revenus, Global Forum for Health Research, Genève, Juin 2007, page 59.

For $r = 0$, $(Ctmd \times pfu) + \partial_{réelle} = \partial^t (1 + er)$ with $Ctmd = CTMD \times nb^t_{ma}$ and $nb^t_{ma} = n \text{ x } tma^t$, then $Ctmd = CTMD \times n \times tma^t$. Then we have $pfu\left(CTMD \times n \times tma^t\right) + \partial_{réelle} = \partial^t (1 + er)$

Maximum coverage of costs

Preferably budgetary support to the actual hospital

$$\text{pfu} = \left[\left(\frac{\partial^t}{n \times tma^t} - \frac{\partial_{réelle}}{n \times tma^t}\right) \times \frac{1}{CTMD}\right] \times (1 + er) \qquad (3)$$

Volume compared to fiscal morbid population (ex ante)

Value of the effective covering of medical costs (ex post)

Direct average total cost of hospital care (ex ante)

Second case: Define the value of *r* to affect investment in the period *t +1* (*spending efficiency*): $r > 0$ with $\partial^t \geq Ctmd \times pfu$

Should $\left(\sum_{i=0}^{nb^t_{ma}} pfu_i \times Ctmd\right) + \partial_{réelle} + r \leq \partial^t (1 + er)$

Then we have $pfu\left(CTM \times n \times tma^t\right) + \partial_{réelle} + r = \partial^t (1 + er)$

$$pfu = \left[\left(\frac{\partial^t}{n \times tma^t} - \frac{\partial_{réelle}}{n \times tma^t} - r\right) \times \frac{1}{CTM}\right] \times (1 + er) \quad avec \; r > \partial^t - \partial_{réelle} \qquad (4)$$

Value of the remainder of the investment required for *t+ 1*

This value r (r_t) can be used in two options :

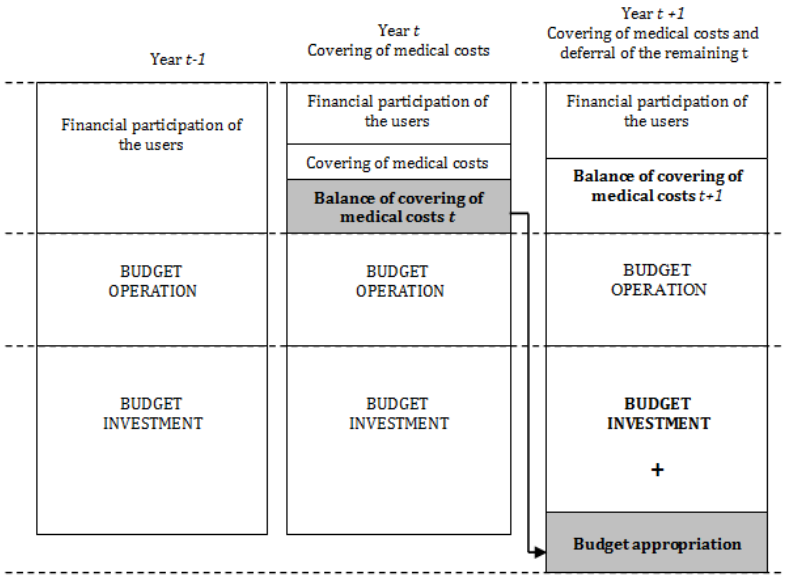
- Assigning r_t to morbidity *t+1* by calculating an estimated effective population $n' = \frac{r_t}{CTM}$

n' is only effective as a morbid t could support the value of the remaining r_t. Compensation by r_t in *t+1* or $ctmd_{t+1} = ctmd_{t+1} - r_t$. The population size in morbidly *t+*1 will $\text{nb}^t_{\text{ma}} = (\text{n} - \text{n}')\text{x tma}^t$.

r_t *is considered the internal funding support.* The advantage is that the value of $ctmd$ can be decreased in *t+1.* Of course, we also have a decrease of *pfu.*

- Assigning r_t to investment in t +1. In *t +1*, the postponement of the remainder r_t can be illustrated in the following figure.

Figure 1. Principle of the allocation the remaining to the investment budget



Source: personal contribution

This increased investment enhances the resources (human and material) and the hospital infrastructure.
In the case of a model with another need of financing (*fin*) to obtain a decreasing[11] variation of the *pfu* the two principles of rationalization are the following:

$$pfu = \left[\left(\frac{\partial^t}{n \text{ x } tma^t} - \frac{\partial_{réelle}}{n \text{ x } tma^t} - fin \right) \text{x} \frac{1}{CTM} \right] \text{x} (1 + er) \quad (5)$$

or $$pfu = \left[\left(\frac{\partial^t}{n \text{ x } tma^t} - \frac{\partial_{réelle}}{n \text{ x } tma^t} - fin - r \right) \text{x} \frac{1}{CTM} \right] \text{x} (1 + er) \quad (6)$$

5. Pricing model of covering the medical costs in hospital

Having the variables:

$\boldsymbol{i}$: care service and/or pharmacy unit

$\boldsymbol{C_i}$: cost of a medical service

$\boldsymbol{CT}$: total cost of medical services

$\boldsymbol{F_i}$: cost paid for a medical service

mp' : multiplier of financial participation of the users

mp'' : multiplier of covering medical costs

An example of numerical simulation of medical service of a patient (or user):

Cost analysis C_1 = 100

Cost of a radiography C_2 = 150

Cost of an echography C_3 = 300

Cost of medication pharmacy unit C_4 = 450

Amount payable by the cost per patient: $F_i = C_i \text{ x } mp'$. For a *pfu* of 15%, we have ***mp'*** = 0.15 and ***mp''*** = 0.85.

$F_1 = C_1$ x ***mp***' = 15, $F_2 = C_2$ x ***mp'*** = 22.5

$F_3 = C_1$ x ***mp***' = 45, $F_4 = C_2$ x ***mp'*** = 67.5

The amount of the envelope of the covering of medical costs is $CT \text{ x } mp''$. Hence, the value to be deducted on the envelope of covering the medical costs of the users is 1 000 x 0.85 = 850: that *is the value in the bookkeeping budget annex of the hospital to balance the various costs of hospital services*.

These different values of $\boldsymbol{F_i}$ are the equivalent of co-payments for our model of covering the medical costs based on willingness to pay with a multiplier *mp'* by the medical services and medicines costs.

6. Conclusion

The costs of hospital care are often expenses that can be catastrophic for the household. The covering of medical costs is a system that can alleviate these costs either for the household, or to the hospital's investment and compensation budget shortfall.

Combining willingness to pay and morbidity shows that the willingness of users to maintain their health and to avoid morbidity (varies by geographical boundaries: socioeconomic factors, climatic factors) are highly sought for the proposal of a funding model to a local hospital. This model maximizes the value of financial participation of the users, having in mind the criteria for budget allocation desired by the decision maker of the hospital sector.

In another paper there will be approached the modeling of the willingness to pay revealed by the household if they propose to apply the consumption tax[12] on alcoholic beverages.

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[11] [...] The poorest households are often forced to reduce their food consumption, practice self-medication and/ or incur catastrophic health expenditure.
IASC (Inter-Agency Standing Committee, Santé et Responsabilité Sectorielle), Éliminer la participation financière des usagers des services de soins de santé primaires en temps de crise, France, Mars 2010, page 2.

[12] The choice of alcoholic beverages has been chosen because they are available worldwide for centuries and their excessive consumption causes tremendous social costs (mortality, social disruption, alcoholic diseases, loss of productivity and poverty etc.) since traditional beverages are produced collectively by the branded products for mass consumption.
[...] In general the way drinkers respond to changes in the price of alcohol is similar to the one they respond to changes in prices of other consumption products. When other factors are also constant, an increase in alcohol prices led to a drop in consumption and a decrease in alcohol-related harm. We realized that in many high-income countries, the demand for alcohol was relatively inelastic to price, like many other consumer goods, that is to say that a change price leads to a decrease in consumption, but relatively smaller than it is the price increase. This means that if one can use the increased tax on alcohol as a strategy to reduce consumption and harm, the state revenue from taxes will actually increase in most countries.
OMS, Comité d'OMS d'experts des problèmes liés à la consommation d'alcool, Série des rapports techniques, 2ème Rapport, n° 944, page 30 à 32.
[...] If the governments of the 49 poorest countries in the world each were allocating 15% of their national budgets to health, they could raise $ 15 billion euros extra per year. These countries could also generate more money for health, by adopting a more efficient system of tax as the one carried out by Indonesia, which has increased its revenue by 10 percentage points. A study of 22 low-income countries showed that they could meet them all at an additional $ 1.42 billion, increasing by 50% the tax on tobacco and alcohol.
OMS, Rapport sur la santé dans le monde en 2010.

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