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

Amaïde Arsan Miriarison TSIKOMIA *, Razvan STEFANESCU**, Daniela SARPE**

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 "pfp" 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 health care 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 costs¹ 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.

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.


© 2012 EAI. All rights reserved.

1 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 national and regional, Law 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 PHAGDIS has changed its name to PHAGECOM (Funding (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.

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 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. 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 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 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 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, decentralized management and state-run (case of co-payments 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 $t$
  - $m^i$: prediction of the tax revenue (ex ante perspective)
  - $DAP_i$: Willingness to pay of each individual $p_i$. $p_i$ is the number of individual respondents in their willingness to pay for a sampling of some of the tax revenue is made, and $1 - p_i$ those who have not given their level of willingness to pay
  - $\text{dap}_{\text{med}}$: the average willingness to pay of $p_i$, obtained relatively to the average income,
    
    $\text{dap}_{\text{med}} = \frac{\sum \text{DAP}_i}{p_i} \times \frac{100}{\text{rm}}$

\[
\text{If the tax levy < Annual average total direct cost of care: the level of care = } \left( \text{Total amount of support from the average total annual direct cost - the levy tax} \right) / \text{Total amount of support;}
\]

\[
\text{If the tax to be levied = Annual direct average total cost of health care: the rate of support is equal to 100%;}
\]

\[
\text{If the tax levy > Annual direct average total cost of health care: the rate of support is equal to 100% and we forecast a surplus. This surplus is the difference between the tax levy and the estimated total amount of support the annual direct average total cost.}
\]

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

\[
\text{3. The funding model based on willingness to pay}
\]

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

\[
\text{The model variables:}
\]

\[
t: \text{the base year for calculating the level of willingness to pay}
\]

\[
n: \text{number of population in the period } t
\]

\[
rm: \text{average income of the household for the period } t
\]

\[
m^i: \text{prediction of the tax revenue (ex ante perspective)}
\]

\[
DAP_i: \text{Willingness to pay of each individual } p_i. \text{ } p_i \text{ is the number of individual respondents in their willingness to pay for a sampling of some of the tax revenue is made, and } 1 - p_i \text{ those who have not given their level of willingness to pay}
\]

\[
dap_{\text{med}}: \text{the average willingness to pay of } p_i, \text{obtained relatively to the average income,}
\]

\[
dap_{\text{med}} = \frac{\sum \text{DAP}_i}{p_i} \times \frac{100}{\text{rm}}
\]

\[
\text{If the tax levy < Annual average total direct cost of care: the level of care = } \left( \text{Total amount of support from the average total annual direct cost - the levy tax} \right) / \text{Total amount of support;}
\]

\[
\text{If the tax to be levied = Annual direct average total cost of health care: the rate of support is equal to 100%;}
\]

\[
\text{If the tax levy > Annual direct average total cost of health care: the rate of support is equal to 100% and we forecast a surplus. This surplus is the difference between the tax levy and the estimated total amount of support the annual direct average total cost.}
\]

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

\[
\text{3. The funding model based on willingness to pay}
\]

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

\[
\text{The model variables:}
\]

\[
t: \text{the base year for calculating the level of willingness to pay}
\]

\[
n: \text{number of population in the period } t
\]

\[
rm: \text{average income of the household for the period } t
\]

\[
m^i: \text{prediction of the tax revenue (ex ante perspective)}
\]

\[
DAP_i: \text{Willingness to pay of each individual } p_i. \text{ } p_i \text{ is the number of individual respondents in their willingness to pay for a sampling of some of the tax revenue is made, and } 1 - p_i \text{ those who have not given their level of willingness to pay}
\]

\[
dap_{\text{med}}: \text{the average willingness to pay of } p_i, \text{obtained relatively to the average income,}
\]

\[
dap_{\text{med}} = \frac{\sum \text{DAP}_i}{p_i} \times \frac{100}{\text{rm}}
\]
\( tma^t \): le plus haut taux de morbidité en hospital (un ex post perspective)

\( nb^t_{ma} \): nombre de morbides au périodes \( t \), \( nb^t_{ma} = tma^t \times n \)

\( CTMD \): coût total direct estimé pour la population hospitalière

\( Cmtd = CTMD \times nb^t_{ma} \): coût total direct moyen des morbides

\( er \): erreur de prévision en pourcentage

\( pfu \): participation financière des utilisateurs en pourcentage du coût des soins

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

Le pack de taxes pour la couverture des coûts de l'hôpital est \( \partial' = \partial_{ma} \times m^t \).

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

\[
\partial' = (\partial_{ma} \times m^t) \times \left( 1 + \frac{er}{100} \right)
\]

(1)

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

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

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:

\[
\left( \partial_{réelle} = \sum_{i=1}^{n} pfu \times Cmtd \right) \leq \partial'
\]

(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 \( r, r = \partial' - \partial_{réelle} = 0 \);
- and having a hangover \( r>0, \partial' - \partial_{réelle} > 0 \) by considering another source of funding \( \text{(fin)} \) where \( (\partial' + \text{fin}) - \partial_{réelle} = r \).

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 \( \partial' \geq (Cmtd \times pfu) \)

\[
\partial_{réelle} \leq \partial'(1 + er), \text{ to simplify the formula, we set } pfu = \frac{pfu}{100} \text{ and } er = \frac{er}{100}
\]

However, the sum of costs of care paid by users \( \sum_{i=1}^{n} pfu \times Cmtd \) and some of the costs of care \( \partial_{réelle} \) must be less than or equal to the volume of tax revenue \( \partial' \) allocated:

\[
\sum_{i=1}^{n} pfu \times Cmtd + \partial_{réelle} \leq \partial'(1 + er)
\]

\(^{10}\) 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.

For \( r = 0 \), \((Cm \times pfu) + \partial\text{ricelle} = \partial'(1 + er)\) with \(Cm = CTMD \times nb'_{m1}\) and \(nb'_{m1} = n \times tma'\), then
\[
Cm = CTMD \times n \times tma'.
\]
Then we have \(pfu(CTMD \times n \times tma') + \partial\text{ricelle} = \partial'(1 + er)\)

Second case: Define the value of \( r \) to affect investment in the period \( t+1 \) (spending efficiency): \( r > 0 \) with \( \partial' \geq Cm \times pfu \)

Should \( \sum_{i=0}^{n} pfu_i \times Cm_i \) + \( \partial\text{ricelle} + r \leq \partial'(1 + er) \)

Then we have \(pffu(CTM \times n \times tma') + \partial\text{ricelle} + r = \partial'(1 + er)\)

\[
pfu = \left[ \left( \frac{\partial'}{n \times tma'} - \frac{\partial\text{ricelle}}{n \times tma'} \right) \times \frac{1}{CTM} \right] \times (1 + er)
\]

\( \text{Value of the remainder of the investment required for } t+1 \)

This value \( R' \) can be used in two options:

- Assigning \( R_i \) to morbidity \( t+1 \) by calculating an estimated effective population \( n' = \frac{R_i}{CTM} \)

\( n' \) is only effective as a morbid \( t \) could support the value of the remaining \( R_i \). Compensation by \( R_i \) in \( t+1 \) or \( Cm_{t+1} = Cm_{t+1} - R_i \). The population size in morbidity \( t+1 \) will \( nb'_{ma} = (n - n') \times tma' \).

\( R_i \) considered the internal funding support. The advantage is that the value of \( Cm \) can be decreased in \( t+1 \). Of course, we also have a decrease of \( pfu \).

- Assigning \( r_i \) to investment in \( t+1 \). In \( t+1 \), the postponement of the remainder \( \Gamma_i \) 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\(^1\) variation of the pfu the two principles of rationalization are the following:

\[
pfu = \left[ \frac{\partial'_{i}}{n \times tma} - \partial_{i} - \text{fin} \right] \times \frac{1}{CTM} \times (1 + er')
\]

or

\[
pfu = \left[ \frac{\partial'_{i}}{n \times tma} - \partial_{i} - \text{fin} - r \right] \times \frac{1}{CTM} \times (1 + er')
\]

5. Pricing model of covering the medical costs in hospital

Having the variables:

- \(I\): care service and/or pharmacy unit
- \(C\): cost of a medical service
- \(CT\): total cost of medical services
- \(F_i\): 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: \(F_i = C_i \times mp'\). For a pfu of 15\%, we have \(mp' = 0.15\) and \(mp'' = 0.85\).

\(F_1 = C_1 \times mp' = 15, F_2 = C_2 \times mp' = 22.5, F_3 = C_3 \times mp' = 45, F_4 = C_4 \times mp' = 67.5\)

The amount of the envelope of the covering of medical costs is \(CT \times mp''\). Hence, the value to be deduced on the envelope of covering the medical costs of the users is \(1000 \times 0.85 = 850\): that is the value in the bookkeeping budget annex of the hospital to balance the various costs of hospital services. These different values of \(F_i\) 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\(^1\) on alcoholic beverages.

---

\(^1\) The poorest households are often forced to reduce their food consumption, practice self-medication and/or incur catastrophic health expenditure.

\(^1\) 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.

\(^1\) 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.

OMS, Rapport sur la santé dans le monde en 2010.
References
[1] Hounkpati Yram Jean-David HOUKPATI, Autofinancement d’une structure de soins, Th. Dictorat, Université CLAUDE Bernard – Lyon 1, 2007;
[2] 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;
[3] Ilunga TSHINKO, Andre-Pierre CONTANDRIPOULOS, Pierre FOURNIER, Plan de paiement anticipé des soins de santé de Bwamanda (Zaire) comment a-t-il été mis en place?, Social Science et Medicine, Volume 40, Issue 8, pages 1041-1052;
[5] ISSA, Méthode de financement des soins de santé: une utilisation rationnelle des mécanismes de financement pour assurer une couverture universelle, Rapport technique n° 05, Moscou, 2007;
[8] MOLGEO Michel, La tarification hospitalière de l’enveloppe globale à la concurrence par comparaison, Anales d’économie et de statistique, n° 58;
[10] OMS, Comité d’OMS d’experts des problèmes liés à la consommation d’alcool, Série des rapports techniques, 2ème Rapport, n° 944, pp. 30-32;