

# COST-EFFECTIVENESS OF ORGANISED INPATIENT CARE FOR STROKE

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## Abstract

**INTRODUCTION:** Every year, 120 000 French are suffering from a stroke. One year mortality rates are around 30% for cerebral infarction and 50% for cerebral haemorrhage. The sequelae from this serious pathology are often extremely persistent with the consequence that individuals who survived a stroke require treatment in all types of care facility in the French healthcare system. **METHODS:** The stroke path within the healthcare system has been simulated, using a Markov modelisation. The chosen length of the simulation is 5 years, which means 20 cycles of 3 months. Markov states were defined from clinical elements of the pathology, disability rate of the patients (Barthel index) and pathways of cares (rehabilitation centers, home, geriatric institutions). Three disability levels were picked up in each path, using the Barthel index. There are 4<sup>(2+3+3)</sup> clinical status, making 45 Markov states, including death, no matter of its cause, as absorbing state. 3, 6, 9 and 12 months mortality rates were calculated for each mechanism from cohort of 213 patients. The course taken by patients through the French healthcare system after acute hospitalisation for stroke was identified from an observational survey carried out by the stroke registry, Dijon. Costs were estimated using the national costs database, PMSI. All calculations of cost were made using the point of view of the healthcare system, limiting expenditure to healthcare consumption and use of medical or medico-social resources (ODAS 97). Expenditures were discounted at 5%. **RESULTS:** The model enabled us to calculate how long patients spent with each of the different levels of disability or in the different places of residence, according to whether they received care in a stroke unit or conventional care. Through these 5 years, 36.9% of patients died. The survivors spent an average of 11.6% of the time in hospital, 14.6% of the time in geriatric institutions and 73.8% of the time at home. Through 5 years with disability consecutive to a hospitalization, 69.2% of those are with mild disability (Barthel 95-100), 16.2% are with moderate disability (Barthel 60-90) and 14.6% are with severe disability (Barthel 0-55). Taking care of the 120 000 annual stroke cases in France would cost € 4.5 billion after 5 years, ischaemic strokes and subarachnoid haemorrhages apart. Of those 43.1% are from short term hospitalization, 4.5% from rehabilitation centers, 26% are institutional facility, 26.4% are home care. The amount of expenditures is proportional to disability rate. A sensibility analysis was preceded. **CONCLUSION:** The incidence approach is the only one that allows a reflection on the conditions of a future change of the costs. An implementation requires a global approach of the disease.

## Introduction - Aims

Every year, 120 000 french are suffering from a stroke. One year mortality rates are around 30% for cerebral infarction and 50% for cerebral haemorrhage. The sequelae from this serious pathology are often extremely persistent, with the consequence that individuals who survive a stroke require treatment in all types of care facility in the French healthcare system (short and medium stay hospitals, domiciliary care, hospice care, long-term hospital care...). The integration of information on outcomes in this context is thus particularly complex and challenging.

## Methods

### 1- Markov models

#### - Analytic approach :

Four clinical states were defined: first ischaemic attack, first cerebral haemorrhage, ischaemic recurrence, haemorrhagic recurrence. Every stroke involves hospitalization with or without complications. Three care pathways were defined after hospitalization: rehabilitation centers, home, geriatric institutions and long-term care. Three disability stages were defined within each of the pathways, using Barthel index. BI=0-55 (severe disability) ; BI=60-90 (moderate disability) ; BI=95-100 (mild disability). There are 4<sup>(2 + 3 + 3)</sup> clinical status, plus death, whatever the cause, giving a total of 45 Markov states.

#### - Model n° 1 : 0 to 3 months

- Length of simulation: 3 months, ie 90 cycles of 1 day.
- Early mortality taken into account (daily mortality rate)
- Transition probability by facility type (home, institutions, rehabilitation center)

#### - Model n° 2 : 3 months to 5 years

Length of simulation: 5 years, ie 20 cycles of 3 months  
Markov states defined from clinical elements that characterize the evolution of the pathology and the losses of autonomy observed for each place patients lived in.

#### - Model n° 3 : Budget impact to 5 years

Excel simulation using an annual incidence of 120 000 to 140 000 patients.

### 2- Calculation of probability and mortality rates

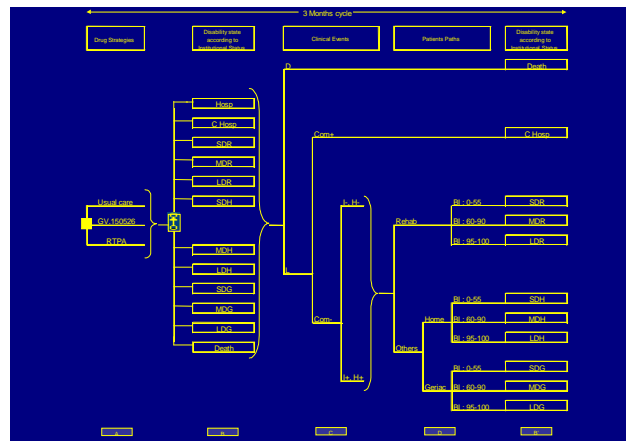
- Analysis of the database built from Dijon stroke registry (specific mortality rate- recurrences rate - patients trajectory according to the Barthel index), from day of hospitalization to a 12 months follow-up.
- Analysis of the file made from trial GLYB3001 (specific mortality rate - taux de mortalité spécifique - patients' trajectory according to the Barthel index); patients were followed up 3 months after hospitalization.
- Mortality rates in France using age group (source INSEE).

### 3- Use of supplies

Short-term care: National costs scale PMSI 2007  
Mid-term care (SSR):  
Use of the PMSI database from Kerpage (313 RSS ordered by Katz index); estimation of standard cost by type of stroke and Barthel index  
Home care : 3 datas for 3 sources (Fédération de la mutualité française - ministère de l'emploi et de la solidarité - université de Nantes)  
Institutional care : there are several organization; les coûts tarifaires sont tous issus de l'enquête ODAS 1997 du ministère l'emploi et de la solidarité.

### 4- Statistical analysis

Estimation of both mortality and recurrence rate using the Kaplan Meier and actuarial methods. (weekly and quarterly rates)  
Student test and analysis (quantitative variables), Chi2 test (qualitative variables), Log Rank test (survival curves)  
Risk  $\alpha = 5\%$ , 95% confidence interval



Hosp = Hospitalization ; R = Rehabilitation centers ; H = Home ; G = Geriatric institute ; D = Disability ; S = Severe ; M = Moderate ; L = Low ; Rehab = probability of rehabilitation center care ; Home = probability of home care ; Geriac = probability of geriatric institute care ; BI = Barthel Index ; 0-55 = severe disability ; 60-90 = moderate disability ; 90-100 = low disability or independence.

## Results

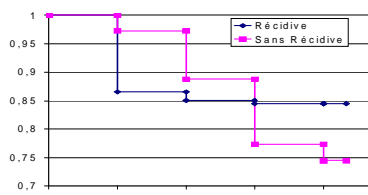
### 1- Mortality and recurrence rates

- 0-3 months:** Analysis of trial (GLYB3001): 166 patients were recruited in France. The patients are aged 67.86 ± 2.2 years old. The analysis allowed calculation of mortality rates during the first quarter: 17.90% over 7 days; 22.22% over 15 days; 26.5% over 30 days and 31.74% over 90 days. As the follow-up of the patients ends after three months, neither quarterly mortality rates, nor recurrence rates were estimated from this file.
- 3-12 months:** Stroke registry (Dijon) : 213 patients were selected and followed for a year, included 187 ischaemic stroke and 18 haemorrhagic stroke. The patients are aged 74 ± 1.7 years old. The analysis allowed the calculation of quarterly specific mortality before recurrence rates: 13.46% (first quarter); 1.74% (second quarter); 0.62% (third quarter); 0% (fourth quarter). The annual specific mortality rate is 15.5%. Both recurrence rate and mortality before recurrence rates were calculated for each quarter. The results are displayed in table 1.

Table 1 : Recurrence rate and mortality after recurrence rate

	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Quarterly recurrence rate	3,77	5,88	4,69	3,89
Biannual mortality rate (after a recurrence)	2,74	8,7	12,9	3,7

Figure 1 : Specific survival curves, with and without recurrence



- > 12 months:** Mortality and recurrence rates between 1 and 5 years were estimated from 2 articles of the Oxfordshire Community Stroke Project :  
- Dennis M, Burn J, Sandercock P, et al. Long-term survival after first-ever stroke: the Oxfordshire Community Stroke Project. Stroke 1993; 24: 795-800.  
- Burn J, Dennis M, Bamford J, et al. Long-term risk of recurrent stroke after a first-ever stroke. The Oxfordshire Community Stroke Project. Stroke 1994; 25: 333-7.

### 2- Patients pathways

- 0-3 months:** Analysis of trial (GLYB3001) : Over 119 patients alive 1 month after hospitalization, 37 are at home, 10 are in institution, 55 are in rehabilitation center and 17 are in hospital. 3 months after hospitalization, the repartition of the 110 patients still alive is described in table 2.4

- When they leave the hospital, the patients that are alive are placed in one of the three places studied: home, institution, rehabilitation center. Transfers between those 3 places and hospital, and the duration of stay in each organization were gathered for trial GLYB3001. Successive transfers were counted and summed for each places to live. The average duration of stay over 3 months was calculated. The multiplication of those 2 parameters gives the number of day-patient by organization. The division of this number by the potential number of day-patient over 3 months gives the probability to be placed in for each organization.

- 3-12 months:** Stroke registry (Dijon) : After hospitalization, 66.7% of patients are going back home, 17.5% are going in institution and 15.8% are going in rehabilitation centers. After 3 months, the repartition by type of care and disability scales of the 156 patients alive is described in table 2.

Table 2 : Distribution of patients after 3 months according to the disability level and the type of care.

Dijon database				
(n = 156)	BI : 95-100	BI : 60-90	BI : 0-55	TOTAL
Home	80,6	12,9	6,5	100
Geriatric	23,3	23,3	53,4	100
Rehabilitation	31,58	26,31	42,11	100

GLYB3001 database (n = 110)				
	Home	Geriatric	Rehabilitation	
Home	62,9	27,42	9,68	100
Geriatric	8,33	50	41,67	100
Rehabilitation	10,71	32,14	57,95	100

- > 12 months:** The patients pathways within the healthcare system are supposed to be the same as pathways between 3 months and 12 months.

### 3- Calculation of costs

- Hospital care : GHM PMSI
- Medium-stay care : Kerpage (Morbihan) PMSI database. 313 weekly summary related to ischaemic stroke and haemorrhagic stroke were ordered in 3 levels, using the Katz index. A total of 3268 reduction acts were analysed. Weekly standard cost of care for mild, moderate and severe ischaemic stroke are respectively €2668, €2720 and €2668. The same costs in case of haemorrhagic stroke are respectively €2561, €2625, and €2668. Taking into account the duration of stay in a rehabilitation center by type of stroke and by disability scale, the costs of care of patients are displayed in table 3.

Tableau 3 : Quarterly standard costs of care in a rehabilitation center (Kerpage)

BI	Ischaemic stroke	Haemorrhagic stroke
0-55	26 026 €	32 478 €
60-90	25 194 €	29 371 €
95-100	1 894 €	12 006 €

- Home care : The costs were evaluated from 3 different sources. Real cost comes from a micro-costing study on the elder of Doubs and Loire-Atlantique. Depending on the Barthel disability scales, costs are estimated in table 4.

- Institutional care : Costs were estimated from several sources. ODAS costs were weighted in order to get the real cost of care. Depending on the Barthel disability scales, costs are mentioned in table 4.

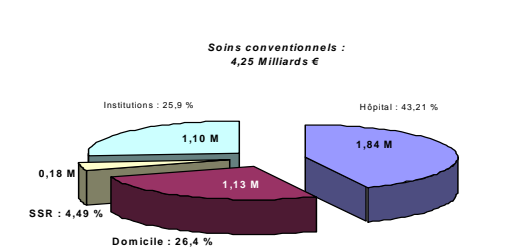
Table 4 : Quarterly standard costs for home care and institutional care

BI	Home	Institution
0-55	2 846 €	5 666 €
60-90	2 236 €	4 862 €
95-100	2 195 €	4 598 €

### 4- Results over 5 years

During 5 years, 36.9% of the patients died. For the patients who survived, time spent in hospital, institution and home respectively represent 11.6%, 14.6% and 73.8%. Over 5 years, the average time spent in disability is 69.2% for mild disability, 16.2% for moderate disability and 14.6% for severe disability. The total cost of care of the 120 000 ischaemic, haemorrhagic or transitional stroke cases for the next 5 years is 64.25 billions, in which 43.2% are related to hospitalizations, 4.5% are related to rehabilitation centers, 26% are related to institutions and 26.4% are related to home care. The amount of expenditure grows with the level of disability. A sensibility analysis was performed.

Figure 2 : Coût de la maladie à 5 ans



## Conclusion

The Markov model allows estimating the cost of a stroke 5 years after the attack. This estimation needs a meticulous search for informations on patients pathways through healthcare system. The analysis of databases (Registry, PMSI, clinical trials ...) allows an access to the exact informations (Mortality, recurrence, duration of stay, probability of transfer and unit costs) which are necessary to calculate the real cost of the disease. By adapting them to the French specificity, foreign surveys can also contribute to that calculation. The incidence approach is the only one that allows a reflection on the conditions of a future change of the costs. An implementation requires a global approach of the disease.