

## THE COST OF MANAGEMENT OF INTRACRANIAL ANEURYSMS BY EMBOLIZATION IN MOROCCO: ABOUT 48 CASES

CHEIKH AMINE<sup>\*1,2</sup>, EL ABBADI NAJIA<sup>3</sup>, ISMAILI HATIM<sup>4</sup>, ABABOU ADIL<sup>4</sup>, CHERRAH YAHYA<sup>1</sup>, EL QUESSAR ABDELJALIL<sup>3</sup>

<sup>1</sup>Team of Pharmacoepidemiology and Pharmacoconomics, Faculty of Medicine and Pharmacy, University Mohammed V Souissi, Rabat, Morocco; <sup>2</sup>Department of Pharmacy, International University Hospital Cheikh Zaid, Rabat, Morocco; <sup>3</sup>Department of Neurosurgery, International University Hospital Cheikh Zaid, Rabat, Morocco; <sup>4</sup>Department of Anesthesia and intensive care, International University Hospital Cheikh Zaid, Rabat, Morocco<sup>5</sup> Department of Interventional Neuroradiology, International University Hospital Cheikh Zaid, Rabat, Morocco. Email: cheikh.amine@gmail.com

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### ABSTRACT

**Objective:** Embolization with coils is increasingly used for the treatment of intracranial aneurysms. In Morocco, this technique is not so responded despite the large number of needy patients and those for several reasons. Our objectives are to exhibit the parameters which influence the cost of embolization technique and the correlation between global cost of treatment and clinical parameters of patients. Also, we want, across this paper, to give some technical informations for insurance health agency to reevaluate the packages set by the health insurance system for the management of patients who needed this technique.

**Methods:** Forty eight patients underwent endovascular treatment of one or more intracranial aneurysms had been studied from January 2010 to April 2012. The cost was assessed by using the micro-costing method that takes into account all direct costs (hospitalizations, physician services, visits, clinical investigations, and medications). The total cost was estimated by adding up the money spent for treatment modality. In other terms the calculation was based on "the fees of medical procedures" as defined by the General Nomenclature of Professional Acts (GNPA) published by the Ministry of Health, which will be referred hereafter as "unit of work". For drugs, the calculation was done by using the prices approved by the Ministry of Health, and for medical devices, the prices used were those applied by our hospital.

**Results:** In total, 48 patients, with 52 aneurysms, were treated, mean age 52.4 + / - 12.5 years. The sex ratio M / F = 0.71. 26 patients were covered by health insurance (52.2%). The median overall stay within 10 days [5-11] in Intensive Care Unit (ICU) stay was 1 day [1 to 2] and medical unit stay was 6 day [3 to 9.75]. The overall average cost of treatment was 9 697.8 €, varying from 4 784.3 € to 32 172.3 €. The cost of pharmaceutical products is 57.6% on average in the overall cost. While the average cost of consumables was 5 612.4 € with a range of 2 499.1 € to 16 370.8 €. To summarize, the overall cost of care is influenced by the number of medical devices and by the size of aneurysm. Furthermore, the pharmaceutical products' cost is especially influenced by the size of aneurysm and the size of aneurysm's colet. However length of stay, hypertension and smoking, and aneurysm's localization do not affect the overall cost.

**Conclusion:** The cost of pharmaceutical products (drugs and medical devices) in the endovascular treatment of intracranial aneurysms remains high and represents a major handicap for the development of this technique in countries with low coverage by a health insurance regimen (34% in Morocco). As we mentioned before the overall cost is especially influenced by the number of embolization's material (coil, micro guide, stent...), by the size of aneurysm and by the size of colet.

**Keywords:** Aneurysm, Cost evaluation, Micro-costing, Insurance health, Pharmaceutical products.

### INTRODUCTION

The overall prevalence of intracranial aneurysm would be between 0.5 to 6% of population, based on angiographic study or autopsy [1, 2]. The frequency of detection of these aneurysms has increased due to the greater use of diagnostic imaging techniques noninvasively.

Aneurysmal rupture, accompanied by a subarachnoid hemorrhage, is associated with a mortality of 30-67% and a morbidity of 15 to 30% [3, 4].

Aneurysmal Subarachnoid Hemorrhage (SAH) is a significant cause of mortality and continuing morbidity worldwide. The annual incidence of SAH due to rupture of intracranial aneurysm is 5 to 10 per 100 000 population [5, 6].

- UK: Between 6 and 8/100 000 population (Flet & al) [7];
- Sweden: 7,4 /100 000 population (Fridrikson & al) [8];
- USA: The annual incidence would be 10/100 000 population, it was approximately 27,000 annual cases of subarachnoid hemorrhage [9]. Mortality in USA by aneurysmal would be approximately 7000 cases per year [10];
- Japan: the incidence is highest reaching 22.7 / 100 000 [11];

- France: the average annual incidence of SAH was low (2/100 000) and stable over time ranging from 2.53 (1.31 to 3.75) for the period 1985 - 1989 to 2.12 (1.04 - 3.21) for 2000-2004 [12].

The peak incidence is between 50 and 60 years [9, 11]. In the study by de Rooij & al. [11] we observe that:

- Incidence per 100 000 population increased with age from 2.0 (1.6 to 2.6) before the age of 25 years to 19.5 between 45-55 years (17.8 to 21.4) and 26.2 among 75 - 85 years (22.5 to 30.4)
- This translated into an increase of the incidence ratio (95% CI) of 0.10 before 25 years (0.08 - 0.14) to 1.34 between 75 to 85 years (1.13 to 1.60) by setting a reference age group 45-55 years.
- Women accounted for between 60 and 65% of patients with bleeding aneurysmal subarachnoid (Bardach & al. and Molyneux & al.). Incidence among women was 1.24 times higher (1.09 to 1.42) than men. This difference appeared after the age of 55 and then increased progressively [11].

In Morocco, we do not have statistics to assess the incidence and prevalence of intracranial aneurysms or aneurysmal subarachnoid hemorrhage. At the onset of aneurysmal subarachnoid hemorrhage, the treatment of aneurysmal malformation is considered an emergency, most often processed within 24 to 72 hours, to avoid

further aneurysmal rupture. Two options exist to treat aneurysmal malformations (exclusion of the aneurysm):

- Either the neurosurgical treatment to be a clip of the malformation;
- Or Neuroradiology treatment (embolization) to occlude the malformation via endovascular.

The third option, no treatment is rarely discussed that for patients with very severe clinical conditions and derogatory or very elderly patients. [13]. The proportion of patients treated with microsurgery decreases since then. The British study of Vindlacheruvu & al. (Middlesbrough) showed that the annual proportion of patients treated by endovascular increased from 1.7% in 1996 to 53% in 1999 [14]. This phenomenon has increased since the publication of the ISAT study in 2002 [15].

The Dutch team of Sluzewki & al. reported that the rate of subarachnoid hemorrhage treated by embolization ranged from 21% in 1995 to 80% in 2002 [16]. In the U.S, the proportion of patients examined by endovascular remains lower: a literature review of 2005 reported 30% of patients treated with this method [17], 28% of treatments for subarachnoid hemorrhage in a study to Boston from 2002 to 2003 [18]. The International Subarachnoid Aneurysm Trial (ISAT) is the first multicenter prospective randomized trial comparing between endovascular treatment and surgery treatment [15]. A total of 2143 patients with ruptured intracranial aneurysms were randomly assigned to clipping (n = 1070) or coiling (n = 1073).

In conclusion:

- On a main criterion functional (modified Rankin score at 1 year), few patients were dead or, had been dependent in the endovascular group than in the neurosurgical group (23.7% against 30.7%) (OR = 0.774, 95 % (from 0.658 to 0.911) p = 0.0019). This corresponded to a reduction in relative risk of being dependent or dead at 1 year was 22.6%, 95% (from 8.9 to 34.2) and an absolute risk reduction of 6.9%, 95% (2.5 to 11.3);
- In the endovascular group there was an increased risk of rebleeding during the first month after treatment ;
- In the endovascular group the risk of re-treatment because of late recurrence aneurysm has increased (6.9 times higher) compared by surgical group. Young age, initial incomplete occlusion of the aneurysm, and the size of the aneurysm, represent the factors of risk.

## MATERIALS & METHODS

Forty eight patients underwent endovascular treatment of one or more intracranial aneurysms were studied from January 2010 to April 2012.

The cost was assessed by using the micro-costing method that takes into account all direct costs (hospitalizations, physician services, visits, clinical investigations, and medications). The total cost was estimated by adding up the money spent for treatment modality. In other terms the calculation was based on "the fees of medical procedures" as defined by the General Nomenclature of Professional Acts (GNPA) published by the Ministry of Health, which will be referred hereafter as "unit of work". For drugs, the calculation was done by using the prices approved by the Ministry of Health, and for medical devices, the prices used were those applied by CHEIKH ZAID hospital.

Cost of treatment was calculated for each patient to encompass their expenses incurred during the time spent as an inpatient for aneurysm's treatment. This consisted of the cost of the initial stay, bed occupancy in ICU and regular hospital bed, laboratory tests, radiology, and the cost of endovascular coiling procedure, including materials (cost of aneurysm clip or endovascular coil and other surgical supplies), the data cost calculation was checked against total cost and individual cost components by the billing department. All costs are presented in US dollars. The

cost of treatment reported in this article does not include the expenditure on additional hospitalization in another institution after discharge, rehabilitation in any institution other than CHEIKH ZAID Hospital, or any anticipated expenditure regarding future procedures.

Statistical analysis: Statistical analysis were performed using SPSS 13.0 for Microsoft Windows XP. Normally, distributed continuous variables were expressed as means and standard deviations, whereas non-normally distributed continuous variables were expressed as medians and interquartile ranges. The correlation between cost and other qualitative and quantitative parameters was established with spearman and Mann Whitney tests. Kruskal Wallis test was used for comparing between groups' costs. The level of significance was fixed at 5%

**Table 1: Clinical parameters of 48 patients treated by embolization**

Characteristic of patients	Number (%)
<b>Health insurance</b>	
• National Fund for public salaries (CNOPS)	8 (16.7)
• National Fund for private salaries (CNSS)	3 (6.3)
• Out of pocket	22 (45.8)
• Private fund for private salaries CMIM	4 (8.3)
• OTHER	11 (22.9)
<b>Tobacco</b>	
• Yes	19 (51.4)
• No	18 (48.6)
<b>Arterial Hypertension</b>	
• Yes	17 (41.5)
• No	24 (58.5)
<b>Admission causes</b>	
• SAH	38 (79.2)
• Recovery (recanalization)	4 (8.3)
• Ophthalmological disorders	3 (6.3)
• Fortuitous	3 (6.3)
<b>Location</b>	
• Anterior communicating	17 (35.4)
• Carotid-ophtalmic	6 (12.5)
• Sylvian	5 (10.4)
• Posterior communicating	4 (8.3)
• Internal carotid termination	4 (8.3)
• Other locations	12 (25)
<b>At admission, the grade WFNS was</b>	
• WFNS I	32 (66.7)
• WFNS II	8 (16.7)
• WFNS III	2 (4.2)
• WFNS IV	6 (12.5)
<b>At admission, the grade GCS was</b>	
• GCS 15	34 (70.8)
• GCS 14	5 (10.4)
• GCS 13	3 (6.3)
• GCS 12	1 (2.1)
• GCS 10	2 (4.2)
• GCS 8	2 (4.2)
• GCS 7	1 (2.1)
<b>Aneurysm number</b>	
• 1 aneurysm	45 (93.8)
• 2 aneurysm	2 (4.2)
• 3 aneurysm	1 (2.1)

## RESULTS

In total, 52 aneurysms in 48 patients were treated, mean age was  $52.5 \pm 12.5$  years. 20 (41.7%) patients were men and 28 (58.3%) were women. The sex ratio M / F = 0.71. 26 (52.2%) patients were covered by health insurance regimen. The median overall stay was 10 days [5 - 11], 1 day in the ICU [1 - 2] and 6 days in medical units [3 - 9.8].

### Results of cost's evaluation versus other parameters

The overall median cost of treatment was 7 528.3 €, it varies from 4 784.3 € to 32 172.2 €. The cost of pharmaceutical products is 57.6% on average in the overall cost. The median of consumables cost was 4 031.7 € with a range of 2 499.1 € to 16 370.8 €.

There is no correlation between on the one hand the total duration of hospital stay or just the ICU stay and secondly the overall cost of care ( $r = 0.243$ ,  $p = 0.096$ ) and ( $r = 0.261$ ,  $p = 0.073$ ) respectively. Also, there is no correlation between hypertension or smoking and the overall cost of care ( $p = 0.771$ ,  $p = 0.480$ ) respectively.

Neither the overall cost, nor the cost of consumables are influenced by the aneurysm localization ( $p = 0.543$ ,  $p = 0.461$ ) respectively.

However, the global cost is significantly influenced by the number of implantable medical device used especially coils ( $r = 0.338$ ,  $p = 0.019$ ), by the size of the aneurysm ( $r = 0.296$ ,  $p = 0.051$ ) but not influenced by the size of the aneurysm's colet ( $r = 0.227$ ,  $p = 0.144$ ).

Furthermore, The pharmaceutical products' cost, especially medical devices, is significantly influenced by the size of aneurysm ( $r=0.545$ ,  $p < 0.001$ ) and by the size of aneurysm's colet ( $r=0.319$ ,  $p=0.03$ ).

### DISCUSSION

The ISAT trial demonstrated that endovascular treatment gave better clinical outcomes measured in 2 months and 1 year of follow-up results for aneurysms suitable for both endovascular coiling and neurosurgical clipping. So, the use of endovascular therapy will increase even in developing countries in the treatment of intracranial aneurysms, therefore, resource allocation should be based on this new pattern of practice.

In our case, cost of pharmaceutical products is a major handicap for the development of this technique (part of pharmaceutical product in overall cost is 57%), specifically coils, micro catheters and the guides. In Morocco, the prices of medical devices are not regulated by Ministry of health, they are free. Thus, hospitals negotiate directly with suppliers the prices of acquisition of these medical devices.

In our institution, the Committee of drugs and medical devices decides on medical devices to be used within the hospital. The rules of pharmaco-economics are often used where possible, that means the price is discussed as if the quality is already acquired.

If several suppliers offer equivalent products in terms of quality or additional terms of size or composition of materials, prices are negotiated with each supplier and price differences may be acceptable in this situation. Unfortunately, the low number of coils used is the main cause of high prices and lack of enforcement of economies of scale in this area.

Otherwise, for this act, the fee paid by Mandatory Health Insurance (MHI) (5,364 €) is only the half of the average full cost calculated in these series. The remaining co-payment is borne by patients. This is the second obstacle, in addition to the high cost of medical devices used, before the development of this technique and its widespread adoption.

Also, the situation becomes increasingly severe in patients who have no medical coverage or who are subject to the new system called Medical Assistance Plan in Economically Deprived which has just been launched in Morocco. This plan will cover the third of the population and the services covered are those lavished only in the public sector. In this case, if public facilities do not include these items (coils, micro catheters, guides and others) in their classifications, patients will have no chance to be treated by endovascular treatment.

So, to develop this technique, we suggest:

- Valuing the cost of this technique and reduce co-payments incurred by patients
- The generalization of Basic Medical Coverage and include medical devices used in this technique in the nomenclature of public health establishments.

In addition, the results of our study show that the overall cost of care is not influenced by the total length of stay or of hospitalization in the intensive care unit, since the cost of hospitalization is low compared to the consumable (136 € for a night of intensive versus 545 € for a single coil) and is not much in the overall amount of support.

Although hypertension and smoking are recognized as risk factors in hemorrhagic stroke; they don't influence the overall cost.

However, the correlation is statistically significant between the cost of consumables and the number of coils and other medical devices that are used, it is also significant between the cost of consumables (drugs and medical devices) and the size of the aneurysm (sac) and the size of Colet aneurysm. These results are logical because the larger the size of the aneurysm, the greater the number of coils is important. Also, the number of devices used is important in accordance to the Colet's size, the Neuro-radiologist is forced to use the balloon dilatation or stent, which implies a significant rise of costs' incurred. However, a few studies have compared the cost of coiling and clipping of ruptured intracranial aneurysms more precisely in countries with limited medical coverage. Between one of them Muhammad Zubair Tahir and al evaluated the Cost-effectiveness of clipping vs coiling of intracranial aneurysms after subarachnoid hemorrhage in a developing country more precisely in Pakistan. "Patients with aneurysmal SAH whom we judged to require coiling had higher charges than patients who could be treated by clipping. The benefits of apparent decrease in length of stay in the endovascular group were offset by higher procedure price and cost of consumables. There was no significant difference in clinical outcome at 6 months" [19]. The average cost of endovascular treatment was estimated at € 3,907.69 in Pakistan [19].

Moreover, other studies have been done in this direction, for example, a comparative analysis of cost-effectiveness of coiling vs clipping has been attempted by Bairstow and al which analyzed 22 patients who were enrolled into ISAT in Perth, Australia. Ten patients were randomized to coiling and 12 to clipping. They concluded that while the endovascular procedure tended to be more expensive in terms of the cost of consumables, this expense was more than compensated by savings in staffing costs, and the period and cost of hospitalization. Following an endovascular procedure, patients tended to return to normal activity or paid employment sooner and have a favorable functional outcome compared with patients following a neurosurgical procedure [20]. Ballet and al presented a similar conclusion in a retrospective study in France [21]. Johnston from the University of California San Francisco performed a multivariate analysis on length of hospitalization. Total length of stay was longer (mean 7 days for surgical patients vs 5 days for endovascular patients), and hospital charges were greater for surgical clipping (\$38 000 for surgical patients vs \$33 400 for endovascular patients) [22]. Javdpour and al analyzed 62 patients who were randomized in the ISAT from the University of Toronto, Canada. There were no significant differences in the total cost of treatment between the endovascular group and the microsurgical clipping group [23]. The benefits of apparent decrease in length of stay in the endovascular group were offset by higher procedure costs. There was no significant difference in clinical outcome at 2 months and at 1 year. At 6 months after coiling, 15 (50%) of 30 aneurysms were completely obliterated, and 19 (63%) of 30 were angiographically stable. However, these conclusions may not be applicable to aneurysm's treatment in all countries. The average cost of endovascular treatment in France was assessed by studying Labalette and al to 14 477.39 € [24]. The cost and availability of health care differ substantially between countries. All these studies originate from developed countries where medical insurance covers most of the medical expense, per capita income is higher than the world average and the surgical management, and interventional treatment has a different fee structure from the rest of the world [19].

### Views

**(A) Health Policy:** For a health system, whether in developing or developed countries, the main objective is to provide quality health care while controlling costs associated with, what is efficiency. Moreover, given the budgetary constraints applied to all players in

the chain of care, health system, government, patients, medical and paramedical professional, health insurance organizations..., it is crucial to analyze the respective costs of each of the proposed protocols and to make findings that can inform decision makers of the care system. This is mainly dependent on the financial and logistical means available in a given country, as the financial accessibility to care for patients who remains highly dependent on the availability of medical coverage and drug prices. Also, the importance of such study is to standardize the medical practices in health establishments with the aim of:

- Providing the same benefits to all patients regardless of other parameters that can influence the decision of the treating physician;
- The choice of a given protocol should be based on scientific data and also pharmaco-economic studies.

This will give tangible facts to the department mandated by the Ministry of Health to negotiate the purchase of medical and non medical supplies and products.

This study shows that for this technique, newly introduced in Morocco, and practiced in only three centers, the amount paid or reimbursed by the health insurance system remains still low and does not encourage health professionals and patients to adopt this technique as much as possible.

Thus given the significant benefits provided by this technique, the health system needs to think about making it more accessible by encouraging radiology centers to settle and by providing more technical and financial facilities. Also, prices of consumables, mainly coils, micro catheters and guides, must be negotiated with the Ministry of Health to ensure prices homogeneity and stabilize the market while providing a volume of consumption enabling suppliers a financial sustainability.

#### **(B) Hospital**

The adoption of endovascular treatment offers some advantages to the hospital structure according to the results obtained. Less hospital days in ICU or intensive care will allow the hospital structure to accommodate additional patients in need of such care. Therefore, and based on the results of the ISAT study, the results achieved by the hospital on these cases will be better once the medical team has mastered this technique.

However, and financially, this intervention requires the hospital structure to commit huge amounts to stock up different sizes of coils and micro catheters. The less use of these items confronts the hospital structure to stock-outs or sometimes to expiration

#### **(C) Health Insurance**

Everywhere in the world, a health insurance system has a main objective that is to ensure an optimal management of its members while maintaining its financial stability. In Morocco, the establishment of a system of Mandatory Health Insurance in 2005 has helped to increase the percentage of covered population from 18% to 34%. This objective could be achieved if a control system is in place to control spending ever-progressive.

In this case, that of endovascular treatment of intracranial aneurysms, the health insurance system has a strong interest to encourage this technique with minimal co-pay for patients. That is to say by increasing the fee allocated to the implementation of this act to cover all expenses related to the care lavished and especially pharmaceuticals, which account for 57% of total costs.

#### **(D) Patients**

In a health system, patients have two major concerns: to have a good health with a lower cost.

Thus, at present in Morocco, and in many countries with similar socioeconomic status, we can define three different populations according to the social security coverage:

- The indigent patients, who are fully supported by the health system. These patients are forced to accept the treatments proposed by the public health system without choices in the strategies and protocols for the management of their diseases;
- Patients covered by health insurance, either public or private;
- Patients solvent but without medical coverage, these patients can have to pay significant fees for their treatments.

In our case, all patients regardless of their class are forced to spend heavily to access such care. The cost of coils and other medical devices is important and can lead to an overwhelming increase of the invoice total, which confronts patients to catastrophic expenses.

Even for patients covered by the regime of mandatory health insurance, the study shows that the fee fixed under this plan only covers half of the overall cost. Note that this package has been fixed between health insurance and public university hospitals, no agreement has been signed with the private sector.

#### **CONCLUSION**

The embolization technique is an effective modality for the treatment of such pathology. Unfortunately, this technique is expensive and not available to all patients, especially those not covered by a health insurance plan. In addition, for patients covered by the compulsory health insurance scheme in Morocco, the co-payment is very important because the package specified by the national health insurance agency and insurance funds remains below the actual value of the management of disease. Through this study and the results found, we invite national insurance agency to review the modalities for setting tariffs for the treatment of intracranial aneurysms by embolization and suggest that pharmaceutical products are supported outside packages and based on the number used.

To control abuse, aneurysm's size and the size of aneurysm colet, can serve as critical means to know the number of medical devices used for each patient.

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Our study was approval by medical comity of CHEIKH ZAID Hospital

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