AHP FOR HTA OF SPINE SURGICAL DEVICES

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ABSTRACT

The purpose of this paper is to describe an application of AHP for Health Technology Assessment to support decision makers in choosing devices for surgical treatments. We apply AHP to allow surgeons to design a hierarchical structure for multi-criteria decision-making, by breaking problem down, and then aggregating the solution of all the subproblems into an analytic conclusion.
In this paper, a case study on neurosurgery, especially to spine surgery, is presented. A sample of 16 patients, which received surgery for cervical herniated disc at one level, has been clustered by used fixings: two kinds of cage, in titanium and carbon, induce intersomatic arthrodesis; Discovery, a disc prosthesis; Somafix, a shape memory superelastic fixing.
By applying this method, mainly through graphical representations, the decision makers understood easily the fitting of alternative with different criteria.
Overall the most important skill of this methodology is the possibility to run through the process of decision; this is a crucial point especially in a public health system.

Keywords: Analytic Hierarchy Process (AHP), Health Technology Assessment (HTA), cervical herniated disc, spine surgery, Quality of Life (QoL).

1. Introduction

The health system is a complex environment, in which different knowledge coexist and cooperate in order to solve complex problems.
In this scenario it is very important, especially in public health systems, to base any decision on a systematic, traceable and well-documented process in the case of long term strategic political decision as in local and operative ones. Health Technology Assessment (HTA) can be a appropriate method to support such decisions. It is an inter/multi-disciplinary and multi-dimensional process to evaluate different technologies, alternative and competitive between them.

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The aim is to support the decision makers in health policies with technical-scientific evaluation.
In this paper the authors deal with a main decision problem in cervical spine surgery: fusion or non fusion systems for cervical herniated disc at one level.
This study analyzes four technological solutions: two kinds of cage, in titanium and carbon, induce intersomatic arthrodesis (fusion); Discovery, disc prosthesis (non fusion); Somafix, shape memory superelastic fixing (non fusion).
The results show that the non fusion technologies satisfy clinical and patients' needs better than the fusion ones. On the other hand, fusion technologies have less impact in the management of health structure. That is because the fusion methods are well established in clinical practice, while the non fusion methods, in particular the Somafix, constitute an entirely new approach to this disease.

2. Methods

This work suggests a method based on both AHP and Mu.S.Me.T.A. proposed by Pecchia et alii in 2007, in which the decision makers are supported to detect the technology that fill needs on different scale. On different scale means to satisfy individual needs as a whole and one by one. An objective function is established in order to detect the best technology overall.
The multicriteria logic, introduced by AHP, allows breaking down the global decision into smaller specific decision-areas (clinical, patient's, managerial needs). Then, the weights of each area on the final decision are assessed. Furthermore within for each of these areas it is assessed the importance of any specific need. Finally, four alternative technological solutions are compared to assess how each one fit for satisfaction of any need.
This method is aimed to give a graphical visualization of the decision process in order to be more confident for decision makers not so skilled with mathematics.
The schematic structure of method is represented in the following algorithm (Figure 1).

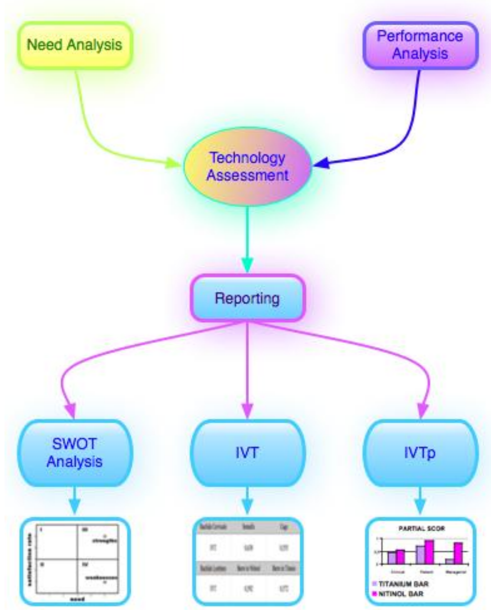


Figure 1. Schematic structure of method.

The main four steps (Need Analysis, Performance Analysis, Technology Assessment and Reporting) are explained one by one.
Need Analysis. This is the first step of the proposed method. It is a crucial point because every need has to be identified and clustered and it requires a deep knowledge of both disease and managerial problem.

The algorithm of need analysis is represented in the following (Figure 2).

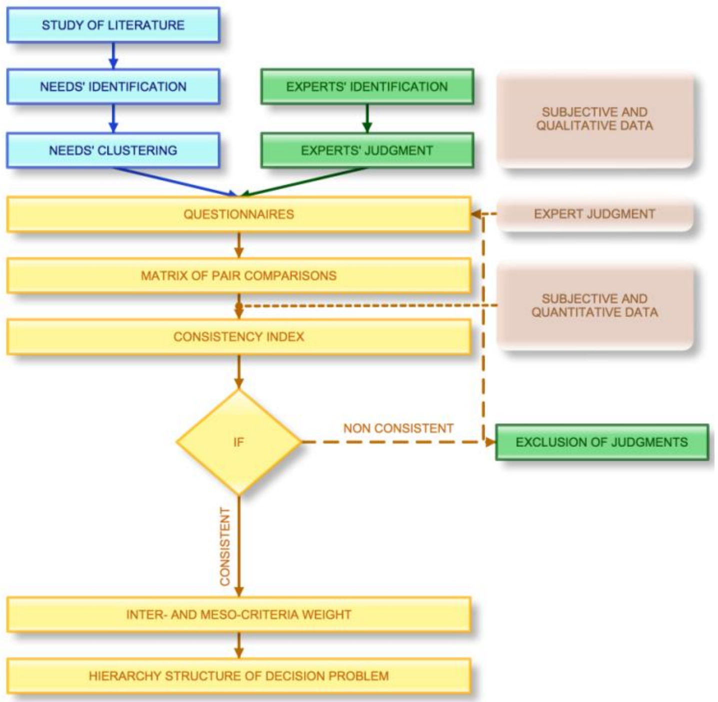


Figure 2. Algorithm of need analysis.

Study of literature is the start of need analysis. The identification and clustering of needs are made in cooperation with an experts' team, selected by decision makers. Between each decision-area, equips of different experts determine how each area affects the total decision (inter-criteria judgment). Furthermore, within each area, one equip determines the weights of specific needs of the same group (meso-criteria judgment).
The judgment of experts (Table 1) is weight using a specific function (W_{exp}) which considers years of specialized activity (Y_{sp}), experience in the spinal surgery (Y_{ss}) and the interest area (A_i).

Table 1. Judgment of experts.

Experience weights			
Years of activity (specialized and in spinal surgery)		Interest area	
Years	Weight	Area	Weight
>15	0,61	Spinal surgery (Surgeon)	0,67
7-15	0,25	neuroreabilitation	0,22
3-6	0,10	Spinal surgery (Assistant)	0,11
0-2	0,04		

$$W_{\exp} = Y_{sp} + (Y_{ss} * A_i)$$

Furthermore, using the Consistency Index method proposed by Saaty and based on the Random Index method proposed by Forman 1990 has tested the coherence of their answers.
Finally, a hierarchical structure of the decision problem was obtained (Figure 3).

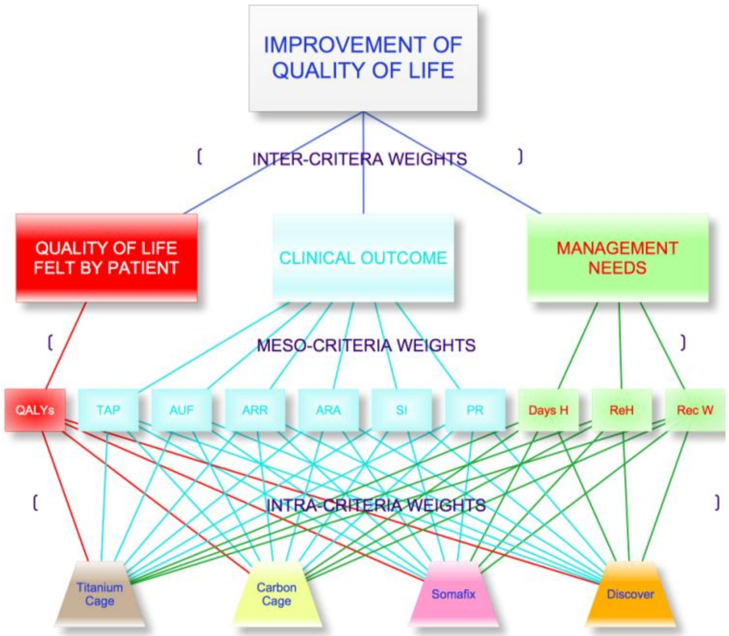


Figure 3. Hierarchical structure of the decision problem.

Performance Analysis. The performance of technology is the satisfaction's degree for each need. This analysis is performed in a simple of 16 patients, which received surgery for cervical herniated disc at one level in the same Hospital: IRCCS Neuromed in Pozzilli (IS), Italy. The performance analysis is the measuring of satisfaction's degree in the simple of patients for each need identified in the need analysis. Specifically, radiological parameters pre- and post-surgery are measured in order to calculate the inter-criteria weight for clinical need (Figure 4).

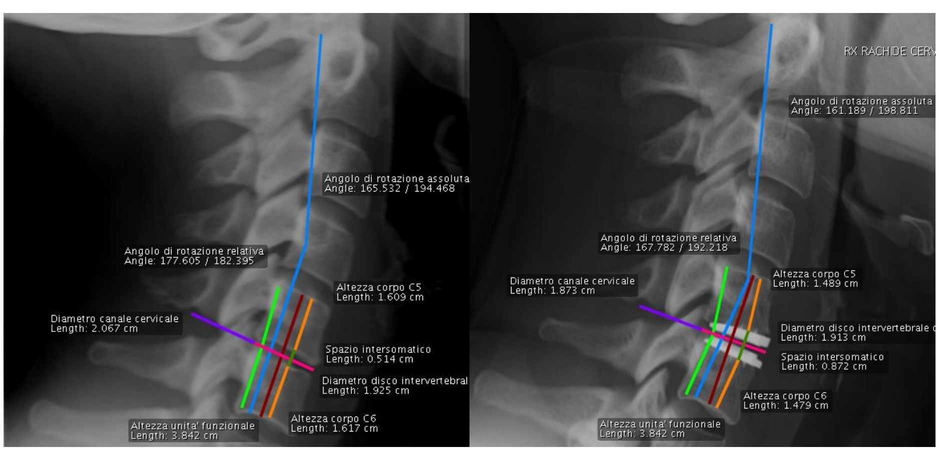


Figure 4. Example of radiological parameters.

The quality of life felt by patients is estimated by using EQ-5D and EQ-VAS questionnaires by EuroQALY. Finally, the performance about managerial need is obtained by considering the days of hospitalization, the cases of new hospitalization for the same disease and interviewing patients about recovering of work.

Technology Assessment. After weighting every criteria (inter- and meso-criteria) and estimating the satisfaction's degree for each need (intra-criteria), the scores for every alternatives are calculated.

Reporting. The results are showed on different scale. A total score is calculated in order to synthesize the whole analysis. The formula is the following.

$$TotScore_{A_1} = \sum_{j=1}^{m} W_{C_j} * \sum_{i=1}^{n_{c_j}} W_{B_i}^{C_j} * W_{A_1}^{B_i^{C_j}} \qquad (1)$$

m = *number of clusters of need*

n_{C_j} = *number of needs which compose the cluster* C_j

W_{C_j} = *inter-criteria weight of the cluster of needs* C_j

$W_{B_i}^{C_j}$ = *meso-criteria weight of the need Bi in the cluster Cj*

$W_{A_1}^{B_i^{C_j}}$ = *intra-criteria satisfaction degree of the alternative A respect to the need* B_i *in the cluster* C_j

By applying the Mu.S.Me.T.A. to AHP it is possible to provide graphically the fitting of any alternative with any need. This representation is obtained by using a Strengths, Weaknesses, Opportunities, and Threats (S.W.O.T.) analysis. This representation can be easily presented to decision makers not well skilled in mathematical methods.

Another representation consists in evaluating the partial score of an alternative A with clusters of needs. The score is calculated using the following formula:

$$Score_{A_1}^{Cj} = \sum_{i=1}^{n_{c_j}} W_{B_i}^{C_j} * W_{A_1}^{B_i^{C_j}} \qquad (2)$$

n_{C_j} = *number of needs which compose the cluster* C_j

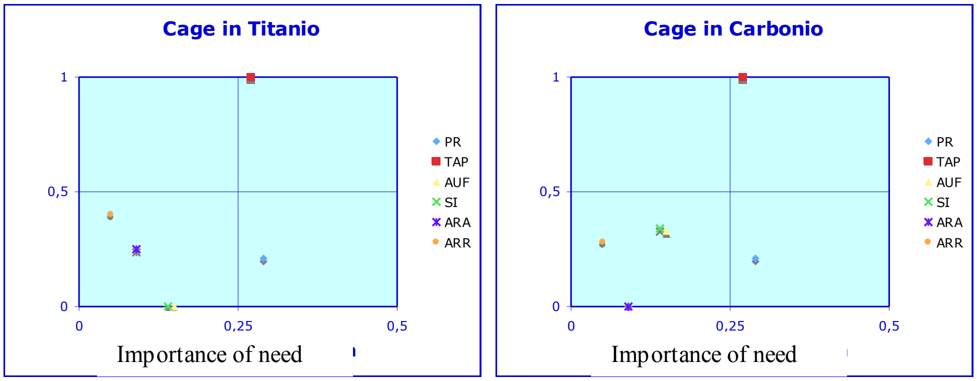
$W_{B_i}^{C_j}$ = *meso-criteria weight of the need* B_i *in the cluster* C_j

$W_{A_1}^{B_i^{C_j}}$ = *intra-criteria satisfaction degree of the alternative A respect to the need* B_i *in the cluster* C_j

In the described problem it is possible to evaluate *m* partial scores for any alternative A that means one for each cluster of needs. Finally a bar representation can easily compare the fitting of any alternative with any clusters of needs.

3. Results

The analysis of case study drives to the results showed in the following. SWOT analysis for clinical needs is represented in the first graphic (Figure 5); the partial scores (Table 2) are given both in the tables and through the diagram chart; the total score (Figure 6; Table 3) in the last table synthesizes this study.



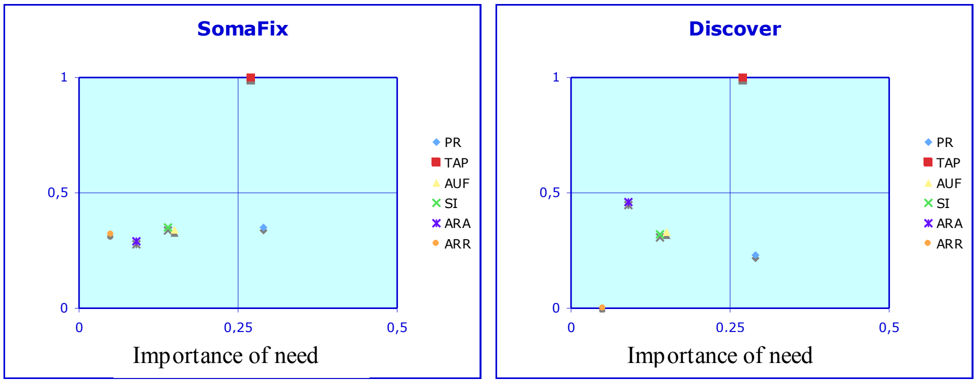


Figure 5. Clinical Outcome.

Table 2. Partial Score.

Partial Score for clinical outcome				
	Titanium Cage	**Carbon Cage**	**SomaFix**	**Discover**
Score	*0,21*	*0,24*	*0,28*	*0,26*

Partial Score for managerial needs				
	Titanium Cage	**Carbon Cage**	**SomaFix**	**Discover**
Score	*0,25*	*0,25*	*0,24*	*0,26*

Partial Score for felt quality of life				
	Titanium Cage	**Carbon Cage**	**SomaFix**	**Discover**
Score	*0,23*	*0,21*	*0,28*	*0,29*

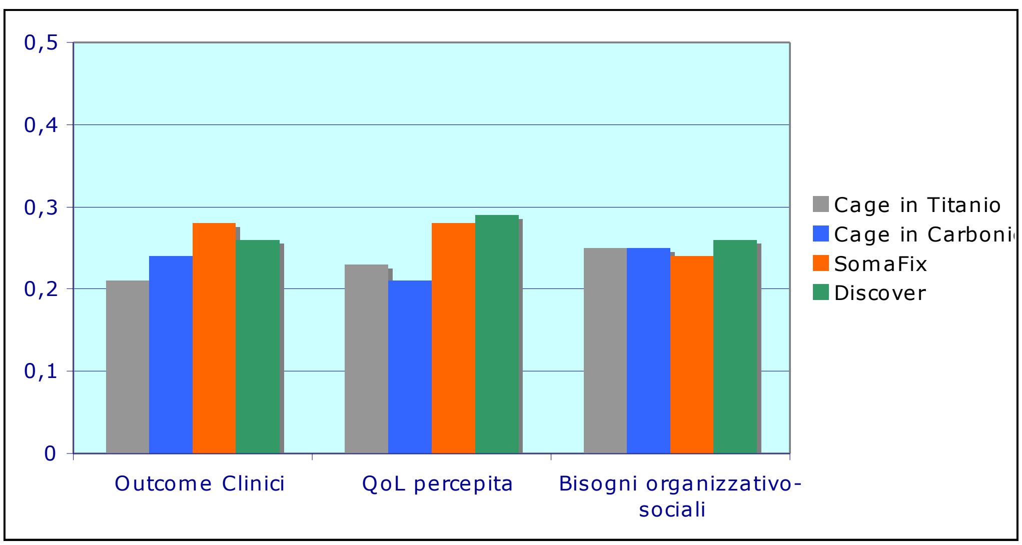


Figure 6. Score Diagram.

Table 3. Total Score.

Total Score				
	Titanium Cage	**Carbon Cage**	**SomaFix**	**Discover**
Total Score	*0,22*	*0,23*	*0,28*	*0,27*

4. Discussion

The method under examination, and particularly with SWOT analysis, outlined and compared the strangeness of different technologies for every identified need. The graphical representation may be easily understood and may be a good support to decisions makers. Besides, the representation of the partial score allows evaluating the satisfaction rate reached by each technology under comparison and for every categories of need. The final decision is obtained considering the judgments of the interviewed experts and the health state of a simple of patients.

In conclusion, the total score gives an indication that the non-fusion technologies are generally preferred over fusion. By analyzing the partial scores is clear then that the fusion technologies have less of an impact in the management and this is understandable considering that these technologies are already in use for many years. On the other hand, the net clinical benefit and improved quality of life perceived by patients, drive the choice to the most innovative non-fusion technologies.

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