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Original Research

Methodology for the evaluation of vascular surgery manpower in France

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SUMMARY

Objectives: The French population is growing and ageing. It is expected to increase by 2.7% by 2020, and the number of individuals over 65 years of age is expected to increase by 3.3 million, a 33% increase, between 2005 and 2020. As the number of vascular surgery procedures is closely associated with the age of a population, it is anticipated that there will be a significant increase in the workload of vascular surgeons.

Study design: A model is presented to predict changes in vascular surgery activity according to population ageing, including other parameters that could affect workload evolution.

Methods: Three types of arterial procedures were studied: infrarenal abdominal aortic aneurysm (AAA) surgery, peripheral arterial occlusive disease (PAOD) procedures and carotid artery (CEA) procedures. Data were selected and extracted from the national PMSI (Medical Information System Program) database. Data obtained from 2000 were used to predict data based on an ageing population for 2008. From this model, a weighted index was defined for each group by comparing expected and observed workloads.

Results: According to the model, over this 8-year period, there was an overall increase in vascular procedures of 52.2%, with an increase of 89% in PAOD procedures. Between 2000 and 2009, the total increase was 58.0%, with 3.9% for AAA procedures, 101.7% for PAOD procedures and 13.2% for CEA procedures. The weighted model based on an ageing population and corrected by a weighted factor predicted this increase.

Conclusion: This weighted model is able to predict the workload of vascular surgeons over the coming years. An ageing population and other factors could result in a significant increase in demand for vascular surgical services.

Introduction

In France, many vascular surgeons will retire over the next 10 years, and the risk that they will not be replaced has raised the issue of predicting future activity in this discipline.[1,2] The French population is growing and ageing.

According to the French National Institute for Statistics and Economic Studies (INSEE), the French population will increase by 1.4% by 2015 and by 2.7% by 2020.[3] The fastest growing segment of the population is individuals over 65 years of age; this age group is expected to increase by 3.3 million (33%) between 2005 and 2020. The ageing index, or the

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proportion of the population over 65 years of age compared with those under 20 years of age, was 71% in 2010 and is expected to increase to 94% by 2020.

Two main factors are responsible for these forecasts. First, people are living longer; life expectancy has increased from 66.7 years for individuals born in 1946 to 76.1 years for those born in 1996. Second, the 'baby boomers' correspond to a wave of population density that will begin to hit retirement age in 2011.

Basic statistics have shown that vascular surgery is primarily performed in elderly patients. Therefore, it can be hypothesized that the workload of vascular surgeons will increase over the next two decades, largely due to the ageing of the French population; however, the extent of this increase is not known. To answer this question, the authors developed a methodology to estimate the number of surgical procedures to be performed in France over the coming years by considering current activity together with demographic changes and an ageing population.

It is recognized that other factors, including technological innovations or political decisions from care holders, could influence the use of vascular surgical services and the need for vascular surgeons. As such, the authors sought to integrate some of these factors into the forecasts. Finally, the results were compared with the annual statistics obtained by the State in order to evaluate the impact of these factors and the accuracy of the model.

Methods

Three types of arterial procedures were studied: infrarenal abdominal aortic aneurysm (AAA) procedures, peripheral arterial occlusive disease (PAOD) procedures and carotid artery (CEA) procedures. Data were extracted from the State Medical Information System Program (PMSI) database, available for 2000 and 2008.

The year 2000 was selected as effective exhaustive coding has been available since that date. The year 2008 was selected in order to have a sufficiently long period of time to validate the predictions. Changes in the classification coding of medical acts in France between 2000 and 2008 meant that the coding system in use in 2000 [Classification of Medical Acts (CDAM)] had to be adapted to fit the current Common Classification of Medical Acts (CCAM) in use in 2008. Code matching between the two classifications was comprehensive. The CCAM includes more codes to specify the same acts as CDAM.

Twenty-nine CDAM codes were selected for 2000 (seven for AAA procedures, 14 for PAOD procedures and eight for CEA procedures), and these were matched with 59 CCAM codes for 2008 (20 for AAA procedures, 22 for PAOD procedures and 17 for CEA procedures) (see Appendix).

The 'effective requirement' for vascular surgery among the population of mainland France for 2000 (T0) was identified from the PMSI database. Data were provided by the French Technical Agency for Hospital Information. A prediction model was established for the three types of procedures based on the age of the population in 2008 (T1). This prediction was prepared using the OMPHALE method developed by INSEE and described elsewhere.[4] Initial projections were carried out by INSEE in 1965, with the aim of calculating future school enrolment.

The OMPHALE method is a complex application that includes a theoretical projection of population, population databases, demographic analysis techniques and tools for building scenarios for the future. Projections are based on the 'components method'. This consists of performing an age distribution based on follow-up of three components: births, deaths and migration.

The OMPHALE method allows projections to be updated continuously by integrating the various censuses, including flows observed by origin and destination. With this method, which is only based on the population, projections are performed on any spatial entity of over 50,000 inhabitants.

Practically, projection to the time horizon T1 of the inhabitants of a territory is calculated from the numbers by sex and age at time T0. Four elements are taken into account for each spatial entity: ageing of individuals by 1 year, addition of births in the year, subtraction of deaths during the year, and addition of net migration.

To be as accurate as possible, these projections were made at 186 specific basins (spatial entity). The construction of these entities is based on the spatial practice of patients by flow analysis from home to hospital. The predictions of vascular surgical workload are realized from the resident population of such entities. Finally, all these local projections were aggregated to obtain the national result.[5] The activity identified for the T1 model was obtained by standardization of the acts according to the age and sex of the population observed at T0, according to the last population census.

The expected modelling of hospital activity at T1 for a spatial entity was expressed as:

$$\text{Exp } T1 = \sum_{k}^{1} P1(T_{iT0})$$

where Exp T1 is the expected hospital activity at T1 for a spatial entity, k is the age group for men and women in the spatial entity, P1 is the population level for k at T1, and T_{iT0} is the rate of each case-mix group according to the age group of men and women in the spatial entity.

Using this approach, the model only relies on the ageing population according to the hypothesis that all other factors are equal. However, the ageing population cannot be the only criterion for the workload evolution. In order to integrate other factors into the model, the expected results found using the model from 2000 to 2008 were compared with the crude numbers observed in 2008 in order to calculate a weighted index. This index represents the differential related to other factors influencing the workload of vascular surgeons. The obtained weighted index was then integrated in the model for 2009, and the calculated and observed data for this period were compared.

Statistical analysis

The comparison between the predictive model and observed surgical workload for 2009 was established using linear regression analysis without constant with JMP software. The coefficients of proportionality and their 95% confidence intervals were calculated. Accuracy of these coefficients has been validated previously by calculating the t ratio and standard error. As shown elsewhere, linear regression close to a value of '1', within 5%, was used to validate the weighted model.[6]