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Improving the forecasting of hospital services: A comparison between projections and actual utilization of hospital services

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ABSTRACT

Objectives: To compare projected and observed hospital inpatient use in Belgium and to draw lessons from that comparison.
Methods: In 2005, projections for hospital service use were generated up to 2015, based on demographic change, substitution from inpatient to day care, and, the evolution of the average length of stay (LOS). The accuracy of the forecasts was assessed by comparing projected and observed population size, admissions and inpatient days, average LOS and percentage change in case mix.
Results: The demographic growth was underestimated. Overall, the baseline projection for hospital admissions was remarkably close to the observed figures but the underlying case mix diverged importantly. With substitution between inpatient and day care, the number of admissions was underestimated by 15%–40%. The number of days was projected to increase in every scenario, whereas a decreasing trend was observed mainly due to the faster decline in average LOS than projected.
Conclusion: Hospital capacity planning is an important component of evidence informed policymaking. Projection results benefit from a well-designed methodology: choice of forecast groups, estimation models, selection criteria, and a sensitivity analysis of the results. To cope with the dynamic and continuously evolving context in which hospitals operate, regular updates to incorporate new data and to reassess estimated trends should be an integral part of the projection framework.

1. Introduction

Accounting for about 20% to 40% of national expenditures on health in Europe, hospital inpatient services occupy a central role in the healthcare landscape [1,2]. Hospitals operate in a changing context and are in a continuous process of reform driven by an ageing population [3,4]; changes in disease burden and in particular an increase in patients with multiple chronic conditions [4–6]; changing opportunities to intervene made possible by new medicines, technological and organisational innovations [4,5,7,8]; and increased pressure to reduce costs and increase performance [2,5,9].

Many European countries are carrying out or have recently introduced reforms reshaping the hospital and healthcare landscape [5,9,10]. Most developed health systems engage in hospital capacity planning, although planning approaches diverge in many aspects, such as planning goals (e.g. impact assessment of the ageing population, reduction of waiting lists, redesign of the health service delivery system etc.), frequency (ad hoc or systematic), geographic granularity or planning horizon [10–14]. As hospital reforms involve substantial time lags, forecast exercises are useful to monitor care provision and provide an early warning of future pressure points, to ensure access to care and allocate hospital infrastructure investments, to preserve quality, to avoid a waste of resources and to guarantee long-term sustainability of the system.

Hospital capacity planning is an important component of evidence informed policymaking and should be well carried out [11–13]. However, policymakers should be aware of the limitations and potential pitfalls of forecasting models as an input for capacity planning. For model developers, it is important to improve upon previous planning studies. To that end, it would be good practice to examine the accuracy of past projections, i.e. compare projected and observed hospital service use over the same period. This to identify the impact of model choices and their implications.

The aim of this study is to compare the projections of Belgian hospital inpatient use made in 2005 with a planning horizon up to 2015 with the observed hospital inpatient use during that period [15]. We assess the divergence between both, discuss potential

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explanations thereof and draw valuable lessons to improve the quality and research methodology of forecasting studies in the future.

There is extensive literature on the measurement of forecast accuracy and on how accuracy can be used to select the best forecast model [16–23]. In the latter case, the available data are split in two periods: an estimation period and a validation period. The estimation data are used to calibrate a forecast model. Next, forecasts are produced for the validation period and their accuracy is assessed to select the best model. However, ex-post evaluations of the accuracy of medium-term projections are rare and to the best of our knowledge, no population-wide forecasts for hospital service use have been evaluated in this way. In 2005 and 2010, reviews have been carried out of the National Bed Inquiry [24] – a UK forecasting study in 2000 on the number of required hospital beds in 2020 [25,26] – and in 2007 a review was made of the Wanless report [27] – a forecasting study in 2002 on the evolution of NHS spending up to 2022 [28]. However, the perspective of the reviews is quite different from ours. The reviews take the projections as policy targets and evaluate whether the targets were attained. They examine in which projection scenario the observed figures can be situated. Contrary to our approach, they do not assess the forecasting methodology with the aim of improving forecasting outcomes and enhance their policy value. In addition, a review of the budgetary projection model for health care of Veterans was made by the RAND corporation, suggesting technical adjustments, rather than providing policy advice [29].

2. Description of the 2005 forecasting study

2.1. Objective and scope

The forecasting report of 2005 was commissioned by the minister of Social Affairs and Public Health to assess whether additional bed capacity was required to meet the care needs of an ageing population. To that end, inpatient hospital service use in Belgium was projected up to 2015, taking into account factors that are quantifiable and expected to affect inpatient care [15]. Inpatient care was defined as all inpatient admissions in general hospitals of individuals living in Belgium. General hospitals comprehend all non-psychiatric care hospitals, i.e. acute, university and specialized care hospitals.

Although policy decisions taken in the period following the publication of the report are in line with its recommendations, no reference to the report was found in official policy documents. The main policy conclusion was that no additional bed capacity was needed to cope with an ageing population, provided that sufficient alternatives to acute hospital care are developed. For example, in the period 2005–2015, the capacity of nursing homes increased by 10%, in particular for high dependency residents, and capacity for short-term care for elderly more than tripled [30,31]. In addition, it was also assumed that a further reduction in average length of stay (LOS) could offset the expected increase in population growth and ageing. While, up to 2002, the national hospital budget was largely allocated to individual hospitals based on a combination of activity levels and the number of beds per hospital, it already included incentives to reduce the LOS. Indeed, in 1994 a bonus-malus system based on a case-mix adjusted LOS calculation was introduced to reallocate a part of the hospital budget: hospitals above the national average LOS were penalised while those below were rewarded [32]. By estimating trends in LOS (see below) the authors implicitly assumed that reduction of LOS would continue at the same pace (at least, if the trend in LOS could be estimated: see below). What was not taken into account was the hospital payment reform in 2002, introducing prospective pathology-based funding [33]. The incentive to decrease LOS intensified as the importance of the average LOS per All Patient Refined Diagnosis Related Group (APR-DRG) in the allocation of the hospital budget increased while the importance of the number of hospital beds decreased.

2.2. Model and assumptions

A model was designed to project hospital inpatient care at three points in time: 2005, 2010, and 2015. The outcome was expressed in terms of admissions and inpatient days.

The model hinges upon a number of assumptions. Ideally, hospital capacity depends on the need for hospital services. In the absence of population-wide data on need for inpatient care, the implicit assumption is that historic usage patterns are a proxy for need in the capacity projections. Observed inpatient service use in 2002 was the starting point of the projection model.

General assumption: *projections of future inpatient service use can be based on observed patterns in historical data that are assumed to continue into the future.*

Other model assumptions reflect choices of the researchers on how they used available information to transform the 2002 base year into capacity projections. Future hospital inpatient care was impacted by three evolutions: the demographic change (based on historical patterns in demographic data), substitution from inpatient care to day care (based on assumptions), and, the evolution of the average LOS (based on historical patterns in hospital data between 1996 and 2002).

Assumption 1. *There is a close relation between inpatient service use, population size and population makeup.*

In a first step, the projected volume of inpatient services was adjusted for the change in population size by age group. To that end, the population was classified in five-year age groups. Demographic projections were not further specified by sex or location.

The projected number of admissions equalled the observed number of admissions by age group in 2002 multiplied by the relative change in population size of the age group. As care use differs between age groups – e.g. pregnancy and childbirth is the predominant care type for females between 20 and 40 years old, whereas the importance of disorders of the circulatory system increases with age –, the projected case mix was affected by the future demographic change. Although the analysis was performed at the level of the APR-DRG, information on the case mix was reported only at the level of Major Diagnostic Groups (MDC).

Assumption 2. *Admission rates are kept constant over time.*

The evolution in admission rates was assumed constant. No estimates of the historic evolution, nor other means to assess the future evolution (e.g. literature review, expert opinions) were conducted.

Assumption 3. *There is a shift from inpatient to day care.*

In a second step, the number of projected admissions was corrected for substitution between inpatient and day care. Eight hypothetical scenarios were developed, each specifying an alternative view on the substitution intensity between both settings. The substitution scenarios assume an immediate shift of selected stays between both settings as from 2005.

In the baseline scenario, no substitution was assumed. In scenarios 1–3, all admissions with LOS below 1 day, 2 days or 3 days respectively, were shifted to day care. Scenarios 4–6 were similar to scenarios 1–3, except that the substitution did not apply to admissions of all APR-DRGs, but of a subset of APR-DRGs more prone to substitution effects. To be included in the subset, a substantial volume of procedures in the APR-DRG had to be performed in a day-care setting and within the APR-DRG, the evolution in admissions and day-care procedures was negatively correlated. Finally, in

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