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Assessing physician productivity following Norwegian hospital reform: A panel and data envelopment analysis

Karl Arne Johannessen [a, *], Sverre A.C. Kittelsen [b, c], Terje P. Hagen [c]

[a] Sykehuspartner Health Enterprise, Oslo, Norway
[b] Frisch Centre, Oslo, Norway
[c] Department of Health Management and Health Economics, Institute of Health and Society, University of Oslo, Oslo, Norway

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ABSTRACT

Background: Although health care reforms may improve efficiency at the macro level, less is known regarding their effects on the utilization of health care personnel. Following the 2002 Norwegian hospital reform, we studied the productivity of the physician workforce and the effect of personnel mix on this measure in all nineteen Norwegian hospitals from 2001 to 2013.

Methods: We used panel analysis and non-parametric data envelopment analysis (DEA) to study physician productivity defined as patient treatments per full-time equivalent (FTE) physician. Resource variables were FTE and salary costs of physicians, nurses, secretaries, and other personnel. Patient metrics were number of patients treated by hospitalization, daycare, and outpatient treatments, as well as corresponding diagnosis-related group (DRG) scores accounting for differences in patient mix. Research publications and the fraction of residents/FTE physicians were used as proxies for research and physician training.

Results: The number of patients treated increased by 47% and the DRG scores by 35%, but there were no significant increases in any of the activity measures per FTE physician. Total DRG per FTE physician declined by 6% ($p < 0.05$). In the panel analysis, more nurses and secretaries per FTE physician correlated positively with physician productivity, whereas physician salary was neutral. In 2013, there was a 12%–80% difference between the hospitals with the highest and lowest physician productivity in the differing treatment modalities. In the DEA, cost efficiency did not change in the study period, but allocative efficiency decreased significantly. Bootstrapped estimates indicated that the use of physicians was too high and the use of auxiliary nurses and secretaries was too low.

Conclusions: Our measures of physician productivity declined from 2001 to 2013. More support staff was a significant variable for predicting physician productivity. Personnel mix developments in the study period were unfavorable with respect to physician productivity.

1. Introduction

The success of modern medicine may in fact become its most serious challenge. Supported by accelerating technological developments, modern medicine is pushing frontiers at increasing speeds. These rapid advancements may exceed the capacities of economic and human resources available in the future. Novel treatments for new patient groups that seemed impossible a few years ago, along with increasing complexity and specialization, have resulted in a growing demand for health personnel. With the limited workforce and labor supply confronting most developed health care systems, the continued rapid development of medicine may not be sustainable (Cooper, 2004; Simoens and Hurst, 2006; Staiger et al., 2009, 2010; Williams et al., 2010).

The need to improve efficiency is therefore urgent. To cope with economic challenges, many financial, political, and organizational investments have been made in most developed health care systems in recent decades (Busse et al., 2008; Magnussen et al., 2009; Oliver and Mossialos, 2005; Rickman and McGuire, 1999; Rumbold et al., 2015; Tuohy, 1999; Wiley, 2005; Wilsford, 1994). In 2002, aiming to reduce political interference, a Norwegian hospital reform transformed hospitals into enterprises owned by the

* Corresponding author. Sykehuspartner Health Enterprise, Hoffsveien 1 D, 275 Oslo, Norway.
E-mail address: xakljo@sykehuspartner.no (K.A. Johannessen).

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government but with full autonomy. One of the major goals was to utilize personnel more efficiently by granting hospitals the power to negotiate the salaries of their own staff members and to decide on their own personnel strategies (Biorn et al., 2010; Tiemann and Schreyogg, 2012). The intention was to create solutions that would stimulate and reward personnel—physicians in particular—for increasing their competence and clinical efficiency, based on the needs of individual institutions.

Hospital productivity and efficiency have been studied extensively at the institutional level, both within individual health care systems and across different national systems. The approaches taken by these studies vary, with some using advanced techniques such as data envelopment analysis (DEA) and stochastic frontier analysis (SFA) and others relying on less advanced techniques (Castelli et al., 2015; Hollingsworth, 2008; Storfa and Wilson, 2015; Varabyova and Schreyogg, 2013). Some studies have examined efficiency within particular specialties and at the individual level (Askildsen, 2006; Bloor et al., 2004; Laudicella et al., 2010; Romley et al., 2015; Schreyogg, 2008; Tiemann, 2008). However, the productivity of health personnel is difficult to assess because of the multiple tasks of patient treatment, teaching, and research, and because of differences among specialties regarding diversity in patient treatments and care levels. No single measure can fully reflect this, and we are often left with macro parameters and proxies, such as billing and reimbursement. Furthermore, because productivity is only one aspect of health care systems, it has been suggested that productivity measures should be related to quality and health outcomes (Menachemi et al., 2015; Romley et al., 2015; Sandy et al., 2015; Stecker and Schroeder, 2013). However, this may be challenging at the institutional level, where multiple treatment procedures and patient groups are pooled, and past work has found that the link between hospital efficiency and quality varies from a positive association to more mixed results (Heijink et al., 2015; Hussey et al., 2013; Kittelsen et al., 2015; Menachemi et al., 2015; Romley et al., 2015, 2013; Stukel et al., 2012; Yasaitis et al., 2009).

Complex scientific results from DEA or SFA, based on proxies, are not everyday statistics known to health personnel and therefore may have limited impact at the bedside. Hypothetically, measures describing the number of patients to whom the personnel provide service may spark action among “the white coats” in everyday practice and have a supplemental value, despite not having the scientific basis as more advanced techniques. A report from the National Health Service (NHS) Institute revealed that patient admissions and completed consulting episodes per consultant varied by over 100% across different NHS trusts in England (Aragon et al., 2015; Castelli et al., 2015; Street and Castelli, 2014). If such differences are real, there would be a substantial gain if the lower-level performers could operate at the average level.

A simple description of productivity is the relation between input and output. The input of health personnel resources may be established through measures of the workforce or salary, whereas the assessment of output is more complex. Metrics such as the number of hospital admissions, daycare treatments, and outpatient consultations are not sufficient alone, but, as a group, they may cover differing pieces of a complex puzzle. However, the large degree of variations between different patient treatments and care levels are not covered. To compensate for this, researchers have used measures thought to reflect some of this variation, such as diagnosis-related groups (DRG), health care resource groups, or relative value units (Biorn et al., 2010; Castelli et al., 2015; Kentros and Barbato, 2013).

The extent of physician services available for patient treatment is the crucial issue, and the utilization of physician resources is therefore important. This, in turn, may depend on organizational perspectives as well as personnel mix (Bank and Gage, 2015; Greene, 2015; Johnson et al., 2008; Newhouse and Sinaiko, 2007; Rodysill, 2003; Sandbaek et al., 2014; Sunshine et al., 2010). We undertook this study to examine physician productivity using panel analysis with limited Information maximum likelihood (LIML) regression and DEA analysis based on metrics of patients treated combined with health personnel indicators.

2. Background

In 2002, all public Norwegian hospitals were transferred from a system of county ownership to central government ownership (Hagen and Kaarboe, 2006). The aim was to increase hospital efficiency by providing greater autonomy with respect to planning, budgeting, and workforce policies. The reform aimed to define hospitals' economic responsibilities more precisely and to implement remuneration for personnel that would stimulate productivity, especially among physicians (Biorn et al., 2010; Magnussen et al., 2009; Verzulli et al., 2011). Hospitals were restructured as health enterprises comprising 1–8 of the previous hospitals and organized into five regional health authorities, which were reduced to four in 2005. During our study period (2001–2013), Norwegian hospitals consisted of five regional university hospitals (the most specialized hospitals, two of which were merged in 2010), 11 central hospitals (two with university functions), and four local hospitals. Norwegian health care is mainly funded by general taxation, and hospital care is paid through a mixture of global funding and activity-based funding (ABF), which is based mainly on the DRG system. Hospitals receive targeted compensation for teaching and research.

3. Aims and objectives

The current study had three aims. First, we investigated whether the utilization of the physician workforce, as assessed by indicators of patient treatment volumes in relation to the number of physicians, has improved since the 2002 hospital reform. Because we did not study the period before the reform was implemented, we had no ambition to examine causality. Second, using panel analysis with LIML estimations (Anderson and Rubin, 1949) and the non-parametric DEA method for estimating a variable returns to scale cost function (Banker et al., 1984; Charnes et al., 1978), we analyzed the relationship between the relative personnel mix (nurses, auxiliary nurses, and medical secretaries) and physician productivity. Third, we examined whether the new remuneration structure implemented with the reform translates into physician efficiency (Bloor et al., 2004; Devlin and Sarma, 2008). In our analyses, we used parameters reflecting patient treatment, research activity, and teaching and related these measures to workforce resources.

4. Methods

4.1. Data sources

The dataset covered the period from 2001, the last year before the reform was implemented, to 2013. All hospital enterprises in Norway (N = 19) were included, and we had data from each hospital each year. Hospital mergers during this period were handled by aggregating the data in the premerger period to the hospital structure in the post-merger period.

Data on workforce resources and salaries were obtained from The Employers Organization Specter and Statistics Norway and are described in Table 1. Salary data consisted of payment for regular work, casual overtime, and on-call services. Activity data were obtained from the Norwegian Patient Register and consisted of the