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Does better structure and process management provide higher outcome quality for the individual patient and among Danish hospital departments?

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Abstract

Objective:

The purpose is to explore whether better structure and process management provide better outcome quality for the individual patient and among hospital departments.

Methods:

Using patient level data in which 4,202 patients across seven vascular departments are pooled we estimate fixed effect logit models for three outcome quality measures; 30 day mortality, death after discharge and wound complications. First, we estimate the association between three process quality measures and the outcome quality for the individual patient. We then profile high- and low-performing departments with respect to structural and process quality measures to explore whether more or less successful departments are characterised by specific features.

Results:

For the individual patient our results show that for death after discharge a higher length of stay reduces the risk of dying. At departmental level, our results suggest that staffing decisions may also be an important factor. However, additional research is needed in order to learn more about how structure and process indicators are associated with high-performance.

Conclusions:

Differences in outcome quality occur due to differences in the needs of patients treated, but also due to differences in how hospital departments organise care.

Content

1. Introduction

Measuring and assessing the quality of health care has been used for many years by health professionals as instruments to improve the quality of their work. As early as 1863, Florence Nightingale viewed outcome information as a means of improving patient outcomes and quality of care (1). Over the past decades public reporting on the quality of health care performance has become increasingly common in order to create competition in relation to the demand for quality of health care services. Further, reimbursement strategies such as pay-for-performance initiatives have emerged as a means of promoting better quality of care by rewarding providers who perform well (2;3). There are numerous studies that measure various kinds of quality in health care as well as many different systems measuring and comparing quality (4). Yet despite this proliferation of research and initiatives, the empirical evidence on the use of such performance measures is rather mixed (4-7).

Comparison of quality performance does not in itself provide any information on what to do to improve quality. Knowing why for example adverse events occur is what is needed in order to prevent them from happening again. Often public disclose of performance data have been based on hospital level data and thus assuming that a common production function applies to all hospital departments. This makes it rather difficult for analysts to make any clear recommendations as to where practical efforts should be directed in case one hospital is found to provide lower quality than others. When seeking to gain further insight into what determines the level of quality, the level of aggregation may be an important factor.

Another limitation in the practical use of performance measures is that analyses or comparisons of quality or other dimensions of performance across production units do not always adequately control for the fact that some hospitals treat more complicated patients. Some patients face higher risks of developing complications or health problems earlier or more often than others due to diverse reasons such as genetics, behaviour (e.g. smoking or alcohol abuse), socio-economic status and environmental (1). Most likely such patients are not randomly distributed and this may result in unfair comparisons across hospitals. It may also provide the hospitals with incentives to avoid patients with higher risks of developing health problems or suffering complications since it may cause them to appear as inefficient or more costly in comparison with others. These problems explain why risk adjustment is important. Thus the purpose with risk adjustment is to determine the influence of individual's characteristics on outcomes (or costs) and other exogenous constraining factors beyond the control of the hospitals (e.g. the capacity in primary health care, and location), and to account for these differences in order to make fair comparisons of costs. Variables applied as risk adjustment factors are factors that are beyond the control of the hospitals and are often referred to as exogenous factors. Inadequate severity-of-illness adjustments may explain why results from benchmarking exercises are often rejected by hospitals and health care professionals, and as a consequence action is seldom taken following the publication of such benchmarking exercises. Thus adequate risk adjustment is essential if results are to be deemed valid and any action to be expected.

When seeking to explore how quality can be improved, it is important to distinguish between characteristics over which the hospital department has control and exogenous constraints over which the hospital department has no influence. For example, management in a hospital department already know that treating less complicated patients are likely to be advantageous both in terms of better reported performance and financially. However, typically management has limited influence over which patients to treat since they serve the population in a defined catchment area with limited possibilities of rejecting patients. This is, at least the case in Denmark, where hospitals are public and there is limited choice among patients. On the other hand, management has a significant influence with respect to personnel decisions such as the staff-patient ratios, specialisation of staff, which type of staff to use for treating certain patients and for certain activities. Thus the quality or quantity of personnel may have a significant impact on the level of quality provided for patients.

In the present study, we have access to a wide number of patient characteristics not traditionally available to researchers as well as measures of structure and process quality. We are able to exploit a rich data set containing details about previous diseases, co-morbidities, smoking status, and socio-economic variables (e.g. income and whether the patient lives alone). By performing an extensive risk adjustment we are able to isolate the patients' intrinsic attributes that inherently increase the likelihood of poor outcomes. It seems reasonable to assume that the hospital departments can exert some degree of control over the level of quality provided by for instance investing more resources in production or improving management. Taking all or a wide number of patient characteristics incurring an exogenous impact on quality into account provide us with a unique opportunity to isolate the departments' ability to exert good quality and to explore which patient level and department specific characteristics that may explain variation in quality.

The association between resource use and quality is inherently affected by issues of endogeneity. In the present study, we attempt to focus on input factors that have little inverse association with adverse events. However, if we do find that greater investment in some input factors are positively associated with an increase in adverse events, we cannot reject that this result could be produced by an inverse causal relationship.

The paper is organised as follows. In section 2, various quality definitions are discussed. Section 3 describes the data available, and we outline our methodological approach. In section 4 we provide some descriptives for the individual departments (section 4.1). Firstly, we explore the possible impact of treatment decisions on quality by controlling for a wide number of patient characteristics, exogenous constraints, and unexplained departmental variation. Secondly, we test for the impact of treatment decisions at the patient level on the occurrence of adverse events (section 4.2). Subsequently, we seek to formulate hypotheses in relation to which departmental characteristics may explain the remaining variation in quality across departments (as reflected by the departmental effects). We profile high- and low-performing departments with respect to structural quality measures to explore whether more or less successful departments are characterised by specific features (section 4.3). This analysis is purely descriptive as the limited number of departments does not allow us to draw statistical inferences on the impact of department specific level of input factors. This is followed by a discussion (section 5) and conclusion (section 6).

2. Definitions of quality

Because of the growing emphasis and interest in measuring and comparing quality, quality is now being assessed in several different ways (8). The most commonly used approach was introduced more than 20 years ago by Donabedian and is based on three dimensions of quality: Structure, process and outcomes (9). Structure refers to the attributes of the settings in which care occurs which may affect the system's ability to meet the health care needs of individual patients or a community (e.g. presence or number of specific groups of staff or access to specific technologies or specific units, and the volume for example in terms of the number of patients treated). Process indicators reflect what the provider did for the patient, and how well it was done (e.g. the proportion of patients treated according to clinical guidelines). An outcome indicator may either reflect intermediate or end-results. Intermediate outcome indicators reflect changes in biological status that presumably affect subsequent health outcomes (e.g. complications or wound infections), whereas examples of end-result indicators are mortality, functional status, quality of life, or patient satisfaction.

The various types of quality are likely to be interdependent to some degree. For instance, certain structures, such as access to the recent technology, up-to-date facilities and highly qualified staff may have a positive bearing on the level of quality provided, and subsequently maybe also for the patient's health. This is widely documented for the relationship between the number and types of nurses to patient staffing (10-12). For instance, Weissman has found that a 0.1 percent decrease in the nurse-patient ratio increases the number of adverse events by 28 percent (13). Moreover, the process of the treatment and care may also influence the final outcome. Good structural quality (e.g. in terms of a clinically optimal combination of personnel), and good process quality for instance by following the relevant guidelines may also result in good outcome quality.

Bearing in mind that the outcome quality is what we are really interested in pursuing, the use of structural and process quality indicators may be problematic for several reasons. These proxies of quality may not be valid indicators as hospitals performing with high structural quality may nevertheless produce low quality in care, in terms of for example mortality or adverse events (intermediary quality). Higher levels of staffing per patient may be a reflection of slack (inefficiency) or as a valid proxy for higher levels of quality. Thus structural and process quality indicators are not necessarily the best indicators of outcome quality, even though they are widely applied. The reasons why these proxies are widely applied is likely due to the lack of more appropriate outcome measures such as complications, quality of life, mortality, functional status, or patient satisfaction, or because these outcome measures are merely are too costly to collect.

In this paper we apply three outcome quality measures. In addition, we introduce a number of structure and process measures in order to examine whether these measures contribute to explain the level of outcome quality.

3. Data and Methods

3.1 Data

Data on patient characteristics and quality were available for 4,202 patients treated in seven (out of eight) vascular departments in 2004. We have applied two quality indicators judged clinically relevant, and these are the 30 day mortality and wound complications. Data on 30 day mortality were drawn from The Causes of Death Registry. Data on wound complications and other patient characteristics were taken from the clinical database, the Danish Vascular Registry, which is a national registry for all vascular departments in Denmark. Data on operating doctor and length of stay are also drawn from the Danish Vascular Registry. The Danish Vascular Registry was established by the Danish Vascular Society and contains information on patient specific characteristics such as age, gender, smoking status, disease status (including previous diseases), and surgical information (14). Also, data on whether the operating doctor is senior and whether the operation is supervised by a senior doctor are drawn from The Danish Vascular Registry. Information on diagnosis was obtained from the National Cost database. The National Costs database is the basis of the Danish case-mix system DkDRG (which is similar in set-up to DRG but is validated according to Danish clinical treatment) under which hospitals are (partly) reimbursed.

Socio-economic characteristics such as income, employment status, information about whether the patient is a pensioner or living alone are drawn from Statistics Denmark, which is an official national registry for detailed statistical information on the Danish population. Income (net income after taxes) and transfers are collected from official tax authorities. Data on treatment with statins are taken from the Danish Medicines Agency. Data on staff-patient ratios, specialisation among doctors, and the number of beds for year 2004 were collected from the individual hospital departments.

In table 1, the quality measures, the patient characteristics, other exogenous constraints and variables applied as factors within managerial control, are presented and described.

Table 1: Description of outcome quality indicators, patient characteristics, other exogenous constraints and variables within managerial control

Outcome quality indicators:	**Description**
Wound complications	Includes all wound complications (hematoma, lymph oozing>2 days and edge necrosis)
Death within 30 days	Patient who dies within 30 days after admission
Death after discharge (within 30 days)	Patient who dies *after* discharge but within 30 days from *discharge*
Exogenous variables (x_1)	
DRG index	DRG-weight /average DRG weight
Age	Patient age
Age^2	Patient age x patient age to allow for a non-linear age effect
Male	Dummy variable equal 1 if patient is male
Smoker/ex-smoker	Dummy variable equal 1 if patient is smoker/ex-smoker
Emergency	Dummy variable equal 1 if patient has been subject to emergency admission
Home care	Dummy variable equal 1 if patient requires home care at discharge
Cerebrovascular	Dummy variable equal 1 if patient has been treated for TIA/amaurosis or stroke
Hypertension	Dummy variable equal 1 if patient has hypertension
Cardial	Dummy variable equal 1 if patient has been treated for cardiac disease
Pulmonal	Dummy variable equal 1 if patient has been treated for pulmonary disease
Diabetes	Dummy variable equal 1 if patient has diabetes
ASA score	Categorical variable (1-5) of the severity of the patient's condition. 1 is normal health condition and 5 is expected death within 24 hours without treatment
Intensive care > 3 days	Dummy variable equal 1 if patient has been in intensive care for more than 3 days
Net income, DKK	The patient's net income
Unemployed	Dummy variable equal 1 if patient is unemployed or on some kind of transfer income
On age pension or early retirement pension	Dummy variable equal 1 if patient is retired or on age pension
Living alone	Dummy variable equal 1 if patient is living alone
Exogenous constraint (z_1):	
Treatment with statins prior to operation	Dummy equal 1 if the patient is in treatment with statins 4 weeks prior to operation
Factors within managerial control (patient level) (z_1):	
Operating doctor	Dummy variable equal 1 if the operating doctor is senior or if the operation is supervised by a senior doctor
Length of stay	Length of stay in days per patient
Factors within managerial control (departmental level) (z_1):	
Nurse-patient ratio	Number of nurses per 10,000 bed days
Doctor-patient ratio	Number of doctors per 10,000 bed days
Specialisation among doctors	The percentage of doctors being senior (consultants) x the number of doctors per 10,000 bed days
Volume	Number of discharges per department
Length of stay	Average length of stay in days per department

3.2 Methods

The purpose is to explore whether factors within the control of the hospitals explain variations in quality after adjusting for the types of patients treated. Firstly, we seek to test whether better process management at patient level provides higher level of outcome quality for the individual patient. Secondly, we follow the approach by McKay and Deily (2005) in profiling into high- and low-performing departments according to a number of structure and process quality indicators (15). The purpose is to explore whether there are differences in these features of high- and low-performing departments.

In order to isolate the association between hospital treatment characteristics (at the individual patient level and departmental level), we control for a wide number of patient characteristics that are expected to incur an exogenous impact on quality. Also, other exogenous constraints such as the demographic structure of the population under consideration, and treatment quality in primary health care sector ought to be taken into account when measuring performance if it is assumed to affect hospital treatment (16). However, due to lack of data only one such variable is applied in the current analysis: Whether the patient is in treatment with statins four weeks prior to operation.

In the literature, characteristics of the providers such as the type of hospital, size, length of stay, occupancy rate etc. are often applied as controls i.e. as exogenous factors. In contrast, the same variables are frequently referred to as structural and process quality indicators suggesting that they are within managerial control and can be reconfigured. For instance higher occupancy rate may be related to excess demand for hospitalisation due to for example poor outpatient care or GPs' excess referral. In that case, hospital characteristics capture unobserved health conditions caused by poor outpatient or GP treatment and can be considered as exogenous factors. A low occupancy rate or longer length of stay may reflect poor management where timely discharge is not arranged, or it may reflect higher quality of services provided. However, length of stay (LOS) may also express unmeasured patient severity. Thus we acknowledge that there is no 'gold standard' as to whether a variable should be considered as within or beyond managerial control. Often it may depend on several context specific issues such as policy relevance, time frame (in the short run few factors may be within managerial control), perspective applied, the objective function, and of course what level of aggregation one is operating at: Hospital management, department management, or others. In the present analysis, we explore the association between treatment process and structural characteristics and quality under the assumption that they are endogenous (i.e. within managerial control) to some degree.

We specify a fixed effect logit model in which all the patients across seven departments are pooled together (17). This fixed effect model has a departmental specific constant capturing unobserved time-invariant departmental specific quality over and above the influence of observed patient characteristics, external factors, and treatment characteristics related to the individual patient. We control for a wide number of patient characteristics (see table 1). Age and gender are the most frequently applied patient characteristics in the literature, probably because they are easily and accurately observed. Also, age is a strong predictor of outcome quality such as the risk of dying. For gender we do, however, not have any prior expectation. We expect case-mix to be positively related to outcome quality. Patients suffering comorbidities (e.g. pulmonal diseases, diabetes) and smokers have a higher risk of suffering complications (18-22). Patients undergoing anaesthesia are more costly, as several studies have found that a higher asa-score is associated with longer length of stays in hospital (23;24). Social deprivation and morbidity are closely related, so we expect lower quality for socially deprived patients (25-27). Moreover, treatment with statins prior to surgery have been found to suffer less complications and are less likely to die (28;29). Our assumption is that taking all these patient characteristics and exogenous constraint into account improves our model, and it enables us more precisely to estimate the association between hospital characteristics that relate to treatment and quality in outcome.

Our model for all patients is specified as:

$$P(q_{ij} = 1) = \Lambda(\alpha_j + \beta_1 x_1 + \gamma_1 z_1) \qquad (1)$$

where q_{ij} is the quality indicator of patient *i* in department *j* taking value 1 for poor quality and zero otherwise. Λ is the logistic distribution function. Thus we assume that unexplained (random) variation in patient quality is symmetrically distributed with zero mean and constant variance. Any remaining systematic differences in quality among departments will be captured by the departmental specific constant α_j. Vector x_1 includes all patient characteristics and exogenous constraints (treatment with statins prior to surgery) applied. Treatment characteristics within managerial control which are exercised at the individual patient level is expressed in z_1 (operating doctor is senior/operation being supervised by senior doctor; length of stay). Length of stay is only included as an explanatory factor in relation to death after discharge in vector z_1. We assume that being operated by a senior doctor or having the operation supervised by a senior doctor improves quality. The impact of length of stay is only tested in relation to death after discharge due to the presence of possible endogeneity in the context of the other quality indicators. We expect that problems with inverse causality are minimised when considering only patients that die after discharge.

We compare quality for all patients being admitted to vascular departments and for emergency patients. With respect to wound complications, we also consider subgroups of patients such as patients undergoing surgery, having peripheral by-pass, and emergency patients. For the patients undergoing surgery, the following patients are excluded: Varicose veins, Percutaneous Transluminal Angioplasty (PTA), and Dialysis access surgery, (arteriovenous fistula). The reason for comparing all patients as well as various subgroups is twofold. Firstly, we want to provide what by many clinicians is perceived as a meaningful comparison of patients, while at the same time recognising that other stakeholders such as politicians often find comparisons of whole departments more appropriate. Secondly, when exploring reasons for poor/good quality some patient groups may be more vulnerable to changes in for instance the degree of specialty and various staff-patient ratios. Hence we seek to explore whether it alters the results and ranking of departments when various groups of patients are compared. We expect that the smaller and more homogenous groups of patients included in the analysis the easier it may be to gain further insight into what determines the level of quality.

The remaining unexplained variation in quality captured in the departmental effects may encompass differences in management, differences in how various resources are prioritised between patients, the choice of which tests and procedures to apply, differences in staff-patient ratios, degree of specialisation among staff etc. In this paper, we have data that allows us to explore whether decisions taken for the individual patient affect the level of outcome quality in terms of the risk of dying and the risk of suffering wound complications. The limited number of departments only allows us to descriptively explore whether department level decisions seems to have an effect on the level of outcome quality. Thus we explore what characterises high- and low-performing departments. High-performing departments are those departments with the lowest excess mortality or wound complications. Excess means deviation from expected overall mean after taking into account the types of patients treated. We examine whether various structural and process management factors are associated with better performance with respect to providing better quality in terms of lower risk of dying and lower risk of suffering wound complications. Thus we compare mean values for the number of nurse staff per patient day, the number of doctors per patient day, the percentage of doctors being senior doctors, and the number of discharges (volume). The latter is applied as an indicator of large scale effect (i.e. practice makes better), and percentage of doctors being senior is applied as an indicator of specialisation. We expect that investment in terms of a higher number of clinical staff per bed day has a positive impact on the level of quality (i.e. higher quality). There is evidence from the literature that an increase in nurse/patient ratio is positively related to quality in terms of preventing adverse events (30). We also expect the number of doctors per bed day to be positively related to the level of quality, and that adequate support and supervision by senior doctors is likewise important. For the volume variable applied we expect that a higher volume is associated with a higher quality. There is evidence in the literature for an association between the level of quality in terms of mortality and the volume of patients for certain subgroups such as abdominal aortic aneurysm surgery (31;32).

Table 2: Mean values, quality, patient characteristics and endogenous variables, by departments

	A	B	C	D	E	F	G	Total
N	701	430	771	899	527	400	474	4,202
Death within 30 days (%)	6.99	2.09	6.35	4.89	3.61	2.00	5.91	4.90
Death after discharge (within 30 days) (%)	2.99	1.40	2.72	3.78	1.71	1.00	2.74	2.57
Wound complications (%)	8.28	20.39	7.12	13.67	8.08	11.85	12.27	11.29
Routine variables:								
DRG index	1.16	0.89	1.05	0.85	1.07	0.99	1.03	1.00
Age	67.4	67.9	66.2	63.8	66.0	65.9	68.1	66.2
Age^2	4,694	4,724	4,602	4,304	4,510	4,458	4,763	4,551
Male	0.59	0.55	0.54	0.58	0.66	0.56	0.59	0.57
Health related variables:								
Smoker/ex-smoker	0.69	0.71	0.72	0.69	0.75	0.83	0.86	0.76
Emergency	0.36	0.26	0.36	0.43	0.32	0.26	0.36	0.34
Home care	0.27	0.16	0.13	0.21	0.20	0.17	0.18	0.18
Cerebrovascular	0.18	0.19	0.20	0.09	0.09	0.15	0.18	0.15
Hypertension	0.57	0.49	0.44	0.41	0.46	0.49	0.52	0.48
Cardial	0.34	0.31	0.33	0.29	0.28	0.24	0.35	0.31
Pulmonal	0.14	0.13	0.16	0.12	0.12	0.09	0.17	0.14
Diabetes	0.17	0.15	0.18	0.16	0.13	0.17	0.16	0.16
ASA score	2.24	2.09	1.97	2.27	1.82	2.00	1.92	2.06
Intensive care > 3 days	0.10	0.02	0.09	0.03	0.09	0.03	0.09	0.07
Socioeconomic variables:								
Net annual income DKK	123,541	124,705	156,951	138,678	140,061	132,566	129,640	136,386
Unemployed	0.18	0.13	0.14	0.18	0.17	0.14	0.20	0.16
On age pension or early retirement pension	0.66	0.67	0.63	0.55	0.61	0.61	0.67	0.62
Living alone	0.40	0.39	0.42	0.50	0.40	0.34	0.39	0.42
Teaching status 1= if teaching hospital	0	0	1	1	1	0	1	-
Exogenous constraints:								
Percentage of patients in treatment with statins prior to hospital admission	19.28	17.97	17.56	10.16	16.04	8.11	16.10	15.05
Factors within managerial control:								
Percentage of patients operated by senior doctor/supervised	24.54	34.88	54.99	59.18	53.89	74.50	67.09	51.83
Nurses per 10,000 bed days	47.8	43.0	33.1	16.0	39.6	28.1	54.6	37.5
Doctors per 10,000 bed days	19.6	15.0	23.0	19.0	16.0	16.0	27.0	19.4
Percentage of doctors being senior doctors	83	56	33	26	44	70	33	47
Length of stay (days)	6.47	6.08	6.56	6.07	7.10	7.76	5.62	6.46
Volume (number of discharges)	701	430	771	899	527	400	474	4,202

4. Results

4.1 Descriptive analysis

There seems to be clear differences in quality across departments both in terms of 30 days mortality and wound complications. The mean 30 days mortality varies from 6.99 percent at department A to 2.00 percent at department F. The mean number of wound complications varies from 7.12 percent at department C to 20.39 percent at department B. The differences in observed patient characteristics across departments suggest that there are differences among departments in the type of patients they treat. The descriptive data beg two questions. First, can the apparent differences in quality be explained by systematic differences in the characteristics of the patients treated? Second, can the differences in process and structural management contribute to explain the level of quality?

4.2 Investigating the impact of patient level treatment decisions

In table 3, we analyse the influence that process quality indicators have on outcome quality, i.e. the risk of suffering wound complications and the risk of dying. For patients dying after discharge a longer length of stay has a statistically significant impact on the risk of dying after discharge. The effect of operating doctor being senior/operation being supervised by senior doctor and treatment with statins prior to operation are not statistically significant explanatory factors. However, what we do observe is that some of the remaining unexplained variation in quality is associated with the place of treatment. This is especially the case of wound complications, where the full model (which includes all patients) shows that a large proportion of the variation in this quality variable is explained by departmental association. In this model there are 14 statistically significant differences in departmental performance when these are compared pair-wise. In contrast, for death after discharge departmental effects all remain statistically insignificant, and the variation is largely explained by patient level factors.

Table 3: Logistic models for quality (*if significant at 5%), Odds ratio

	30 day mortality		*Death after discharge*	*Wound complications*			
Variable	All	Emer-gency	All	All	Surgery	Peripheral bypass	Emergency
	N=4,202	N=1,184	N=4,202	N=4,202	N=2,565	N=498	N=1,176
DRG index	1.2095*	1.2425*	1..3736*	1.1121*	1.0573	1.2858	0.9246
Age	1.1195	1.0609	1.0160	1.0454	1.0573	1.0324	1.0607
Age^2	0.9996	1.0001	1.0000	0.9998	0.9997	0.9997	0.9998
Male	2.7509*	2.9835*	1.7373*	0.9690	0.8289	0.7822	0.8201
Smoker/ex-smoker	1.5826*	1.3642	1.2717	1.0745	1.1471	0.8267	1.0445
Emergency	2.8419	-	2.0296*	0.9560	0.7909	0.8129	-
Home care	1.4291	1,3210	1.9683*	0.6972*	0.7210	0.6718	0.7024
Cerebrovascular	1.1428	1.2772	1.2982	0.9267	0.8474	1.1028	0.7328
Hypertension	1.1785	1.0277	1.2319	1.1461	1.1207	0.7973	1.1968
Cardial	1.1495	0.9723	0.9644	1.0326	1.0556	1.6335*	0.8230
Pulmonal	1.1446	1.1851	1.5013	1.0992	1.2047	1.1877	1,2680
Diabetes	0.4043*	0.4497*	1.1625	1.1199	1.2722	0.9321	1.8123*
ASA score	2.2283*	2.6866*	1.9742*	1.2017*	1.0240	1.1955	0.8299
Intensive care> 3 days	1.4457	0.8445	1.2656	1.6415*	1.5545	1.5163	2.4869*
Net monthly income (1.000)	0.7039*	0.6922*	0.7695*	1.0008	1.0018	1.0188	1.0042
Transfer income and/or unemployed	0.7104	0.4941	0,9422	1.6571*	1.7184	2.2369*	3.2238*
Pensioner/early retirement pension	0.3084*	0.1915*	1.1291	1.2615	1.2389	2.3184	1.7918
Living alone	1.4990*	1.2170	1.6248*	1.0641	1.0305	1.0445	0.9249
Length of stay	-	-	0.9409*	-	-	-	-
Treatment with statins 4 weeks prior to operation	1.3801	1.7396	0.5065	1.2133	1.1387	1.2029	0.6927
Operating doctor is senior/operation supervised by senior	0.9042	0.7385	1.0246	0.9260	0.9547	1.4388	0.8272
Departmental effects* [(i)]*:							
A	2.6841*	3.9777*	1.0116	0.2935*	0.3041*	0.5784	0.3151*
C	2.9642*	4.9823*	1.3318	0.2949*	0.3229*	0.2866*	0.2587*
D	1.9363	2.7096	1.8866	0.6879*	0.8007	0.9983	0.8873
E	1.8569	1.5959	0.9791	0.3595*	0.3201*	0.4646	0.2456*
F	1.0586	1.0787	0.7537	0.6456*	0.6090*	0.5972	0.7254
G	2.2361*	3.0945	1.0698	0.5519*	0.4563*	0.4234*	0.5297
Pseudo R^2 [(ii)]	38.40	37.91	31.31	5.13	4.59	6.73	7.77

Number of statistical significant pairwise differences (iii)	4	4	0	14	12	4	8

i) Department B is left out and the departmental effects should be interpreted as deviation from department B.

ii) The R^2 is calculated in a multilevel regression as an adjusted within R^2, i.e. adjusted for departmental effects.

iii) The departments are compared pairwise, and the difference in their departmental effects is tested using a t-test.

4.3 Characteristics of high- and low-performing departments

We distinguish between high- and low-performing departments and explore whether there are any associations between departmental structural and process management indicators that explain variations in the level of outcome quality. It is important to emphasize that because of the limited number of departments, we do not apply these variables in a regression analysis, but merely on a descriptive basis. In table 4, the departments are grouped into high- and low-performing departments for the 30 day mortality and wound complications. High-performing departments are defined as those three departments with lowest risk-adjusted excess (i.e. higher than overall mean) mortality and wound complications, respectively. The low-performing hospitals are defined as the three departments with the highest risk adjusted excess mortality and excess wound complications, respectively.

As depicted in table 4, there are differences both between high- and low-performing departments. For 30 day mortality (when considering all patients), high-performance departments are on average characterised by a higher percentage of doctors being senior doctors. However, counter to our expectations high-performance departments are not characterised by higher intensity of nurses per bed day. For wound complications high-performing departments (when considering all patients) are characterised by more nurses and doctors per bed day and a higher degree of specialisation among doctors.

Table 4: Profiling of high- and low performing departments

	30 day mortality		*Wound complications*		*Wound complications, peripheral by-pass patients*	
Variable	High-performing departments	Low-performing departments	High-performing departments	Low-performing departments	High-performing departments	Low-performing departments
Nurses per 10,000 bed days	36.80	45.17	40.17	29.03	42.43	35.60
Doctors per 10,000 bed days	15.67	23.20	19.53	16.67	22.00	17.87
Percentage of doctors being senior doctors	56.67	49.67	53.33	50.67	36.67	55.00
Volume (number of discharges)	452	649	666	576	597	677
Case-mix index	0.98	1.08	1.09	0.91	1.15	1.19

5. Discussion

The access to a wide number of patient characteristics in this study provided us with a unique opportunity to explore if variations in outcome quality are caused by differences in the types of patients treated or due to poorer or better structure and process management either at the patient level of more generally at the departmental level. Our results suggest that not all the apparent differences in observed outcome quality (table 2) among departments can be explained by systematic differences in the types of patients treated. This naturally begs the question: What explains the remaining differences after taking into account the types of patients treated, given that we have taken into account all possible patient characteristics.

Our most significant result is that after adjusting for patient characteristics and allowing for intrinsic differences in departmental performance, length-of-stay has a marked and statistically significant impact on the risk of dying after discharge. For the individual patient our results suggest that for death after discharge a longer length of stay reduces that risk significantly (6 percent). However, counter to our expectations the effect of the operating doctor being senior and treatment with statins prior to operation was not statistically significant. There does, however, appear to be a tendency towards lower risk of dying when being operated by a senior doctor. Clearly, we are limited by the number of patients when considering various groups and subgroups of patients and this may be a reason for us not finding a statistically significant effect of this variable. This is particularly the case for patients having a peripheral by-pass where the total number of patients is only 498.

We did, however, find that after controlling for differences in patient characteristics and patient specific treatment differences, that the place of treatment was still associated with variations in the level of quality. This was especially the case for wound complications. A comparison of departmental characteristics suggests that poor quality (i.e. a high level of wound complications), may be associated with a lower nurse-bed ratio. This is, however, only a hypothesis that is generated from our descriptive data. Future research should verify whether there is indeed a causal relationship.

Our findings suggest that high-performing departments vary across the quality outcome measures applied. Hence our study suggests that quality is a multidimensional concept and that hospital departments performing well on one dimension do not necessarily perform well on other dimensions. Our results suggest that relative assessments and target setting based on only one measure may provide inappropriate incentives to hospital managers. However, it is an unavoidable fact that it is always a problem finding available quality indicators that capture quality aspects relevant for all or a large share of the patients.

Especially, one department (B) has a significantly higher percentage of patients suffering wound complications. This department remains an outlier even after taking into account the types of patients treated. As shown in table 2, this department is characterised as a non-teaching hospital with a lower doctor-bed day ratio, a slightly higher nurse-bed day ratio, and a slightly higher percentage of doctors being senior. Thus there does not appear to be any obvious explanations as to whether this department has significantly more wound complications. We, however, have to bear in mind that most of the variation in especially wound complications remains unexplained after controlling for a wide number of both health related and socio-economic characteristics of the patients. This suggests that the risk of suffering wound complications is less influenced by patient characteristics and more by other factors either within or beyond managerial control.

Clearly, caution should be exercised when interpreting the results from the descriptive analysis at the departmental level due to the limited number of departments. Further research is needed into what determines the level of outcome quality at either patient level or department level after taking into account the types of patients treated. When analysing hospital departments in a small country like Denmark, this is however an unavoidable fact the analyst have to face, if we do not have access to patient level data. We have partly tried to overcome this by using patient level data, but a limitation is that we only have access to a limited number of structure/process measures at patient level. Another issue is that we have taken a wide number of patient characteristics into account, but there may be other exogenous factors besides treatment with statins prior to operation that we were not able to control for. This could be differences in scope of services in and the capacity of the primary health care sector. Market conditions and hospital ownership are not that relevant in Denmark since the choice of hospital by consumers (or providers) is rather limited, and all hospitals are public.

6. Conclusion

It can be concluded that differences in quality provided occur due to differences in the needs of patients treated, but also due to differences in how hospital departments organise care. We have shown that the individual patient runs a lower risk of dying after discharge for longer length of stays. At departmental level, our results suggest that staffing decisions may also be an important factor. However, additional research is needed in order to learn more about how structure and process indicators are associated with high-performance.

References

(1) Iezzoni LI. Reasons for risk adjustment. Risk Adjustment for Measuring Health Care Outcomes. 3 ed. Chicago: Health Administration Press; 2003. p. 1-16.

(2) Petersen LA, Woodard LCD, Urech T, Daw C, Sookanan S. Does pay-for-performance improve the quality of health care? Annals of Internal Medicine 2006;145(4):265.

(3) Lindenauer PK, Remus D, Roman S, Rothberg MB, Benjamin EM, Ma A, et al. Public reporting and pay for performance in hospital quality improvement. New England Journal of Medicine 2007;356(5):486.

(4) Propper C, Wilson D. The use of performance measures in health care systems. In: Jones AM, editor. The Elgar companion to health economics.Cheltenham: Edward Elgar; 2006. p. 326-34.

(5) Street A. The resurrection of hospital mortality statistics in England. J Health Serv Res Policy 2002 Apr;7(2):104-10.

(6) Mannion R, Goddard M. Impact of published clinical outcomes data: case study in NHS hospital trusts. BMJ 2001 Aug 4;323(7307):260-3.

(7) Farley DO, McGlynn EA, Klein D. Assessing quality in managed care: health plan reporting of HEDIS performance measures. Policy brief (Commonwealth Fund) 1998;(298):1.

(8) Sousa P, Uva AS, Pinto F. Risk-adjustment model in health outcomes evaluation: a contribution to strengthen assessment towards quality improvement in interventional cardiology. International Journal for Quality in Health Care 2008;20(5):324.

(9) Donabedian A. The quality of care. How can it be assessed? JAMA 1988;260(12):1743-8.

(10) Blegen MA, Goode CJ, Reed L. Nurse staffing and patient outcomes. Nurs Res 1998 Jan;47(1):43-50.

(11) Aiken LH, Smith HL, Lake ET. Lower Medicare mortality among a set of hospitals known for good nursing care. Med Care 1994 Aug;32(8):771-87.

(12) Weissman JS, Rothschild JM, Bendavid E, Sprivulis P, Cook EF, Evans RS, et al. Hospital workload and adverse events. Med Care 2007 May;45(5):448-55.

(13) Weissman JS, Rothschild JM, Bendavid E, Sprivulis P, Cook EF, Evans RS, et al. Hospital workload and adverse events. Med Care 2007 May;45(5):448-55.

(14) The Danish Vascular Registry. Annual Report 2001. www.karbase.dk: The Danish Vascular Registry; 2001.

(15) McKay NL, Deily ME. Comparing high- and low-performing hospitals using risk-adjusted excess mortality and cost inefficiency. Health Care Manage Rev 2005 Oct;30(4):347-60.

(16) Jacobs R, Smith PC, Street A. Measuring Efficiency in Health Care: Analytical Techniques and Health Policy. 1 ed. Cambridge: Cambridge University Press; 2006.

(17) Wooldridge JM. Econometric Analysis of Cross Section and Panel data. Cambridge,Mass: MIT Press; 2001.

(18) Librero J, Peiró A, Ordiñana R. Chronic Comorbidity and Outcomes of Hospital Care: Lenght of Stay, Mortality, and Readmission at 30 and 365 days. J Clin Epidemiol 1999;52(3):171-9.

(19) Mapel DW, Hurley JS, Frost FJ, Petersen HV, Picchi MA, Coultas DB. Health Care Utilization in Chronic Obstructive Pulmonary Disease. A case-control study in a Health Maintenance Organization. Arch Intern Med 2000;160(17):2653-8.

(20) Olveira-Fuster G, Gonzales-Romero S, Olvera-Marquez P, Aguilar-Diosdado M, Carral-Sanlaureano F, Soriguer-Escofet F. Excess Hospitalizations, Hospital Days, and Inpatient Costs among People With Diabetes in Andalusia, Spain. Diabetes Care 2004;27(8):1904-9.

(21) Rochon PA, Katz JN, Morrow LA, McGlinchey-Berroth R, Ahlquist MM, Sarkarati M, et al. Comorbid illness is associated with survival and length of hospital stay in patients with chronic disability. A prospective comparison of three comorbidity indices. Med Care 1996;34(11):1093-101.

(22) Theadom A, Cropley M. Effects of preoperative smoking cessation on the incidence and risk of intraoperative and postoperative complications in adult smokers: A systematic review. Tobacco Control 2006;15(5):352-8.

(23) Husted H, Holm G, Sonne-Holm S. Få patient karakteristika påvirker indlæggelsesvarigheden ved operation med hofte- og knæalloplastik. Ugeskr Læger 2004;166(37):3197-201.

(24) Olesen OB, Petersen NC. The use of data envelopment analysis with probalistic assurance regions for measuring hospital efficiency. Journal of Productivity Analysis 2002;17:83-109.

(25) Gornick ME, Eggers PW, Reilly TW, Mentnech RM, Fitterman LK, Kucken LE, et al. Effects of Race and Income on Mortality and use of Services among Medicare Beneficiaries. The New England Journal of Medicine 2008;335(11):791-9.

(26) Carlisle R, Johnstone S. The relationship between census-derived socio-economic variables and general practice consultation rates in three town centre practices. The British Journal of General Practice 1998;48(435):1675.

(27) Weissman JS, Stern R, Fielding SL, Epstein AM. Delayed Access to Health Care: Risk Factors, reasons, and consequences. Ann Intern Med 1991;114(4):325-31.

(28) O'Neil-Callahan K, Katsimaglis G, Tepper MR, Ryan J, Mosby C, Ioannidis JPA, et al. Statins decrease perioperative cardiac complications in patients undergoing noncardiac vascular surgery The Statins for Risk Reduction in Surgery (StaRRS) study. Journal of the American College of Cardiology 2005;45(3):336-42.

(29) Poldermans D, Bax JJ, Kertai MD, Krenning B, Westerhout CM, Schinkel AFL, et al. Statins are associated with a reduced incidence of perioperative mortality in patients undergoing major noncardiac vascular surgery. Circulation 2003;107(14):1848.

(30) Weissman JS, Rothschild JM, Bendavid E, Sprivulis P, Cook EF, Evans RS, et al. Hospital workload and adverse events. Med Care 2007 May;45(5):448-55.

(31) Holt PJE, Poloniecki JD, Gerrard D, Loftus IM, Thompson MM. Meta-analysis and systematic review of the relationship between volume and outcome in abdominal aortic aneurysm surgery. British Journal of Surgery 2007;94(4):395-403.

(32) Holt PJE, Poloniecki JD, Loftus IM, Michaels JA, Thompson MM. Epidemiological study of the relationship between volume and outcome after abdominal aortic aneurysm surgery in the UK from 2000 to 2005. British Journal of Surgery 2007;94(4):441-8.

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