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COST SAVINGS AND HEALTH LOSSES FROM REDUCING INAPPROPRIATE ADMISSIONS TO A DEPARTMENT OF INTERNAL MEDICINE

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Abstract

Objectives: Inappropriate hospital admissions are commonly believed to represent a potential for significant cost reductions. However, this presumes that these patients can be identified before the hospital stay. The present study aimed to investigate to what extent this is possible.
Methods: Consecutive admissions to a department of internal medicine were assessed by two expert panels. One panel predicted the appropriateness of the stays from the information available at admission, while final judgments of appropriateness were made after discharge by the other.

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Results: The panels correctly classified 88% of the appropriate and 27% of the inappropriate admissions. If the elective admissions predicted to be inappropriate had been excluded, 9% of the costs would have been saved, and 5% of the gain in quality-adjusted life-years lost. The corresponding results for emergency admissions were 14% and 18%.
Conclusions: The savings obtained by excluding admissions predicted to be inappropriate were small relative to the health losses. Programs for reducing inappropriate health care should not be implemented without investigating their effects on both health outcomes and costs.

Keywords: Cost-effectiveness, Hospital, Health benefit, Sensitivity and specificity, Cost analysis

Increasing health care costs have given rise to a variety of strategies for cost containment. One of them is to deny care when health benefits are negligible. It is commonly believed that the reduction of unnecessary or inappropriate health care would result in substantial savings (2;3;7). In particular, this applies to inappropriate hospital admissions, for which high rates have been found in many countries (1;4;14;21;23;26). However, the finding of a high rate of inappropriate admissions retrospectively does not necessarily indicate a potential for cost reductions. To reduce the number of such admissions and to obtain savings, clinicians must be able to identify them as inappropriate before or at the time of admission, that is, before diagnostic and therapeutic interventions are undertaken. The assumption that this is possible has, to our knowledge, not been investigated (29;31;35).

In the Tromsø Medical Department Health Benefit Study, 24% of the admissions to the department of internal medicine at a teaching hospital were found inappropriate (12). This estimate was made by expert panels using a structured consensus method that has been found reliable for a random sample of the included patients (9). In the present study, we investigated whether cost reductions could have been obtained by letting the expert panels predict appropriateness solely on the basis of information available at the time of admission. The aim of the study was twofold: a) to estimate the sensitivity and specificity of these predictions; and b) to estimate the costs saved if they had been used for reducing the number of admissions and the potential health losses for patients falsely predicted not to need hospitalization.

METHODS

Subjects

In 1993, 5,151 patients were admitted to the department of internal medicine at the University Hospital of Tromsø. During a 6-week period from February 1, 1993, all admissions were eligible for inclusion in the study. Patients transferred from other university hospitals (n = 3), those admitted for evaluation or continuation of treatment initiated during a previous stay (n = 27), or those admitted for inclusion in drug trials (n = 2) were excluded, as well as one patient whose medical record could not be found. Nine planned readmissions were merged with the primary admission, resulting in 479 included admissions.

These admissions were randomly assigned to three groups with probabilities of .10 (group 1), 0.45 (group 2), and 0.45 (group 3). Two expert panels (A and B) were recruited, each consisting of an internist, a surgeon, and a general practitioner who were all board-certified. For each admission in groups 2 and 3, appropriateness was predicted at admission by one of the panels, and a final judgment of appropriateness was made by the other panel after discharge (Figure 1). The admissions in group 1 were assessed by both panels after discharge to study interpanel agreement (9).

The study was approved by the Regional Ethics Committee and the Norwegian Data Inspectorate.

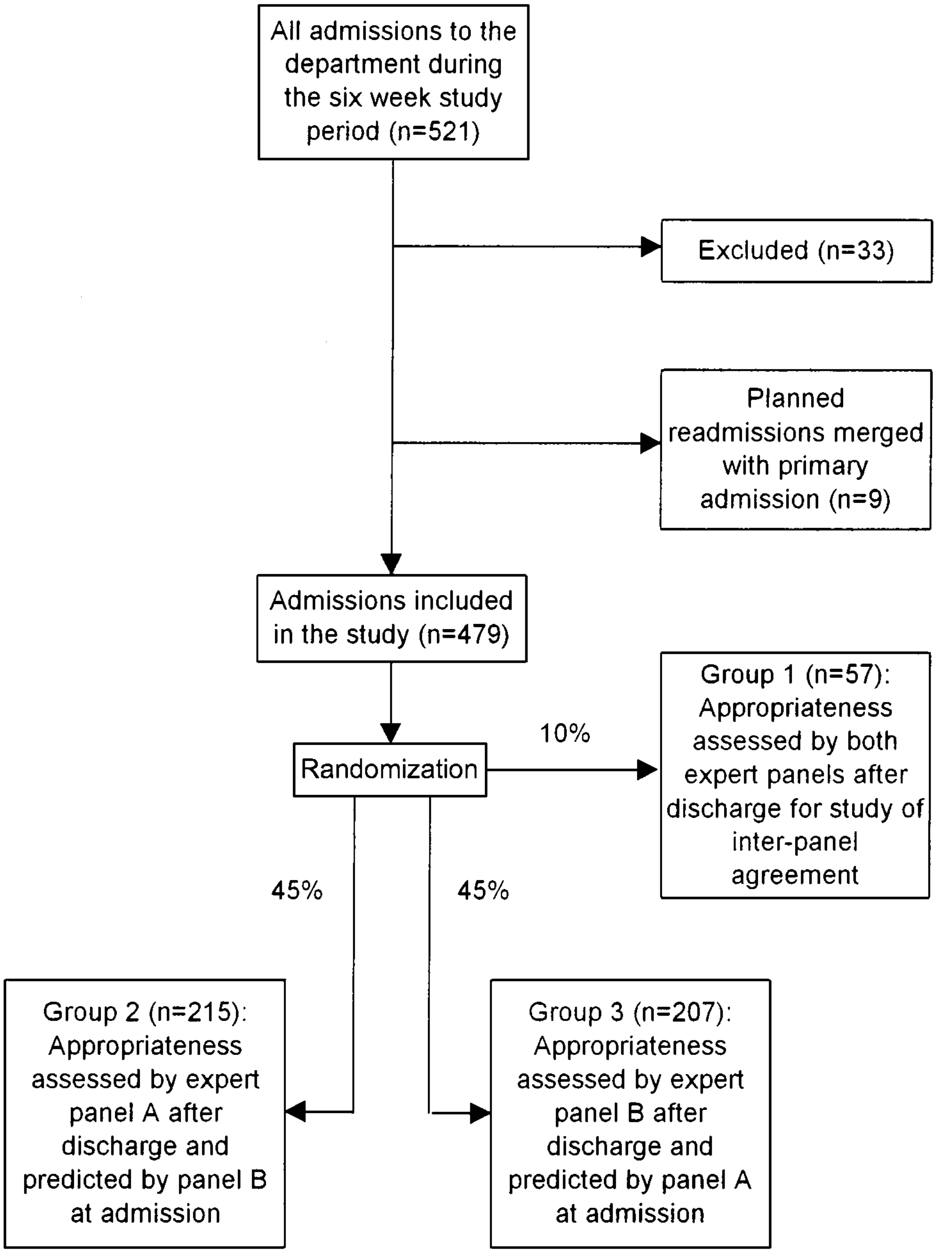

Figure 1. Inclusion of patients and assessment of appropriateness in the Tromsø Medical Department Health Benefit Study.

Predictions of Appropriateness

An admission was defined as appropriate if it resulted in a health benefit that could not have been obtained on a lower care level. For prediction of health benefit, the experts were provided with the patient's complete medical history and the results of the physical examination as obtained at admission. No information about the course of the hospital stay after the time of admission was given. Using a method that has been described in more detail previously, the experts then made predictions of the health gain from the hospital stays in

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terms of healthy-years equivalents (HYEs) (9). HYE is a measure of life-years adjusted for quality of life where 1 HYE represents 1 year in full health (19;24). Although there are some theoretical differences between HYE and the more well-known quality-adjusted life-years (QALYs), the latter term will be used in this paper (18;34).

The measurement of gain in QALY has limited sensitivity for improvement in quality of life of short duration relative to the remaining lifetime. To compensate, the experts also predicted the improvement in health-related short-term quality of life during the hospital stay or shortly after discharge relative to the expected quality of life without admission (11). Finally, they predicted whether patients with health benefits could have obtained the same benefit in primary care or in an outpatient clinic.

The predictions were first made by each expert individually, and then discussed in a meeting of the three members of each panel when there was disagreement according to predefined criteria. Further details of the method, a discussion of methodologic problems, and results regarding its reliability have been published previously (9).

For each admission, final assessments of health benefit and care level were made by the other panel after discharge. The results of these assessments, which in the following will be termed the observations, have been reported in detail previously (10;11;12). The predicted and observed appropriateness of the admissions were determined from the assessments of health benefit and necessary care level. To estimate the sensitivity and specificity of the prediction that an admission would be appropriate, the predictions were compared with the observations as the gold standard. The formulae used were:

$$\text{sensitivity} = \frac{\text{no. of admissions both predicted and observed to be appropriate} \times 100}{\text{no. of admissions observed to be appropriate}}$$

and

$$\text{specificity} = \frac{\text{no. of admissions both predicted and observed to be inappropriate} \times 100}{\text{no. of admissions observed to be inappropriate}}$$

Groups 2 and 3 were pooled for this analysis.

Cost Analysis

Direct costs in 1993 Norwegian kroners (NOK) (US $1 = NOK 7.50) incurred by the patients during their stays in the department were estimated from the perspective of the hospital. Overhead costs were allocated to the service and clinical departments according to the step-down allocation method (6). For each patient, costs were estimated on the basis of unit costs and utilization of services. Unit costs were estimated for the output of all service departments (radiology, microbiology, etc.). Utilization of services was registered from hospital databases and the medical record for each individual patient.

The costs of nurse and physician labor and "hotel costs" were apportioned according to length of stay for each ward separately.

Further details of the cost analysis have been given previously (12).

Statistical Methods

Multivariate logistic regression analyses were performed with the SAS statistical package (SAS Institute, Cary, NC).

Ninety-five percent confidence intervals of statistical parameters were estimated with the bootstrap algorithm, except for the logistic regression (8). The kappa statistic was used for assessing agreement between the expert panels for assessments about the admissions in group 1 (5).

Table 1. Predictions and Observations of Appropriateness of Consecutive Admissions to a Department of Internal Medicine

	Observations after discharge		
Predictions at admission	Inappropriate admissions (%)	Appropriate admissions (%)	Total (%)
Inappropriate admissions	28 (27)[a]	38 (12)	66 (16)
Appropriate admissions	74 (73)	282 (88)[b]	356 (84)
Total	102 (100)	320 (100)	422 (100)

[a] Specificity.
[b] Sensitivity.

RESULTS

Agreement Between the Expert Panels

Group 1 (n = 57), in which all patients were assessed by both expert panels after discharge, was used for estimating the agreement for judging that an admission was appropriate. The overall agreement was 0.75 and the kappa statistic was 0.41 (95% CI 0.15–0.68), i.e., fair agreement (15).

Prediction of Appropriateness

Of the admissions in groups 2 and 3 (n = 422), the expert panels predicted that 66 (16%) would be inappropriate and 356 (84%) appropriate. The relationship between these predictions and the observations made by the panels after discharge is shown in Table 1. The panels were able to identify 88% of the appropriate admissions but only 27% of the inappropriate admissions. In other words, the sensitivity and specificity of the prediction that an admission would be appropriate were 88% and 27%, respectively.

To explore whether there was an association between the predictions and the observations, a logistic regression analysis was performed with the predictions as the dependent variable. The observations of appropriateness, gender, age, and dummy variables for diagnostic categories were included as independent variables. Elective and emergency admissions were analyzed separately. For emergency admissions, the fit of the model was poor (chi-square for covariates 17.56; *df*, 13; $p = .18$). For elective admissions, the fit was better (chi-square for covariates 25.15; *df*, 10; $p = .005$). Only the observations of appropriateness made after discharge and gender were significant regressors. No interaction between these two variables was observed ($p = .22$). Because the odds ratio for the observations is indicative of the panels' predictive abilities in this model, the absence of this interaction means that these abilities were the same for men and women. However, because of the gender variable, the sensitivity and specificity for the two sexes were different. Based on the crude data, the sensitivity for elective admission of men was 96% and of women, 75%. The specificities were 21% and 50%, respectively. Sensitivities and specificities estimated from the model were similar.

Clinical details of the five patients with the greatest predicted health benefits who were judged to be inappropriate after discharge and of the five patients predicted to be inappropriate with the greatest health benefits can be found in Table 2.

Reducing the Number of Admissions

The mean cost of stay for the inappropriate admissions was US $2,532, and for the appropriate admissions, US $5,800. The observed mean gain in QALY was 2.3. The median bed occupancy rate in the study period was 0.84 (interquartile range, 0.79 to 0.89).

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Table 2. The 10 Patients With the Greatest Discrepancy Between Predicted and Observed Health Benefits

Sex	Age in years	ICD-9 code	Appropriateness/ health gain		Total cost in US$	Clinical details
			Predicted	Observed		
Female	28	034	50 QALY	Inappropriate	1,714	Admitted for suspected meningitis, but was diagnosed to have acute streptococcal tonsillitis. Treated with antibiotics. Could have had the same health benefit without admission.
Male	43	482	29 QALY	Inappropriate	632	Discharged after stay for pneumonia treated with antibiotics 4 days earlier. Readmitted because of fever and slight hemoptysis. An elevated mycoplasma titer was found and he was given doxycycline.
Female	40	427	11 QALY	Inappropriate	611	Paroxystic supraventricular tachycardia. Admitted for magnesium loading as part of work-up. Borderline result, magnesium not instituted.
Male	64	785	9 QALY	Inappropriate	17,229	Admitted for septicemia and multiorgan failure. Treated with mechanical ventilation and hemodialysis. Died after 4 days in hospital
Male	48	412	7 QALY	Inappropriate	1,199	Acute myocardial infarction 3 years previously. Uncharacteristic chest pain. Normal findings on coronary angiography.
Female	28	038	Inappropriate	51 QALY	1,273	Successfully treated septicemia with group A streptococci. Not diagnosed as septicemia at admission.
Male	60	250	Inappropriate	13 QALY	1,379	Non–insulin-dependent diabetes mellitus for 4 years. Now persistent hyperglycemia. HbA1C 18.6, S-glucose 24. Insulin treatment initiated.
Female	42	413	Inappropriate	13 QALY	3,318	Previously considered for possible angina pectoris. Now admitted for chest pain. Coronary angiography showed stenosis of left anterior descending coronary artery and hypokinesia of left ventricle. Aortacoronary bypass planned.
Male	63	038	Inappropriate	12 QALY	8,367	Successfully treated urosepsis.
Female	64	427	Inappropriate	8 QALY	3,954	Admitted for atrial fibrillation caused by idiopathic dilated cardiomyopathia. Treated with digitoxin, verapamil, and warfarin.

Table 3 shows the effects in terms of costs saved and QALY lost from excluding admissions predicted to be inappropriate. For elective admissions, 9% of the total costs would have been saved and 5% of the total QALY lost. For electively admitted men, 10% (95% CI, 5–17) of the admissions would have been excluded, 5% (95% CI, 2–9) of the costs saved, and 2% (95% CI, 0–9) of the QALY lost (n = 102). For electively admitted women, the corresponding percentages were 34 (95% CI, 22–48), 17 (95% CI, 6–39), and 12 (95% CI, 2–33)(n = 50).

The cost savings from denying care to inappropriate emergency admissions would have been 14% and QALY losses, 18% (Table 3).

Sensitivity Analysis

The effect of better predictions of appropriateness was explored. To obtain a best-case scenario, the most beneficial admissions among those that had been falsely classified as inappropriate were reclassified as appropriate, and the most costly among those that had been falsely classified as appropriate were reclassified as inappropriate. Assuming that the sensitivity could only be improved slightly from the observed 88% to 90%, but that the specificity could increase from 28% to 50%, 6 and 23 patients, respectively, would need to be reclassified. Under these assumptions, US $11,983 was saved per QALY lost (Table 4).

Savings and health losses were also estimated under the assumptions that the inappropriate admissions had the same cost as the appropriate admissions, and that all gains in QALY had been overestimated by 100%. Finally, when combining these two assumptions with improved sensitivity and specificity, US $26,131 was saved per QALY lost (Table 4).

DISCUSSION

At present, any strategy for reducing the number of inappropriate admissions to hospitals would have to involve clinical judgment in one way or another. The focus of the present study was whether the information available at the time of admission was sufficient for making such judgments for actually admitted patients. To explore whether costs could have been reduced without resulting in unacceptable health losses, we used panels of experienced board-certified specialists to provide a higher level of expertise than the average admitting physician. To ensure that the panels had all relevant data available, a board-certified specialist of internal medicine (B.O.E.) prepared the summaries that were the basis of their assessments. Even so, the panels' predictions of appropriateness were poor. While they were able to correctly identify 88% of the appropriate admissions, only 27% of the inappropriate admissions were detected. If the admissions predicted to be inappropriate had been excluded, significant savings would have been obtained (12%), but at the cost of an almost equal percentage of the total benefit in QALY (14%)(Table 3).

Some difficulty for one panel in predicting the other panel's assessment after discharge would be expected due to interobserver variation, but this is similar to clinical practice, where judgments of inappropriateness would have to be made by different doctors. There exists no gold standard method for judging inappropriateness that does not rely on clinical judgment. However, fair agreement between the panels was found in the agreement study of group 1. Uncertainty about diagnosis and effect of treatment at admission was probably the most important explanation for the poor predictions. Presumably, there was insufficient information for making any accurate estimate of the effect of the hospital stays for many of the patients (Table 2). It is difficult to see how this situation could have been improved for emergency admissions, but more information could perhaps have been obtained for elective patients before admission to allow better predictions. Since one-third of these admissions were inappropriate as judged after discharge, the potential for better selection of patients was considerable (Table 3).

Table 3. Effects of Reducing the Number of Admissions to a Department of Internal Medicine on the Basis of Predictions of Appropriateness Made at Admission Compared to the Potential Effects If the Predictions Had Been Perfect (n = 422)

	Effects of not admitting patients predicted to have been inappropriately admitted				Potential effects if predictions had been perfect	
Admission category	% of patients not admitted (95% CI)	% of costs saved (95% CI)	% of gain in QALY lost (95% CI)	Costs saved (US$)/ QALY lost (95% CI)	% of patients not admitted (95% CI)	% of costs saved (95% CI)
Elective (n = 152)	18 (12 to 24)	9 (5 to 15)	5 (1 to 12)	3,910 (1,887 to 21,548)	34 (27 to 43)	17 (11 to 26)
Emergency (n = 270)	14 (11 to 19)	14 (5 to 26)	18 (6 to 34)	1,693 (474 to 6,525)	19 (14 to 23)	10 (6 to 15)
All (n = 422)	16 (12 to 19)	12 (6 to 22)	14 (5 to 27)	1,953 (699 to 5,688)	24 (20 to 28)	12 (9 to 16)

Table 4. Sensitivity Analysis of Health Losses and Cost Savings From Excluding Admissions Predicted to Be Inappropriate

	QALY lost	Costs (US$) saved	Costs saved (US$)/ QALY lost
Result of study	134	262,985	1,961
Assumptions in sensitivity analysis			
Sensitivity, 90% and specificity, 50%	32	381,399	11,983
Cost of appropriate and inappropriate admissions equal	134	330,692	2,466
Overestimation of all gains in QALY by 100%	67	262,985	3,922
All three scenarios above combined	16	415,870	26,131

Rationing based on the panels' predictions of appropriateness would have saved US $3,910 per QALY lost for elective and 1,693 for emergency admissions (Table 3). Since the cost analysis only included costs incurred during the included stays, the savings may have been underestimated. The reason is that many patients with chronic diseases would subsequently have been treated in other parts of the hospital, e.g., in outpatient clinics and other clinical departments, where more costs would have been incurred, partly as a consequence of decisions about follow-up made during the included stays. If the patient had not been admitted in the first place, these costs would have been saved in addition to the costs incurred during the included stay. In some studies, US $50,000 per QALY has been used as an upper limit for interventions considered to be cost-effective (17;20), which in the present investigation would correspond to the minimum amount that would have had to be saved per QALY lost. However, even allowing for a substantial underestimation of costs and overestimation of gains in QALY, the savings per QALY in the present study would have been lower. In the sensitivity analysis, US $26,131 per QALY was the maximum saving attained when assuming both higher sensitivity and specificity, more costly inappropriate admissions, and lower gains in QALY than observed (Table 4).

One possibility for improving the panels' predictions could have been to give a more detailed specification of the alternatives to hospital care. This approach was chosen by Coast et al. (4) who considered 12 alternatives to admission to a department of general medicine and geriatrics. However, although an alternative was found for 20%, few resources were saved by exploiting this potential (4).

An interesting finding of this study was that rationing of elective admissions would have had different effects for the two sexes. Few resources would have been saved and few QALYs lost for men, whereas a 17% cost reduction would have been obtained at the cost of a 12% loss in QALY for women. The logistic regression analysis indicated that this effect was independent of diagnosis. The difference was not caused by different predictive abilities for the two sexes, since this would have been shown by a significant interaction term between gender and observed appropriateness. This result suggests that reducing admissions in this manner might have discriminated against women.

Most previous studies of inappropriate admissions have relied on the Appropriateness Evaluation Protocol (AEP) and similar instruments (25;28;33). The AEP has also been used in a major effort to assess the extent of inappropriate health care in the European Union (22). The main differences between the AEP and our method were: a) the AEP partly relies on information that is only available after admission, thus precluding its use for predicting inappropriate admissions; and b) it is a screening tool that has been validated against expert clinical judgment, whereas we used clinical judgment directly for evaluating the admissions (16;32;33). Our results question the assumption that this instrument could reduce hospital costs to any significant degree without leading to health losses. The same applies to other forms of utilization review, which in the United States have been shown to reduce both

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the number of admissions and costs (13;27;29;30;35). None of these studies includes an assessment of how this affects the quality and outcome of care.

Some limitations of the cost analysis should be noted. First, we were not able to calculate marginal costs, i.e., the cost of treating one more patient, which are most relevant for estimating potential savings. Since the department operated below full capacity, the savings obtained would have been lower than our estimates. Second, the cost analysis was made from the hospital's perspective. A societal perspective would have been preferable, but the task of estimating societal costs for the heterogeneous group of patients in a department of internal medicine would have been insurmountable. It can be assumed that many patients would have been treated elsewhere if not admitted, and that the societal savings would have been lower than our estimates. Last, we did not include the cost of implementing a procedure for judging appropriateness at admission, which would also have had to be subtracted from the savings. Accordingly, a cost analysis without these limitations would probably have supported our findings.

POLICY IMPLICATIONS

We conclude that, in the investigated department, reducing the number of admissions based on predictions of appropriateness at admission would have resulted in unacceptable health losses relative to the savings. The extent to which this conclusion can be generalized is uncertain, but it indicates that a high rate of inappropriate admissions does not necessarily imply that cost savings of the same magnitude can be obtained. In the absence of evidence to the contrary, decision makers should not implement programs to reduce inappropriate admissions without considering their effects on both costs and health benefits.

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