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The Impact of Admissions for the Management of End-Stage Renal Disease on Hospital Bed Occupancy

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Key Words
End-stage renal disease, management · Hospital bed occupancy · ESRD, admission episodes · ESRD, frequency of admission

Abstract
Background: End-stage renal disease (ESRD) is increasingly prevalent but the inpatient costs associated with this condition are poorly defined due to limitations with data extraction and failure to differentiate between hospitalisation for renal and non-renal disease reasons. The impact of admissions primarily for the management of ESRD on hospital bed utilisation was assessed over a 5-year period in a large teaching hospital. ***Methods:*** All admission episodes were reviewed and the ESRD group was identified by a primary International Classification of Diseases code for ESRD or a non-specific primary renal failure code with a secondary code for ESRD. The frequency and duration of hospitalisation and contribution to bed day occupancy of this group with ESRD was determined. ***Results:*** There were 70,808 patients responsible for a total of 116,915 admissions and 919,212 bed days over the study period. Of these, 988 (1.4%) patients were admitted for the management of ESRD, accounting for 2,387 (2.0%) of admissions and utilisation of 23,011 (2.5%) bed days. After adjustment for age and gender, those admitted for ESRD management were significantly more likely to have a prolonged admission exceeding 30 days (odds ratio 1.46, 95% confidence interval 1.23–1.72, $p < 0.001$). When the admission was an emergency rather than an elective event, the patient was 4.6 times more likely to be hospitalised for over 30 days. ***Conclusions:*** Persons admitted for ESRD management are hospitalised more frequently and for longer than the overall inpatient population, occupying a substantial number of bed days.

Introduction

The cost of health care provision is substantial and continually rising. In the United Kingdom, the National Health Service (NHS) Institute for Innovation and Improvement has offered guidance to improve NHS efficiency and productivity [1]. One such strategy is aimed at reducing the mean length of stay (LOS) of patients admitted to a hospital, with comparative evidence that those with similar diagnoses in the United States are hospital-

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ised for shorter time periods [2]. Our previous work suggested that targeting resources to those patients with very prolonged admissions would further improve overall efficiency [3].

End-stage renal disease (ESRD) is an increasingly common chronic disease that is associated with substantial health care costs [4]. These are estimated at USD 12 and 20 billion annually for the United States private and public healthcare systems, respectively [5]. Approximately 40% of those costs are associated with inpatient care. The impact of ESRD on the NHS and other publicly-funded healthcare system resources is poorly recorded. Previous analysis of hospital bed utilisation by Ham et al. [2] identified the 11 most important admitting diagnoses in relation to bed occupancy within the NHS. Due to data limitations, analysis was restricted to those persons over the age of 65 years. ESRD was not amongst these diagnoses.

We hypothesised that the number and clinical complexity of persons with ESRD make it an important reason for admission and a major cause of hospital bed occupancy and that the limitations with data extraction and the exclusion of persons younger than 65 years in previous reports may have underestimated the economic burden associated with ESRD. We retrospectively reviewed all admissions to our hospital over a 5-year period to assess the frequency and duration of admission, and the contribution to overall bed occupancy of those hospitalised primarily for the management of ESRD.

Methods

Setting

The Belfast City Hospital (BCH) Trust is a modern 744-bed university teaching hospital providing acute local services and several key regional clinical specialties. There is no provision for paediatric or obstetric services. During the 2004/2005 financial year, the hospital dealt with 24,248 day cases, 47,313 accident and emergency attendances and 194,729 outpatient appointments.

The hospital is the regional referral centre for renal medicine and provides all acute renal transplant services for Northern Ireland (population 1.75 million). The outpatient haemodialysis facility has 43 stations serving a population of approximately 700,000.

Participants

Full details of dataset construction have previously been described in depth [3]. In summary the BCH Patient Administration System (PAS) was interrogated to provide all admission data for the period 1 January 2001 to 31 December 2005. Only completed episodes were considered. Data included hospital number, gender, date of birth and age, postcode, admission date, admission unit, mode of admission, diagnoses, date of discharge and mode of discharge.

Diagnostic Codes

The International Classification of Diseases 10th edition (ICD-10) codes were available for all admission episodes. The diagnostic codes identified as responsible for the greatest bed day utilisation within the NHS in England were considered for analysis [2]. These were stroke, hip fracture, chronic obstructive pulmonary disease (COPD), bronchitis/asthma, heart failure, kidney/urinary tract infection, acute myocardial infarction, and angina pectoris. Table 1 contains the individual ICD-10 extraction codes used. Joint replacement surgery and coronary bypass surgery are not performed at the BCH site, so only 8 of the 11 leading causes of bed day usage were considered in this study.

Admissions related primarily to the management of ESRD were identified by 2 methods. The first was by a primary admission diagnostic code for ESRD: N18.0, N18.8, N19.x, and N99.0. Data were also extracted if the admission episode had a non-specific primary renal failure ICD-10 code (N17.0) and a secondary code specifying ESRD. Admission episodes relating to the management of individuals with a renal transplant, ICD-10 code (Z94.0), were not included within this analysis.

LOS

The duration of each coded admission was calculated by the interval between admission and discharge in complete days. Those patients attending Accident and Emergency who were subsequently discharged without requiring inpatient admission are not included in analysis. For further analysis, a LOS exceeding 30 days was considered as a prolonged admission. Our previous analysis identified 30 days as the 95th percentile with regard to the LOS amongst all BCH admissions; analysis of bed occupancy amongst prevalent ESRD patients in the United States also used this period to define lengthy hospitalization [3, 6].

Statistical Analysis

Descriptive analysis of the demographics, administrative and clinical variables are reported as mean with standard deviation (SD) or median values with inter-quartile range (IQR) as appropriate to their distribution. The Mann-Whitney U test was used for non-parametric analyses.

A multivariate logistic regression model, incorporating age, gender and the primary admission diagnosis, was used to assess the influential factors in prolonged LOS. Results are presented as odds ratios [95% confidence interval (CI)] with associated p values. Additional logistic regression analysis using robust variance standard errors was performed to adjust for any correlation of LOS within individuals. Values of $p < 0.05$ were considered statistically significant. All analyses were carried out using STATA release 10 (Stata Corporation, College Station, Tex., USA).

Results

Overall Admission Episodes

There were 70,808 patients responsible for a total of 116,915 admissions over the study time period. The total number of bed days occupied was 919,212. Admissions due to the 9 primary diagnostic groups investigated within this study accounted for 163,795 (17.8%) of total bed

Table 1. The primary diagnoses and extraction codes used in the analysis of admission episodes

Primary diagnosis	ICD-10 extraction codes	NHS* bed days, %	BCH bed days, %	NHS* LOS days	BCH LOS (days)	
					mean ± SD	median (IQR)
Stroke	I61-I64 I60.9 I67.9 I67.8	2.0	4.0	27.1	27.2±45.9	11.5 (25)
Hip fracture	S72.1 S72.0	1.5	0.9	26.9	40.5±59.3	26.0 (44.5)
COPD	J44.1 J44.0 J44.8 J43.9	1.4	2.7	9.9	9.4±13.3	6.0 (6)
Bronchitis/asthma	J120.9 J40.x J46.x J45.9	1.2	0.5	11.7	5.1±7.0	3.0 (4)
Heart failure	I42.0 I50.9 J81.x I50.1	1.2	2.7	12.4	12.3±18.7	7.0 (11)
Kidney or urinary tract infection	N39.0 N15.0/1	0.9	1.9	15.9	14.4±27.6	6.0 (11)
Myocardial infarction	I21.4 I22.9 I21.9	0.8	1.3	9.4	5.5±11.5	2.0 (5)
Angina pectoris	I20.9 I20.0 I20.8	0.7	1.3	5.8	3.4±7.9	1.0 (2)
ESRD	N18.0 N19.x N18.8 N99.0 N17.0 + any of above	unknown	2.5	unknown	9.6±17.6	4.0 (9)

* NHS data as reported by Ham et al. [2] (LOS unspecified whether mean or median).

days occupied. Stroke was responsible for the greatest single proportion of bed occupancy 37,032 days (4.0%), followed by heart failure and COPD (2.7% each). The relative contributions of the remaining diagnoses to overall bed occupancy, and comparison with 2001 NHS results, are contained in table 1.

ESRD Admission Episodes

There were 988 patients admitted primarily for the management of ESRD. These accounted for 2,387 separate admission episodes and 23,011 total bed days. Thus, in this 5-year period, 1.4% of patients, 2.0% of admissions, and 2.5% of bed days were related directly to ESRD.

Frequency of Admission

The median (IQR) number of admissions was 1 (1) and there were 49,420 (42.3%) single-admission episodes recorded. The median (IQR) number of admissions for those with ICD-10 codes of interest was as follows: stroke 2 (2), hip fracture 2 (2), COPD 4 (8), bronchitis/asthma 2

Table 2. Analysis of predictors of prolonged hospital stay (>30 days)

Predictors	Total admissions	Admission >30 days, n (%)	Odds ratio*	95% CI	p
Gender					
M	59,482	2,409 (4.0)	reference group		
F	57,433	3,058 (5.3)	1.17	1.10–1.25	<0.001
Age					
<55	48,569	707 (1.5)	reference group		
55–64	19,237	592 (3.1)	2.22	1.96–2.56	<0.001
65–74	21,877	1,110 (5.1)	3.6	3.28–4.14	<0.001
75–84	19,555	1,775 (9.1)	6.5	5.81–7.21	<0.001
≥85	7,677	1,283 (16.7)	12.1	10.81–13.58	<0.001
Primary diagnosis					
Stroke	1,026	336 (32.7)	4.05	3.52–4.65	<0.001
Hip fracture	124	89 (71.8)	5.81	4.37–7.74	<0.001
COPD	2,549	94 (3.7)	0.56	0.44–0.68	<0.001
Bronchitis/ asthma	821	9 (1.1)	0.20	0.15–0.56	<0.001
Heart failure	1,889	158 (8.4)	0.98	0.83–1.16	0.85
Kidney/UTI	1,067	131 (12.3)	1.83	1.51–2.21	<0.001
Myocardial infarction	2,058	51 (2.5)	0.45	0.34–0.58	<0.001
Angina	3,486	56 (1.6)	0.31	0.24–0.41	<0.001
ESRD	2,222	165 (7.4)	1.46	1.23–1.72	<0.001

* Adjusted model contains primary diagnoses as listed, age and gender.

(4), heart failure 3 (4), kidney/urine infection 2 (3), acute myocardial infarction 1 (1), angina 2 (2), and ESRD 3 (4).

LOS

The overall median LOS was 3 (7) days. The median LOS was 2 (5) days for those admitted once, but those individuals who had multiple admissions were more likely to stay significantly longer and their median stay was 4 (8) days ($p < 0.001$).

The median LOS (IQR) for each of the 9 admitting diagnoses of interest is detailed in table 1. Admissions due to hip fracture or stroke were longest in duration, and those due to ischaemic heart disease (acute myocardial infarction or angina pectoris) were the shortest. The median LOS for patients admitted for ESRD management was 4 (9) days.

A small number of admissions (5,467) were prolonged (LOS >30 days). These episodes represented less than 5% of the total admissions but accounted for 37% of overall bed occupancy (341,107 days). The proportion of prolonged admissions within each diagnostic group is detailed in table 2.

Age

The mean age for all admissions was 56.8 (20.7) years. Patients in almost all the primary diagnostic groups considered were on average older than the all-admissions mean: stroke 73 (12) years, hip fracture 83 (7) years, COPD 70 (11) years, bronchitis/asthma 50 (20) years, heart failure 73 (13) years, kidney/urinary tract infection (UTI) 62 (23) years, acute myocardial infarction 65 (13) years, and angina pectoris 64 (11) years. Those patients admitted for the management of ESRD had a mean age of 62 (17) years. Restricting our analysis to individuals older than 65 years of age would have excluded 1,226 (51%) of all admissions for ESRD management.

Prolonged Admissions

Compared to a reference group aged <55 years, the odds ratio (OR) for a prolonged stay (>30 days) increased incrementally and significantly with age, reaching 12.1 (95% CI 10.81–13.58, $p < 0.001$) for those 85 years or older (table 2). This was the most influential factor in predicting prolonged admission. Female patients were significantly more likely to have a LOS exceeding 30 days than male patients (OR 1.17, 95% CI 1.10–1.25, $p < 0.001$).

After adjustment for age and gender, those admitted for the management of ESRD remained at a significant risk of prolonged LOS (OR 1.46, 95% CI 1.23–1.72, $p < 0.001$). The primary diagnoses of stroke (OR 4.05), hip fracture (OR 5.81), and urinary sepsis (OR 1.83) were the only other admissions associated with a greater risk for prolonged hospitalisation (table 2).

Emergency and Planned Admissions

There was a significant difference in the duration of LOS amongst ESRD patients depending on whether their hospitalisation was as emergency or an elective event. Of the 998 admissions for the management of ESRD, 320 were recorded as an emergency, 44 (13.8%) of whom stayed more than 30 days. Of the 678 planned admissions, only 18 (2.7%) had a prolonged hospitalisation [OR 4.7 (2.6–8.4), $p < 0.001$].

Discussion

ESRD has poorly understood financial and human resource costs within the NHS [6, 7]. While calculation of outpatient dialysis costs is relatively straightforward, in-

patient costs directly related to renal disease are difficult to quantify. Persons with ESRD have multiple co-morbidities that may require hospitalisation and yet are not directly attributable to their renal disease. Grun et al. [6] estimated that 12% of the healthcare costs of dialysis patients in London were attributable to in-patient admissions, but they did not distinguish between renal disease related and hospitalisations for other reasons. In light of this methodological challenge, we chose to restrict our analyses to admissions directly related to the management of ESRD, which are easily extracted using pre-specified ICD-10 codes. This provides a practical, objective, and reproducible method of assessing the impact of ESRD management on bed utilisation in the NHS or indeed any other healthcare system.

Principal Findings

Within the BCH Trust, admissions related directly to the management of ESRD accounted for 1.4% of patients, 2.0% of admission episodes and 2.5% of overall bed occupancy over a 5-year period. This identifies ESRD as the fourth most important primary admission diagnosis in terms of bed occupancy after stroke, heart failure and COPD. This finding is in contrast to the report of Ham et al. [2] who did not identify ESRD, or renal disease of any form, as one of 11 most important admitting diagnoses in terms of NHS bed occupancy. There may be more than one explanation for this discrepancy.

Compared to the other common admitting diagnoses, ESRD implicitly describes chronicity and as such when coded on discharge is more likely to be included in a subsidiary rather than a primary code. This is not an issue encountered with the other admitting diagnoses investigated. Restricting our analysis to those with ESRD as the primary admitting code (N18.0) would have failed to identify approximately 60% of those admitted for management of ESRD. The remaining admission episodes identified contained a non-specific renal failure code as their primary admitting diagnosis with a subsidiary ICD-10 for ESRD or dialysis provision. A failure to appreciate the varying methods of coding admissions for the management of ESRD will underestimate its impact on resource utilisation.

Ham et al. [2] concentrated on persons older than 65 years on the premise that 'older people make the greatest use of acute beds'. Our results are consistent with this hypothesis, and we found a significant incremental risk of prolonged hospitalisation with increasing age. However, in persons admitted for the management of ESRD, over half are younger than 65 years of age. Thus despite the increasing age of the dialysis population [4], ESRD has a substantial disease burden in younger people. An assessment of NHS bed occupancy limited to the older population will therefore underestimate the financial burden associated with the management of ESRD.

ESRD patients represent a sub-population of hospital admissions who require a disproportionately high level of ongoing medical and specialist nursing care. Whilst persons with ESRD are relatively few in overall inpatient numbers, they represent a significant challenge to health service provision due to their undeniable clinical complexity and chronicity [8, 9]. In our study, their frequency of admission was comparable to patients with heart failure and second only to those with COPD. In addition, the median LOS of ESRD patients is greater than that for the hospital inpatient population as a whole. With the increasing age of the dialysis population, and the unequivocal prolongation of hospitalisation in older people, we anticipate that ESRD management will be increasingly important in bed day occupancy and resource utilisation within the NHS. Hospital administrators and those planning health service provisions will need to be cognizant of this important group.

While some variability in the use of ICD-10 extraction codes cannot be completely excluded as a possible source of error within this study, the size and duration of the available data lends robustness to our conclusions. Given that the aim of this study was to capture those patients hospitalised primarily for the management of ESRD, we are confident from our clinical experience that in this institution, where the Regional Nephrology Unit for Northern Ireland is based, the care of such individuals would have almost exclusively been under the care of the renal team. The degree of consultant input and documentation in the notes will have minimised, though not eliminated, the inaccuracy of discharge coding. We are additionally reassured by the consistency in coding across the 5-year study period.

In general, the findings related to LOS in our hospital are comparable to those previously reported for the NHS in England in 2001 [2]. While there are some variations, the main diagnostic groups retain their positions of importance in the causes of bed occupancy. The differences reported probably reflect centre-specific effects (such as the exclusion of joint replacement and coronary bypass procedures in our study) and importantly, the absence of age restriction in our analysis.

In conclusion, we have identified that admissions relating directly to the management of ESRD are impor-

tant in terms of overall bed occupancy and resource utilisation. This effect has previously been underestimated due to coding methodology and age restrictions. Persons with ESRD are admitted more frequently and for longer than the overall hospital population. With a projected increase in both the absolute numbers and age of persons with ESRD, there are important implications for service planning and provision. Accurate quantification of these costs will require a prospective longitudinal study.

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