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TYPE: ORIGINAL ARTICLE

NOTE: *OAs should not exceed 3000 words and the main text should be arranged under the headings of: Abstract, Introduction, Methods, Results, Discussion, Conclusion and References.*

TITLE: *(No more than 35 words)*

The relationship between in-hospital location and outcomes of care in patients of a large general medical service.

ABSTRACT: *(Should be structured for Original Articles, as per below; no more than 250 words.)*

Background: The discrepancy between the number of admissions and the allocation of hospital beds means many patients admitted under the care of a general medical service can be placed in other departments' wards. These patients are called "outliers" and their outcomes are unknown.

Aims: To examine the relation between the proportion of time each patient spent in their "home ward" during an index admission and the outcomes of that hospital stay.

Methods: Data from Flinders Medical Centre's (FMC) patient journey database were extracted and analysed. The analysis was carried out on the patient journeys of patients admitted under the General Medicine units.

Results: Outlier patients' length of stay (LOS) was significantly shorter than that of the inlier patients (110.7 hours cf 141.9 hours; $p < 0.001$). They had a reduced risk of readmission within 28 days of discharge from hospital. Outlier patients' discharge summaries were less likely to be completed within a week (64.3% cf 78.0%; $p < 0.001$). Being an outlier patient increased the risk-adjusted risk of in-hospital mortality by over 40%. 50% of deaths in the outlier group occurred within 48 hours of admission. Outlier patients had spent longer in the Emergency Department (ED) waiting for a bed (6.3 hours cf 5.3 hours; $p < 0.001$) but duration of ED stay was not an independent predictor of mortality risk.

Conclusion: Outlier patients had significantly shorter LOS in hospital, but significantly greater in-patient death rates. Surviving outlier patients had lower rates of readmission but lower rates of discharge summary completion.

KEYWORDS: *(Five key words in order of importance for indexing purposes should be supplied below the abstract and should be taken from those recommended by the US National Library of Medicine's Medical Subject Headings (MeSH) browser list at <http://www.nlm.nih.gov/>)*

Health care delivery, home ward, outcome, ward inlier, ward outlier

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BACKGROUND: (*Brief statement of relevant work or clinical situation, and hypothesis, if applicable.*)

It is commonplace for Australian general hospitals to work at high levels of bed occupancy. The medical and surgical wards of many of our hospitals are often between 95% and 100% occupied. In consequence, it is often difficult to place patients in the “home wards” of clinical teams. Recently admitted patients, especially those admitted as an emergency, may have to spend periods of time as “outliers” because a bed is not immediately available in a preferred location. Having groups of patients who are “outliers” can disrupt both team-based and ward-based models of care, and fragment the care provided for the patients by medical, nursing and allied health clinicians.¹ Medication errors, for example, are higher in patients housed in an outlier ward.² However, concerns about “outliers” remain largely anecdotal as there are a limited number of studies on the effects of outlier status either on measures of efficiency of care such as hospital Length of Stay (LOS), or on measures of quality of care such as mortality risk, readmission rates and completion rates of the discharge summary. Patients with heart failure stayed longer in hospital if they spent time in an “outlier” ward, though their mortality risk and readmission rates were unaffected.³ A short term observational study of an elderly care unit reported that outlying patients had a longer LOS and higher three month readmission rate than patients accommodated in their home ward despite similar mortality and co-morbidity rates.⁴ Government expectations that patients will spend less than four hours in Emergency Departments (ED) may increase the frequency with which patients are placed in wards that are not the “home wards” of in-taking medical or surgical teams. More comprehensive studies are clearly warranted.

The primary aim of this study was to examine the status of a patient as a “ward inlier” or a “ward outlier” and measures of outcomes during and after admission, taking into account a range of the clinical characteristics of the patients in question. Patients were assigned to inlier or outlier status by the computerised bed management system of the hospital using instantaneously updated information pertaining to the allocated home wards of all inpatient units working within the hospital. We then assessed the patients’ LOS in hospital, their risk of in-hospital death and their risk of readmission or death within four weeks of discharge relative to the proportion of time each patient spent in their “home ward” during their index admission. We also collected information on the patients’ age, the time they spent in the ED awaiting a bed, and their co-morbidities, so that we would be able to compute a co-morbidity index. We then used those factors to control for confounding factors known to affect inpatient LOS.

AIMS: (*Brief statement of the overall aim/purpose.*)

To examine the relation between the proportion of time each patient spent in their “home ward” during an index admission and the outcomes of that hospital stay.

METHODS: *(Laboratory or other techniques used, including statistical analysis. Outcome measures clearly stated.)*

Ethics approval was granted by the Southern Adelaide Health Service / Flinders University Human Research Ethics Committee. We examined all hospital inpatient stays for patients admitted to and discharged by the General Medicine (GM) service in Flinders Medical Centre (FMC). The GM service comprises a combination of short and long stay units each with a defined “home ward” location. A “home ward” is defined as the ward where the multidisciplinary team primarily responsible for the care of a particular patient is located. The GM service controlled about 100 inpatient beds out of about 500 beds in FMC as a whole and cared for patients with complex multi-system pathology. The wards that were “home wards” for this service changed over six years but always were clearly and operationally defined throughout the period of observation. The percentage of patients who were outliers was a regularly reported hospital indicator and considerable care was taken to keep the relevant data systems up to date. If the patient was not treated within a “home ward” for the GM unit allocated to care for the patient, they were defined as being an outlier.

Data

The data were extracted from FMC’s special purpose patient journey database (January 1st 2003 to September 20th 2009). Only patients allocated to the care of the seven GM units for their entire stay were considered. The data set has information on inpatient ward movement from the time of their admission up until their discharge. The patient journey database is a continuously updated extract from the hospital’s basic patient admission and tracking databases. All patient movements between wards and between units are identified, ‘time-stamped’ and recorded. Inlier or outlier status is automatically altered at the time of the patient movement or unit re-allocation. Patients under the care of GM but housed in the intensive care, high dependency or coronary care units were classified as inliers while in that unit.

The initial extract of 23, 439 records from the patient journey database was merged with data from other databases, most importantly, the hospital’s ED computerised database, to obtain the various variables needed for the analysis that were not captured in the patient journey database, giving a new sample size of 23,312. 674 (2.89%) journeys were deleted from the sample due to incomplete time values. We categorised the journeys into “Journeys with LOS > 30 days”, “those discharged from ED” (see below) and “All Other Journeys”. The Register of Births, Deaths and Marriages was accessed to identify those patients who died within 28 days of discharge.

Exclusions

Outlier LOS in FMC may be affected by a number of administrative hospital processes, including:

- 1) A patient, having arrived at the ED, can be administratively admitted to the hospital but then discharged from the ED without ever entering the body of the hospital. Under those circumstances, the LOS of that patient is short but they will be viewed as an outlier because they never entered their home ward.
- 2) The longer a patient stays in hospital, the more likely that patient is to be moved into their “home ward”. After 30 days, further delay in discharge commonly relates to administrative concerns such as finding placement in an appropriate residential care facility.⁵ Under those circumstances, the placement problems confound the potential differences in LOS outcomes between inliers and outliers.

For these reasons, we excluded from study those 2,086 inpatients discharged from the ED (100% outliers) and those 629 patients staying in hospital over 30 days (84% inliers).

After leaving the ED, most inpatients (51%) spent all their admission in their “home ward”. Fewer (17%) spent all their admission in an outlier ward. The remainder were transferred between outlier and inlier locations during their admission and we allocated patients according to where they spent the majority $\geq 70\%$ of their admission. Most patients ($\sim 90\%$) were allocated either to a group comprising those who spent $\geq 70\%$ of their hospital stay in their “home ward” (inlier) or a group comprising those who spent $\geq 70\%$ of their admission outside their “home ward” (outlier). All patients had been assigned a Diagnostic Related Group (DRG) for their separation. The patients’ DRGs were used to identify the DRG based average LOS for their DRG, and these lengths of stay formed the predicted LOS for each patient.

Statistical analysis was performed using STATA® 12.2. We used Poisson regression analysis to adjust our LOS, mortality and readmission data for inpatient age and Charlson co-morbidity index⁶ as modified by Quan and colleagues.⁷

RESULTS: *(Statistically significant results and relevant negative data cited.)*

After exclusions (Table 1), we were left with 19,923 patients of whom 15,213 were classified as inliers, 2,592 were outliers and 2,118 who did not fit into either category.

The characteristics of the inliers and outliers are presented in Table 2, which also includes univariate comparisons where relevant. The risk of readmission within 7 or 28 days was substantially lower in the outlier group. Since death will have effects upon LOS, mode of discharge and readmission risk data were also examined excluding in-hospital deaths and these findings were unaltered (data not shown). Discharge summaries were less likely to be completed in the outlier population.

On the basis of their DRG, the predicted LOS for each patient was calculated and also expressed relative to their actual LOS. The DRG-based mean predicted LOS for inlier and outlier groups were very similar (5.98 days, SD 4.12 & 5.72 days SD 3.98 respectively) and the median LOS was 5 days for both. The actual LOS was about 1 day shorter than predicted in outliers but was similar to predicted in inliers.

We examined our data using Poisson regression looking for an effect of outlier status upon mortality, on LOS, on readmission rate and on discharge summary completion. We adjusted for the patients’ age, Charlson index, gender and length of time spent waiting for a bed in the ED in all cases. We found that outlier status was a significant predictor of increased in-hospital mortality (Relative Risk of 1.41; 95% CI 1.16-1.73; $p = 0.001$) and of reduced LOS (LOS reduction to 0.77; 95% CI 0.74-0.81; $p < 0.001$). We also found the likelihood of discharge summary completion within 2 days was lower for outliers (Relative Risk of: 0.66; 95% CI 0.62-0.71; $p < 0.001$). The risk of readmission within seven days was not significantly affected by outlier status, but the reduction in risk of readmission for outliers within 28 days of discharge was notable (Relative Risk 0.68, 95% CI 0.52 – 0.89; $p = 0.004$).

The diagnostic profiles of patients who died in hospital were similar for inliers and outliers and not influenced by outlier or inlier status. About 16% of the outlier's in-hospital deaths occurred in non-medical wards and none of the inlier's in-hospital deaths occurred in non-medical wards.

DISCUSSION : *(Referable to the aims of the study and may include suggestions for future action.)*

A tertiary hospital's GM service embraces a wide variety of patient illnesses and a range of illness acuity, disease complexity and patient ages. This study demonstrates that, over a period of more than six years, the location of care of a GM patient in the hospital carried implications separate to the complexity of their illness and their age.

Unlike findings from earlier, more limited and specialised studies,⁴ the FMC LOS was shorter in outlying patients suggesting efficiency of care was not compromised by having patients housed in outlying wards. Like others,^{8,9} we do not equate a shorter LOS with improved quality of patient care. Readmission within a week is more likely to reflect quality of care and this was not compromised. Interestingly, the risk of readmission within 28 days was lower for an outlying patient even after in-hospital deaths were excluded from the analysis. The reduced LOS for outliers was unexpected and occurred despite exclusion of patients whose LOS was predictably affected by non-clinical processes associated with allocation of inlier or outlier status. The one day difference between predicted and actual LOS in the outlier and not in inlier patients suggests outlier ward location affected LOS irrespective of the principal diagnosis of the patient.

Inliers and outliers have differing mean ages but similar predicted LOS, Charlson indices and diagnoses. There was an increase of over 40% in mortality risk in those who were outliers and they were more likely to die within 48 hours of admission. Neither the clinical condition nor the medical, surgical or intensive care nature of the ward explained these consequences of being an outlier. It remains possible that allocation to an outlier ward was a consequence of importance being given to providing single room accommodation for patients for whom conservative rather than active treatment was deemed appropriate. There was some support for this possibility in a limited review of the discharge summaries of a sample of patients who had died, but a prospective study is required to properly examine this possibility.

Patient age and co-morbidity separately impose significant effects upon in-hospital mortality, LOS and risk of readmission.¹⁰ After controlling for these confounders, our analysis confirmed that outlier status remained a significant predictor of both increased inpatient death and reduced inpatient LOS. The risk of death after discharge was unaffected by the patient having been an outlier. Discharge summary completion was slower for the outlying patients resulting in delayed communication between the hospital medical team and clinicians in the community.

Our study has limitations. It is retrospective and observational, and has relied on information available in hospital administrative data sets. Most importantly, it is derived from one hospital and one clinical service, albeit a large service within that hospital. Results from this setting may not be generalizable, though the use of one service only minimises variation due to differences in medical management and casemix in relation to inlier and outlier status. The work clearly needs replication elsewhere, with an expanded patient population. Ethical and practical issues preclude a randomized intervention trial of the study of outlier status, but a prospective observational study would allow collection of robust clinical data currently not accessible from administrative datasets. Issues that could be studied in a prospective study include the range, appropriateness and impact on LOS of investigation performed during hospital stays, and the impact of decision making in relation to issues such as requirement for single room accommodation. Our definition of outlier could also be altered to reflect broader streams of care – medical patients in surgical wards and vice versa.

Conclusion:

We have studied one aspect of the impact of the organisation of care on the quality of care provided to GM patients in a busy general hospital. The location of a patient's care appears to have a substantial impact on the outcomes of care provided. Hospital LOS was significantly reduced for patients who were ward outliers and their risk of readmission within 28 days was also reduced but in-hospital mortality was significantly increased. Further research is needed to identify those factors that are influencing LOS to ensure that any organisational benefits that might derive from a reduced LOS are not being obtained at the expense of less than optimal care.

REFERENCES: (*Supply a maximum of 60 references. Style and punctuation should conform to the Vancouver format. List all authors when six or fewer; when seven or more list the first six and add et al. The issue number should not be quoted. Website references – treat as other reference. In the text, references should be cited using superscript Arabic numerals in the order in which they appear. If cited only in tables or figure legends number them according to the first identifications of the table or figure in the text. In the reference list, the references should be numbered and listed in order of appearance in the text.*)

1. Ben-Tovim DI, Bassham JE, Bennett DM, Dougherty ML, Martin MA, O'Neill SJ, et al. Redesigning care at the Flinders Medical Centre: clinical process redesign using "lean thinking". *Med J Aust.* 2008;188(6 Suppl):S27-31.
2. Warne S, Endacott R, Ryan H, Chamberlain W, Hendry J, Boulanger C, et al. Non-therapeutic omission of medications in acutely ill patients. *Nurs Crit Care.* 2010;15:112-117.
3. Alameda C, Suarez C. Clinical outcomes in medical outliers admitted to hospital with heart failure. *Eur J Intern Med.* 2009 ;20:764-767.
4. Xu G, Whitaker E, Hubbard I. Inpatient elderly care: Reducing re-admission rates. *British J of Health Care Management.* 2011;17:599-602.
5. Victor CR, Healy J, Thomas A, Seargeant J. Older patients and delayed discharge from hospital. *Health Soc Care Community.* 2000 ;8:443-452.
6. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis.* 1987;40:373-383.
7. Quan H, Sundararajan V, Halfon P, Fong A, Burnand B, Luthi JC, et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Med Care.* 2005 ;43:1130-1139.
8. Kossovsky MP, Sarasin FP, Chopard P, Louis-Simonet M, Sigaud P, Perneger TV, et al. Relationship between hospital length of stay and quality of care in patients with congestive heart failure. *Qual Saf Health Care.* 2002 ;11:219-223.
9. Thomas JW, Guire KE, Horvat GG. Is patient length of stay related to quality of care? *Hosp Health Serv Adm.* 1997 ;42:489-507.
10. Libroero J, Peiro S, Ordinana R. Chronic comorbidity and outcomes of hospital care: length of stay, mortality, and readmission at 30 and 365 days. *J Clin Epidemiol.* 1999 ;52:171-179.

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TABLES: (Should be self-contained and complement but not duplicate information contained in the main text.)

Table 1: Characteristics of excluded patients

Discharged from the Emergency Department (n=2086)	
Age, years (SD)	69.43 (20.64)
Charlson Index (SD)	0.90 (1.54)
In hospital mortality, n (%)	63 (3.02)
LOS > 30 Days (n=629)	
Age, years (SD)	79.04 (12.35)
Charlson Index (SD)	2.45 (2.57)
In hospital mortality, n (%)	39 (6.20)

The characteristics of inpatients either admitted to GM but discharged from the ED and those admitted to GM but discharged at least 30 days after admission. Where appropriate, data are expressed as mean (SD)

Table 2: Characteristics and outcomes of inlier and outlier patients

	≥70% Outlier Hrs (n=2592)	≥ 70% Inlier Hrs (n=15213)	P- value
Age, years (SD)	69.7 (19.1)	72.7 (17.2)	<0.001
Charlson Index (SD)	1.5 (1.9)	1.5 (1.9)	0.468
Time spent in the ED, hrs (SD)	6.3 (7.2)	5.3 (5.63)	<0.001
Total in-hospital LOS, hrs (SD)	110.8 (113.3)	141.9 (139.3)	<0.001
In-hospital mortality, n (%)	117 (4.5)	537 (3.5)	0.014
In-hospital mortality within 48 hours of admission, n (%)	59 (50.4)	120 (22.4)	<0.001
Mortality within 28 days of discharge, n (%)	179 (6.9)	953 (6.3)	0.210
Readmitted within 7 days, n (%)	30 (1.2)	308 (2.0)	0.003
Readmitted within 28 days, n (%)	53 (2.1)	746 (4.9)	<0.001
Discharge Summary sent within 2 days of discharge, n (%)	1055 (40.7)	9317 (61.2)	<0.001
Discharge Summary sent within 7 days of discharge, n (%)	1666 (64.3)	11873 (78.0)	<0.001
* Respiratory disease (incl.	507 (20)	2743 (18)	

asthma, infection), n (%)			
* Cardiac disease (incl. failure, infarction), n (%)	319 (12)	1634 (11)	
* Other sepsis (incl. urinary, cellulitis), n (%)	186 (7)	1106 (7)	
* Collapse/hypotension, (%)	176 (7)	929 (6)	
* Renal disease (incl. failure, nephritis), (%)	130 (5)	934 (6)	

The characteristics and outcomes of patients admitted to general medicine who spent their inpatient time mostly as an inlier or as an outlier. Where appropriate, data are expressed as mean (SD). Chi-square tests were used to compare categorical variables, and t tests for continuous variables.

** Primary diagnosis.*

FIGURES: *(The legend should be self-explanatory. Number consecutively in Arabic numerals; cite in consecutive order in the main text. Please position on a separate page; incorporate legends and definitions of any symbols used; explain all abbreviations and units of measurement.)*

SUBHEADINGS: *(Insert as appropriate and as many as needed under the generic headings.)*

MEASUREMENTS: *(All measurements must be given in SI units.)*