Title: Patient and non-patient factors associated with short internal medicine hospital admissions

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Abstract

Background: Short hospital admissions may represent targets for interventions to avert unnecessary admissions or expedite inpatient care. We examined physician and situational factors associated with short internal medicine hospital admissions.

Methods: This was a multicentre cross-sectional study between April 1, 2012 and March 31, 2015 at 5 teaching hospitals in Toronto, Ontario. We included all internal medicine admissions through the emergency department (n=56,055). We examined physician (years of practice, sex), situational (time and day of admission, physician workload), and patient (age, sex, comorbidity level, ambulance transport to hospital, recent admission, and the laboratory-based acute physiology score) predictors of short admission to hospital, which was defined as patients discharged home alive in two possible time windows: less than 24 or less than 72 hours.

Results: Patients discharged in less than 24 hours and less than 72 hours accounted for 7.6% and 31.6% of admissions, respectively. After controlling for patient factors, patients of women physicians were less likely to have admissions lasting less than 24 hours (adjusted Odds Ratio 0.81, 95%CI:0.75-0.88) or 72 hours (aOR 0.82, 95%CI:0.79-0.86). Patients admitted at night or on a weekday were significantly more likely to have admissions lasting less than 24 hours (night: aOR 2.65, 95%CI:2.36-2.98, weekday: aOR 1.24 95%CI: 1.15-1.34) or less than 72 hours (night: aOR 1.26, 95%CI: 1.19-1.33, weekday: aOR 1.06 95%CI: 1.01-1.10).

Interpretation: Short internal medicine admissions are common and associated with physician and situational factors in addition to patient factors, suggesting some admissions could be avoided or made more efficient.

Introduction

Given the high costs of hospital care, there is significant interest in averting unnecessary hospital admissions and reducing length-of-stay. Interventions designed to either avoid(1) or reduce the length of hospital admissions have included hospital-at-home(2), short stay or observation units(3–7), and rapid access clinics.(8) Patients with short hospital length-of-stay may be candidates for these models of expedited and streamlined care.

Patient age, illness severity, level of comorbidity, and functional status have all been associated with longer hospital length-of-stay.(9–15) However, less is known about the situational or physician factors and resource use associated with short medical admissions. This information may highlight opportunities to improve care. To inform the design of interventions that target patients with potentially avoidable or brief hospital admissions, we examined the patient, physician, and situational characteristics associated with short hospital admissions to internal medicine wards. In addition, we described the use of hospital resources by patients with short admissions.

Methods

Design, Setting, and Participants

This was a multicentre cross-sectional study involving 5 academic hospitals in Toronto, Ontario, who were participating in the General Medicine Inpatient Initiative (GEMINI).(16) All Ontario residents have access to publicly funded essential hospital services. The participating hospitals cater to a diverse urban population, and range in size from 433 to 1,325 acute inpatient beds. General internal medicine (GIM) patients accounted for 39% of emergency department (ED)admissions to hospital and 24% of hospital bed-days.(16)

We included all patients admitted to the GIM service through the ED and discharged between April 1, 2012 and March 31, 2015. The GIM services operate on a hospitalist model, are staffed predominantly by internists, and include clinical teaching units, non-teaching hospitalist services, and one family medicine inpatient unit.(16) We excluded patients who were missing provincial health insurance numbers (n=646, 1.1%), because these were needed to ascertain previous healthcare usage. We also excluded patients who were missing data on the sex of the most responsible physician (n=1,524, 2.6%) or ambulance transport to hospital (n=3, <0.01%).

Data Sources

Data for GEMINI were collected from administrative sources and hospital information systems and linked at the individual patient level, as has previously been described.(16) Patient demographics and clinical characteristics were collected from hospital administrative databases as reported to the Canadian Institute for Health Information (CIHI).(17) Laboratory and radiology results, blood transfusions, and in-hospital medications were extracted from hospital information systems. Laboratory data were cleaned by removing non-numeric values.

Each hospital admission was attributed to a single ‘most responsible physician’ as per the CIHI Discharge Abstract Database, defined as the physician who is “responsible for the care and treatment of the patient for the majority of the visit to the health care facility".(17) Physician characteristics were collected from the College of Physicians and Surgeons of Ontario publicly-available physician information database.(18)

Outcomes and Measures

The main outcome was discharge home alive after a short hospital admission. There is no universally-accepted definition of what constitutes a short hospital admission. Short stay units are designed to monitor patients for the first 24(3) to 72 hours.(9,12) Therefore, we conducted two parallel analyses to compare longer hospitalizations to those lasting a) less than 24 hours, and b) less than 72 hours. Patients who died in hospital, left hospital against medical advice, or were transferred to another acute inpatient, rehabilitation, or palliative care facility were categorized along with longer admissions.

We examined patient, physician, and situational factors associated with short admission. Patient characteristics included: age, sex, Charlson comorbidity score,(19) the Laboratory-based Acute Physiology Score (LAPS, a measure of illness severity),(20,21) ambulance transport, admission to a short stay unit (which was available at two participating hospitals), admission to GIM at a study site in the 30 previous days, and fiscal year of admission. Physician characteristics included years since medical school graduation and sex. Situational factors included the day of admission categorized as weekend or weekday, time of admission categorized as 'day' (8:00 to 16:59:59), 'evening' (17:00 to 24:00), or 'night' (00:00:01 to 7:59:59), and the volume of admissions to GIM in the previous 12 hours. This 12-hour time window was pre-specified as a measure of the workload of the admitting GIM physicians in the ED.

We categorized each admission into a clinical condition based on their principal discharge diagnosis using the Clinical Classifications Software (CCS) tool,(22) which aggregates ICD-10 diagnoses into 285 mutually exclusive clinically-relevant categories. We report the number of admissions in which at least one of the following was used: order for intravenous medication, radiograph, computed tomography (CT) scan, ultrasound scan, magnetic resonance imaging (MRI) scan, red blood cell transfusion, endoscopy procedure, or bronchoscopy procedure. We also report the mean time spent in the ED and the proportion of patients admitted to the intensive care unit.

Statistical Analysis

We first compared patient characteristics among those discharged home alive in less than 24 hours, 24-72 hours, and all other admissions using chi-square and Kruskall-Wallis tests for categorical and continuous variables, respectively. Second, we performed two multilevel logistic regression analyses, accounting for the nested structure of our data: patients nested within physicians nested within hospitals. In the first analysis, short admissions were defined as having a length-of-stay less than 24 hours and compared with all others. In the second analysis, short admissions were defined as having a hospital length-of-stay less than 72 hours. To explore whether patient characteristics might contribute to differences in short admissions related to situational factors, we compared patient characteristics among short admissions at different times of day or on the weekend using chi-square and Kruskall-Wallis tests. Third, we report the 15 most common discharge diagnoses for patients discharged home alive in less than 24 hours, 24 to 72 hours, and all other admissions. Finally, we report the hospital resources used by patients with admissions of different durations. All analyses were performed using 'R' version 3.3.2.

Results

The final study sample included 56,055 admissions. Overall, 10,360 admissions (18.5%) resulted in transfer to another inpatient, rehabilitation, or palliative care facility, 3,264 admissions (5.8%) ended with death in hospital, and 1,253 admissions (2.2%) ended with patients leaving against medical advice. Patients were discharged home alive within 24 hours in 4,245 admissions (7.6%) and between 24 to 72 hours in 13,442 admissions (24.0%). The overall median length of stay was 4.4 days (interquartile range 2.25-8.54).

Patient Characteristics Associated with Short Admission

Patients with shorter admissions were significantly younger, had lower comorbidity, were less likely to arrive by ambulance, had a lower average LAPS, and were less likely to have a recent prior admission (Table 1). In multi-level regression models, increasing age, higher Charlson comorbidity index, transport via ambulance, recent admission, and higher LAPS were all associated with a significantly lower likelihood of short admission, when defined as either less than 24 hours or less than 72 hours (Table 2).

Physician Characteristics Associated with Short Admission

The number of years since physician graduation was not significantly associated with the likelihood of short admission under either definition (Table 2). Patients of women physicians were significantly less likely to have short admissions lasting either less than 24 hours (adjusted odds ratio 0.80, 95% CI 0.74-0.86) or less than 72 hours (aOR 0.82, 95%CI 0.79-0.86).

Situational Factors Associated with Short Admission

Short admissions lasting less than either 24 or 72 hours, were more likely for patients admitted in the evening or night (Table 2). Short admissions were significantly more likely for patients admitted on a weekday, although this effect was stronger for admissions lasting less than 24 hours (aOR 1.26, 95% CI 1.17-1.36) than for admissions lasting less than 72 hours (aOR 1.05, 95% CI: 1.01-1.10). There was no significant association between short admissions and the number of patients admitted to GIM in the previous 12 hours (Table 2).

Compared to patients with short admissions who were admitted in the day-time, patients admitted in the evening or at night were older ($p<0.001$) but were not consistently different in comorbidity level or illness severity (Tables S1 and S2). Patients with admissions lasting less than 72 hours who were admitted on the weekend had more severe illness than those admitted on weekdays, indicated by greater rates of ambulance transport (43.4% vs 40.0%, $p<0.001$) and greater LAPS (mean 16.04 vs 15.35, $p<0.004$), but these differences were not seen among admissions lasting less than 24 hours (Tables S3 and S4).

Common Discharge Diagnoses

The most common discharge diagnoses differed somewhat among admissions of different durations (Table 3). Non-specific chest pain, syncope, adverse effects of medical drugs, and alcohol-related disorders were among the 15 most common causes of admissions lasting less than 24 or less than 72 hours but not longer admissions. Epilepsy and vertigo were among the most common causes of admissions lasting less than 24 hours. No single diagnosis represented more than 4.1% of admissions lasting less than 24 hours, 6.5% of admissions lasting between 24 and 72 hours, or 5.7% of all other admissions.

Resource Use in Short Admissions

Patients with hospital admissions lasting less than 24 hours and 24-72 hours spent on average 14.8 hours (SD 6.6) and 15.7 hours (SD 9.0) in the ED, respectively (Table 4). Among patients with admissions lasting less than 24 hours and 24-72 hours, intravenous medications were ordered for 65.7% and 79.8%, respectively, and CT scans were performed for 36.8% and 39.1%, respectively. Among patients with admission lasting less than 72 hours, 1925 (10.9%) did not receive any intravenous medication, CT scans, magnetic resonance imaging, ultrasound, endoscopy, bronchoscopy or intensive care.

Interpretation

This large multicentre study found that short admissions to GIM were common and were associated with both patient and non-patient factors. We found that 31.6% of admissions in GIM lasted less than 72 hours and 7.6% lasted less than 24 hours. After controlling for other factors, short admissions were more common for patients admitted overnight or on weekdays and for patients cared for by men physicians. We also identified discharge diagnoses that were more common among short admissions and described their hospital resource usage. Our finding that physician and situational factors are associated with short admissions highlights opportunities to further streamline care.

Several interventions have been directed toward patients with short length-of-stay(1) such as short stay or observation units,(3–7) hospital-at-home,(2) or rapid-access clinics.(8) Our findings offer insights for the design and delivery of these interventions for medical patients. First, we identified the most prevalent conditions affecting patients with short length of stay in GIM. It may be difficult to organize programs around individual diseases, because no single condition comprised more than 6.5% of short admissions. However, certain conditions were more common among short admissions: chest pain, syncope, alcohol-related disorders, and adverse drug effects. Second, intravenous medication and radiologic and endoscopic investigations were important in the care of short stay patients. Providing expedited access to these treatments and investigations may be an important component of short stay interventions. Third, patients were more likely to have a short stay when they were admitted in the evening or at night. Thus, accessing short stay interventions should ideally be possible outside of typical working hours.

Short admissions may represent avoidable hospitalizations or efficient hospitalizations that would otherwise have been longer. This may explain why short admissions were more common in the evening and overnight but less common on the weekend. After-hours admissions at participating hospitals are performed by in-house residents, who typically review cases with staff physicians before discharging patients. Residents may prefer not to “disturb” their staff physician and elect to review the case the next morning rather than discharge a patient overnight. It may also be difficult to coordinate aspects of a patient's discharge overnight, resulting in a brief but potentially avoidable admission. On the weekend, it may be difficult to coordinate patient discharges or patients may experience delays in receiving tests or procedures.(23,24) Further, covering physicians on the weekend may be less likely to discharge a patient with whom they are less familiar. Short admissions may be less likely on weekends because patients who would otherwise be discharged remain in hospital. Whereas, short admissions may be more likely on weeknights as patients who would otherwise be discharged home are admitted overnight in the ED. Short admissions in the evening, at night, or on weekends, did not occur for patients with lower comorbidity or less severe illness as might be expected if admissions were primarily due to logistical factors. Nevertheless, our findings are consistent with a body of literature suggesting differential access to care and patient outcomes at night and on weekends compared with weekdays(23–26) and we identify an interesting difference between nights and weekends.

Patients of women physicians were less likely to have short admissions even after controlling for years of physician practice and numerous patient factors such as age, comorbidities, and illness severity. The validity of the comparison between men and women physicians is strengthened in this cohort because all patients were admitted non-electively through the ED and thus physician assignment occurred through a pseudo-random process, mitigating selection effects similar to other observational studies.(27) Although patient outcomes may differ between hospitalists and non-hospitalists,(28) all physicians in our sample were hospitalists and almost all physicians were internists. Thus, sex-related differences were not likely to be due to differences in specialty or patient case mix. Recent analyses suggest that patients of women physicians may have better outcomes than men physicians.(27) In the absence of analyses regarding mortality and readmissions rates, we cannot comment on the possible relationship between shorter length of stay and quality of care. Further research should seek to understand whether women physicians are more likely to discharge patients directly from the ED without hospital admission or less likely to discharge patients quickly from hospital, and whether such decisions contribute to differences in patient outcomes.

There are several important limitations to our study. First, we only included GIM patients, not all medical admissions. We chose to focus on GIM because it is a large inpatient service in our hospitals and our objective was to understand models of care. Second, we included five teaching hospitals, and thus our results may not be generalizable to non-teaching sites where models of care and staffing differ. Although our study was conducted in a Canadian context, the median length-of-stay (4.4 days) was similar to studies in Europe and the USA,(29,30) supporting the generalizability of our findings. Third, we were unable to collect data about patient living situation, caregiver support, functional status, or socioeconomic status, which likely have important effects on hospital length-of-stay. Fourth, care in GIM is often delivered in teams and multiple physicians may care for individual patients. Misattribution may occur when assigning patients to a single most responsible physician. However, error resulting from this misclassification would be non-differential between physicians and unlikely to affect our results. Moreover, handovers are less likely for patients with shorter admissions. Finally, we did not collect data on patients who were seen by the GIM service in the ED but not admitted to hospital.

In conclusion, short hospital admissions to GIM are common. They occur more frequently when patients are admitted in the evening or overnight and when physicians are men. Interventions to streamline care for these patients and avert hospital admissions may be more effective if they are accessible outside of typical working hours and provide access to intravenous medication and radiological and endoscopic interventions.

Table 1. Patient characteristics associated with duration of admission to GIM

Table 2. Multi-level regression models of patient, physician, and situational characteristics associated with short admissions to GIM.

Table 3. Fifteen most common discharge diagnoses among admissions to GIM with different durations.

Table 4. Resource use among GIM admissions of varying duration.

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Table 1. Patient characteristics associated with duration of admission to GIM

Patient Characteristic	< 24 hours N = 4245	24-72 hours N = 13442	All Others N= 38368	p-value
Age – median (IQR)	63 (45, 78)	67 (50, 81)	74 (59, 84)	<0.001
Female – n (%)	2155 (50.8)	6722 (50.0)	19026 (49.6)	0.288
Charlson Comorbidity Index – n (%)				<0.001
0	1846 (43.5)	4666 (34.7)	8809 (23.0)	
1	962 (22.7)	3061 (22.8)	7737 (20.2)	
2	557 (13.1)	2210 (16.4)	6785 (17.7)	
3+	880 (20.7)	3505 (26.1)	15037 (39.2)	
Transported via Ambulance – n (%)	1531 (36.1)	5700 (42.4)	21533 (56.1)	<0.001
Admitted in prior 30 days* – n (%)	372 (8.8)	1283 (9.5)	5315 (13.9)	<0.001
LAPS - mean (sd)	13.0 (12.4)	16.3 (13.9)	21.4 (17.1)	<0.001
Admitted on Weekend – n (%)	929 (21.9)	3516 (26.2)	10152 (26.5)	<0.001
Time of Admission – n (%)				<0.001
Day	398 (9.4)	2832 (21.1)	8398 (21.9)	
Evening	1795 (42.3)	5156 (38.4)	14828 (38.6)	
Night	2052 (48.3)	5454 (40.6)	15142 (39.5)	

Table 1 Legend: Hospital admissions were categorized as patients discharged home alive in less than 24 hours, 24 to 72 hours, and all other admissions. The day of admission was categorized as weekend (Saturday or Sunday) or weekday. The time of admission was categorized as ‘day’ (8:00 to 16:59:59), ‘evening’ (17:00 to 24:00), or ‘night’ (00:00:01 to 7:59:59). *Admitted to GIM at a study site in prior 30 days. Statistical significance for differences across length-of-stay categories was calculated using chi-square analysis for categorical variables and Kruskall-Wallis test for continuous variables. LAPS: Laboratory-based acute physiology score.

Table 2. Multi-level regression models of patient, physician, and situational characteristics associated with short admissions to GIM.

	Model A: <24 hours		Model B: <72 hours	
Characteristics	Adjusted Odds Ratio (95% CI)	p-value	Adjusted Odds Ratio (95% CI)	p.value
Patient Characteristics				
Age	0.99 (0.99, 0.99)	<0.001	0.99 (0.99, 0.99)	<0.001
Female Sex (Patient)	0.96 (0.90, 1.02)	0.167	0.97 (0.94, 1.01)	0.126
CCI Score 0	1.97 (1.79, 2.16)	<0.001	1.75 (1.66, 1.84)	<0.001
CCI Score 1	1.63 (1.47, 1.79)	<0.001	1.54 (1.46, 1.62)	<0.001
CCI Score 2	1.20 (1.08, 1.34)	0.001	1.29 (1.21, 1.36)	<0.001
Not Transported via Ambulance	1.44 (1.34, 1.54)	<0.001	1.47 (1.41, 1.53)	<0.001
Admitted in prior 30 days*	0.84 (0.75, 0.94)	0.003	0.77 (0.73, 0.82)	<0.001
LAPS	0.97 (0.97, 0.98)	<0.001	0.98 (0.98, 0.98)	<0.001
Physician Characteristics				
Physician Sex Female	0.80 (0.74, 0.86)	<0.001	0.82 (0.79, 0.86)	<0.001
Years Since Graduation	1.00 (1.00, 1.00)	0.776	1.00 (1.00, 1.00)	0.186
Situational Factors				
Admitted Weekday	1.26 (1.17, 1.36)	<0.001	1.05 (1.01, 1.10)	0.022
Admitted Evening	2.61 (2.33, 2.92)	<0.001	1.23 (1.17, 1.30)	<0.001
Admitted Night	2.73 (2.44, 3.07)	<0.001	1.29 (1.22, 1.37)	<0.001
GIM Admissions in Past 12 hours	1.05 (0.99, 1.12)	0.111	1.02 (0.98, 1.05)	0.401
Admitted to Short Stay Unit	1.56 (1.39, 1.74)	<0.001	2.35 (2.17, 2.54)	<0.001
Fiscal Year of Admission	1.09 (1.05, 1.14)	<0.001	1.05 (1.03, 1.08)	<0.001

Table 2 Legend: Adjusted odds ratios were derived from multi-level logistic regression models. Three-level models were fit, with patients nested within physicians nested within hospitals. Patient and situational characteristics were specified as level one, physician characteristics were specified as level two, and admitting hospital was specified as a fixed-effect level three variable. For variables with more than 2 categories, the reference categories were: CCI score 3 (high comorbidity) and admission in the day-time (vs evening and night). *Admitted to GIM at a study site in prior 30 days. CCI Score: Charlson Comorbidity Index score. GIM: General Internal Medicine. LAPS: Laboratory-based acute physiology score.

Table 3. Fifteen most common discharge diagnoses among admissions to GIM with different durations.

<24 Hours		24-72 Hours		All Others	
Diagnosis	N (%)	Diagnosis	N (%)	Diagnosis	N (%)
Nonspecific chest pain	167 (4.1)	Pneumonia	811 (6.5)	CHF	2251 (5.7)
Intestinal infection	163 (4.0)	COPD	731 (5.8)	Pneumonia	2028 (5.1)
COPD	153 (3.8)	Urinary tract infections	676 (5.4)	Urinary tract infections	1823 (4.6)
Pneumonia	150 (3.7)	Gastrointestinal hemorrhage	598 (4.8)	COPD	1740 (4.4)
Syncope	124 (3.1)	CHF	580 (4.6)	Delirium, dementia, cognitive disorders	1444 (3.7)
Urinary tract infections	123 (3.0)	Fluid and electrolyte disorders	445 (3.5)	Gastrointestinal hemorrhage	1170 (3.0)
Fluid and electrolyte disorders	112 (2.8)	Intestinal infection	445 (3.5)	Septicemia	1016 (2.6)
Gastrointestinal hemorrhage	111 (2.7)	Syncope	376 (3.0)	Acute cerebrovascular disease	996 (2.5)
DM with complications	111 (2.7)	DM with complications	332 (2.6)	Fluid and electrolyte disorders	854 (2.2)
CHF	101 (2.5)	Skin and subcutaneous tissue infections	257 (2.0)	DM with complications	833 (2.1)
Adverse effects of medical drugs	100 (2.5)	Alcohol-related disorders	255 (2.0)	Intestinal infection	822 (2.1)
Epilepsy; convulsions	100 (2.5)	Nonspecific chest pain	238 (1.9)	Acute renal failure	806 (2.0)
Alcohol-related disorders	99 (2.4)	Influenza	233 (1.9)	Skin and subcutaneous tissue infections	793 (2.0)
Dizziness or vertigo	92 (2.3)	Adverse effects of medical drugs	222 (1.8)	Other connective tissue disease	780 (2.0)
Other lower respiratory disease	90 (2.2)	Pancreatic disorders	222 (1.8)	Aspiration pneumonitis	767 (1.9)

Table 3 Legend: Grey shading: Diagnosis among the top 15 across all categories. Green shading: Diagnosis among top 15 in admissions <24 and 24-72 hours only. Blue (<24 hours), purple (24-72 hours), and red shading (all others): Diagnosis among 15 most common in each respective category only. Hospital admissions were categorized as patients discharged home alive in less than 24 hours, 24 to 72 hours, and all other admissions. The 15 most common discharge diagnoses were identified by the Clinical Classifications Software categorization of ICD-10 codes. COPD: Chronic obstructive pulmonary disease and bronchiectasis; DM: Diabetes mellitus; CHF: Congestive heart failure.

Table 4. Resource use among GIM admissions of varying duration.

Resource	<24 hours N = 4245	24-72 hours N = 13442	All Others N = 38368
Time in Emergency Department – mean hours (SD)	14.8 (6.6)	15.7 (9.0)	16.4 (9.9)
Intravenous Medication* – n (%)	2788 (65.7)	10722 (79.8)	33022 (86.1)
Radiography* – n (%)	2803 (66.0)	10013 (74.5)	33260 (86.7)
Computed tomography* – n (%)	1561 (36.8)	5254 (39.1)	21772 (56.7)
Ultrasonography* – n (%)	418 (9.8)	2363 (17.6)	12110 (31.6)
Magnetic Resonance Imaging* – n (%)	144 (3.4)	842 (6.3)	4983 (13.0)
Red Blood Cell transfusion* – n (%)	86 (2.0)	593 (4.4)	4522 (11.8)
Endoscopy* – n (%)	92 (2.2)	1053 (7.8)	4037 (10.5)
Bronchoscopy* – n (%)	1 (0.0)	39 (0.3)	965 (2.5)
Intensive Care Unit admission – n (%)	18 (0.4)	101 (0.8)	2509 (6.5)
No advanced interventions† – n (%)	779 (18.4)	1146 (8.5)	1347 (3.5)

Table 4 Legend: *Number of admissions that used at least one of this test or treatment. †Number of admissions in which none of the following tests or treatments were used: intravenous medication, computed tomography, ultrasonography, magnetic resonance imaging, endoscopy, bronchoscopy or intensive care unit.

Supplementary Tables

"Patient, physician, and situational factors associated with short hospital admissions in General Internal Medicine"

Table S1. Baseline characteristics among patients discharged home alive within 24 hours of admission, categorized by time of admission.

Table S2. Baseline characteristics among patients discharged home alive within 72 hours of admission, categorized by time of admission.

Table S3. Baseline characteristics among patients discharged home alive within 24 hours of admission, categorized by weekend versus weekday admission.

Table S4. Baseline characteristics among patients discharged home alive within 72 hours of admission, categorized by weekend versus weekday admission.

Table S1. Baseline characteristics among patients discharged home alive within 24 hours of admission, categorized by time of admission.

Patient Characteristic	Admitted in Day (N=398)	Admitted in Evening (N=1795)	Admitted in Night (N=2052)	p-value
Age – median (IQR)	56 (36, 74)	63 (47, 78)	63 (45, 79)	<0.001
Female – n (%)	203 (51.0)	894 (49.8)	1058 (51.6)	0.552
Charlson Comorbidity Index – n (%)				0.041
0	198 (49.7)	748 (41.7)	900 (43.9)	
1	81 (20.4)	397 (22.1)	484 (23.6)	
2	44 (11.1)	249 (13.9)	264 (12.9)	
3+	75 (18.8)	401 (22.3)	404 (19.7)	
Transported via Ambulance – n (%)	142 (35.7)	650 (36.2)	739 (36.0)	0.978
Admitted in prior 30 days* – n (%)	48 (12.1)	170 (9.5)	154 (7.5)	0.005
LAPS - mean (sd)	12.9 (12.0)	13.0 (12.2)	13.0 (12.7)	0.984

Table S1 Legend: The time of admission was categorized as 'day' (8:00 to 16:59:59), 'evening' (17:00 to 24:00), or 'night' (00:00:01 to 7:59:59). *Admitted to GIM at a study site in prior 30 days. Statistical significance for differences across categories was calculated using chi-square analysis for categorical variables and Kruskall-Wallis test for continuous variables. LAPS: Laboratory-based acute physiology score.

Table S2. Baseline characteristics among patients discharged home alive within 72 hours of admission, categorized by time of admission.

Patient Characteristic	Admitted in Day (N=3230)	Admitted in Evening (N=6951)	Admitted in Night (N=7506)	p-value
Age – median (IQR)	64.00 [47.00, 80.00]	67.00 [51.00, 81.00]	66.00 [49.00, 80.00]	<0.001
Female – n (%)	1536 (47.6)	3553 (51.1)	3788 (50.5)	0.003
Charlson Comorbidity Index – n (%)				0.249
0	1243 (38.5)	2518 (36.2)	2751 (36.7)	
1	734 (22.7)	1564 (22.5)	1725 (23.0)	
2	496 (15.4)	1092 (15.7)	1179 (15.7)	
3+	757 (23.4)	1777 (25.6)	1851 (24.7)	
Transported via Ambulance – n (%)	1488 (46.1)	2683 (38.6)	3060 (40.8)	<0.001
Admitted in prior 30 days* – n (%)	334 (10.3)	656 (9.4)	665 (8.9)	0.052
LAPS - mean (sd)	15.6 (13.5)	15.5 (13.7)	15.5 (13.6)	0.89

Table S2 Legend: The time of admission was categorized as ‘day’ (8:00 to 16:59:59), ‘evening’ (17:00 to 24:00), or ‘night’ (00:00:01 to 7:59:59). *Admitted to GIM at a study site in prior 30 days. Statistical significance for differences across categories was calculated using chi-square analysis for categorical variables and Kruskall-Wallis test for continuous variables. LAPS: Laboratory-based acute physiology score.

Table S3. Baseline characteristics among patients discharged home alive within 24 hours of admission, categorized by weekend versus weekday admission.

Patient Characteristic	Admitted on Weekday (N=3316)	Admitted on Weekend (N=929)	p-value
Age – median (IQR)	63 (46, 79)	61 (44, 77)	0.138
Female – n (%)	1705 (51.4)	450 (48.4)	0.117
Charlson Comorbidity Index – n (%)			0.887
0	1436 (43.3)	410 (44.1)	
1	760 (22.9)	202 (21.7)	
2	436 (13.1)	121 (13.0)	
3+	684 (20.6)	196 (21.1)	
Transported via Ambulance – n (%)	1196 (36.1)	335 (36.1)	1
Admitted in prior 30 days* – n (%)	273 (8.2)	99 (10.7)	0.025
LAPS - mean (sd)	12.8 (12.2)	13.4 (13.0)	0.19

Table S3 Legend: The day of admission was categorized as 'weekday' (Monday to Friday) or 'weekend' (Saturday and Sunday). *Admitted to GIM at a study site in prior 30 days. Statistical significance for differences across categories was calculated using chi-square analysis for categorical variables and Kruskall-Wallis test for continuous variables. LAPS: Laboratory-based acute physiology score.

Table S4. Baseline characteristics among patients discharged home alive within 72 hours of admission, categorized by weekend versus weekday admission.

Patient Characteristic	Admitted on Weekday (N=13,242)	Admitted on Weekend (N=4,445)	p-value
Age – median (IQR)	66 (49, 80)	67 (49, 81)	0.21
Female – n (%)	6703 (50.6)	2174 (48.9)	0.05
Charlson Comorbidity Index – n (%)			0.642
0	4877 (36.8)	1635 (36.8)	
1	2998 (22.6)	1025 (23.1)	
2	2056 (15.5)	711 (16.0)	
3+	3311 (25.0)	1074 (24.2)	
Transported via Ambulance – n (%)	5303 (40.0)	1928 (43.4)	<0.001
Admitted in prior 30 days* – n (%)	1222 (9.2)	433 (9.7)	0.324
LAPS - mean (sd)	15.4 (13.6)	16.0 (13.6)	0.004

Table S4 Legend: The day of admission was categorized as ‘weekday’ (Monday to Friday) or ‘weekend’ (Saturday and Sunday). *Admitted to GIM at a study site in prior 30 days. Statistical significance for differences across categories was calculated using chi-square analysis for categorical variables and Kruskall-Wallis test for continuous variables. LAPS: Laboratory-based acute physiology score.

ORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational stud collected health data.

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location manuscri where ite reported
bstract					
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found		RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and timeframe within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	Abstract
on					
d	2	Explain the scientific background and rationale for the investigation being reported			Introducti
	3	State specific objectives, including any prespecified hypotheses			Introducti
gn	4	Present key elements of study design early in the paper			Methods - Design, S Participar
	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection			Methods - Design, S Participar

s	6	*(a) Cohort study* - Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study* - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study* - Give the eligibility criteria, and the sources and methods of selection of participants *(b) Cohort study* - For matched studies, give matching criteria and number of exposed and unexposed *Case-control study* - For matched studies, give matching criteria and the number of controls per case		RECORD 6.1: The methods of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	Methods - Design, S Participar
	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.		RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	Methods - Outcomes Measures
es/ nt	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group			Methods - Sources
	9	Describe any efforts to address			Statistical

		potential sources of bias			Analysis
	10	Explain how the study size was arrived at			Methods - Design, S Participan
e	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why			Methods - Outcomes Measures
	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) *Cohort study* - If applicable, explain how loss to follow-up was addressed *Case-control study* - If applicable, explain how matching of cases and controls was addressed *Cross-sectional study* - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses			Methods - Statistical Analysis
s and ethods		..		RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population. RECORD 12.2: Authors should provide information on the data	Methods - Sources

				cleaning methods used in the study.	
		..		RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	Methods - Sources
s	13	(a) Report the numbers of individuals at each stage of the study (*e.g.*, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed) (b) Give reasons for non-participation at each stage. (c) Consider use of a flow diagram		RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.,* study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	Results
e data	14	(a) Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders (b) Indicate the number of participants with missing data for each variable of interest (c) *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)			Results
ata	15	*Cohort study* - Report numbers of outcome events or summary measures over time *Case-control study* - Report numbers in each exposure category, or summary measures of exposure			Results

		Cross-sectional study - Report numbers of outcome events or summary measures			
ts	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period			Results
yses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses			Results
	18	Summarise key results with reference to study objectives			Interpreta
s	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias		RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	Interpreta
on	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar			Interpreta

		studies, and other relevant evidence			
bility	21	Discuss the generalisability (external validity) of the study results			Interpreta
rmation					
	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based			Title Page
ty of aw ng		..		RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	N/A

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. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medi*