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**TITLE:**

The impact of weekend admission and changes in treating team on patient flow and outcomes in adults admitted to hospital with community-acquired pneumonia

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**CONTRIBUTIONS:**

SVM completed the literature review, contributed to study design and interpretation of results, and led the drafting of the final manuscript for publication. ML compiled the study database and led the data linkage process, developed and executed the statistical analysis plan, and contributed to study design and interpretation of results. GM conceived the study and contributed to the interpretation of results. HK and EJ contributed to study design and the interpretation of results. All authors contributed to and reviewed the final manuscript prior to submission.

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## INTRODUCTION

Hospital workflow factors, including organisational processes pertaining to admission, ward rounds and discharge planning, have been previously shown to impact on patient outcomes. The most extensively studied factors include outliers (patients admitted to non-home based wards), inter-ward transfers and time and day of admission.<sup>1-4</sup> The latter includes the well-described ‘weekend effect’, where weekend admissions (generally Saturday and Sunday in most countries) have been shown to have poorer outcomes compared to those on weekdays (Monday to Friday).<sup>2</sup> This includes both significantly higher mortality rates and increased length of stay across a range of presentations, including amongst General Medicine and pneumonia patients seen in some<sup>1,3,5-8</sup> but not all studies.<sup>9,10</sup>

Previous studies have also indicated that ward outliers, patients admitted to a ward that is different to the one where their treating clinical team is usually based, have increased mortality<sup>4,11</sup>, length of stay and readmission rates<sup>12-14</sup> compared to patients admitted to their treating team’s ‘home’ wards, and that frequent bed moves are associated with higher rates of falls, medication errors, pressure ulcers, delays in treatment<sup>15</sup>, wound infections<sup>16</sup> and increased length of stay.<sup>15</sup> Conversely, continuity of medical staff has been associated with lower post-discharge mortality, lower readmission rates and lower healthcare costs.<sup>17</sup> This raises significant concerns regarding the common “merry-go-round” scenario pervasive in many large hospitals, where organisational factors can drive frequent moving of patients either between different physical healthcare spaces or between different supervising medical personnel and teams.

Community-acquired pneumonia (CAP) is the fourth-leading cause of mortality worldwide<sup>18</sup>, and in Australia is currently the single leading reason for non-same-day hospital admission, with over 100, 000 hospital admissions per year.<sup>19</sup> The direct healthcare costs of

hospitalisation for community-acquired pneumonia are estimated to be greater than A\$600 million annually.<sup>20</sup> As a disease highly associated with ageing and co-morbidity<sup>21</sup>, CAP patients often require complex multi-disciplinary care and well-co-ordinated discharge planning. They are therefore likely to be particularly prone to organisational and staffing factors that impact on continuity of care. Given the high health and economic burden CAP has on the modern health system, better understanding the impact of workflow factors on patient and health-system outcomes has potential to identify structural health system changes that could significantly reduce adverse patient outcomes and hospital costs.

By utilising a well-characterised prospective longitudinal cohort of patients restricted to a single, well-defined primary diagnosis of CAP, we aimed to evaluate both weekend effects and effect of change of medical team in a population and hospital setting representative of modern healthcare in Australia.

## **MATERIALS & METHODS**

### **Data source**

The data used in this longitudinal cohort were sourced from the Improving Evidence-Based Treatment Gaps and Outcomes in Community-Acquired Pneumonia study (IMPROVE-GAP); a stepped-wedge cluster-randomised trial that evaluated a new evidence-based model of care for CAP.<sup>22,23</sup> The IMPROVE-GAP databank incorporated data collected prospectively from four sources; i) the study's standardised case report form, ii) the patient electronic medical record, iii) the institutional data warehouse and iv) the Victorian Births, Deaths and Marriages Registry. Outcome data was extracted by analysts blinded to the study objectives. Definitions and measurement methods for individual outcomes and covariates are outlined

below. IMPROVE-GAP was approved by the Melbourne Health Human Research Ethics Committee (HREC) (MH2016.014).

### **Setting and Population**

IMPROVE-GAP was conducted over 12 months (August 2016 to July 2017) at two tertiary academic hospitals in Melbourne, Australia.<sup>22,23</sup> An institutional review board approved waiver of participant consent and broadly inclusive eligibility criteria ensured the study sample was representative of the ‘real world’ population of CAP patients in this setting. All patients admitted under a General Internal Medicine (GIM) unit meeting a standardised CAP case definition were eligible (n=917), with the only exclusion criteria being: i) a decision to apply palliative management at admission (n=42), or ii) prior enrolment in IMPROVE-GAP or another ongoing research study (n=43) (see Figure 1). Each of the two hospital campuses has four organisationally distinct GIM units, each of which is staffed by separate teams consisting of interns, registrars and a senior consultant physician. Admission criteria are identical for all GIM units and case-mix is uniform across hospitals and GIM units.

For this sub-analysis, two additional exclusion criteria were applied to participants who: i) transferred from a GIM team to an alternative specialty medical team (e.g. Respiratory Medicine, Cardiology, Urology, Pain Medicine etc.) during their admission (n=9), or ii) did not have their admitting team coded within the administrative database (n=51) (Figure 1).

Like most Australian hospitals, compared with the 5-day working week, staffing is significantly reduced across allied health and medical disciplines on weekends. On weekend days there is one medical consultant physician that covers all units, assisted by approximately 25% of the junior medical staff that would be present on a weekday. Evening and night medical staffing levels are similar on all days of the week. Allied health services are also significantly reduced on weekends and although nurse-patient ratios remain the same, access to specialty nursing services such as wound care and diabetes educators is reduced.

### Exposure of interest

Two exposures of interest were explored in this analysis using binary (yes/no) indicators of:

i) changes in treating team (from one GIM unit to another, or from a specialty medical unit to a GIM unit); and ii) presentation to hospital on the weekend (between 2400-hours Friday and 2400-hours Sunday).

### Confounding variables

Clinically plausible potential confounding variables were defined *a priori* on the basis of both prior literature<sup>24-30</sup> and the clinical opinion of the investigators (ML, HK, GM, EJ).

Covariates included in adjusted models were: age (years, categorised as <70, 70-84 and  $\geq 85$ ), sex (male/female), smoking status (dichotomised as ever vs. never smoked), residential status (dichotomised as living in the community vs. aged care facility/supported accommodation), language spoken at home (English vs. another language), whether living with a partner or not (i.e. spouse or partner vs. widowed, separated or single), aggregate comorbidity burden (measured by a modified Charlson Comorbidity Index (CCI) which did not adjust for age as this was already adjusted for separately<sup>31</sup>), CAP illness severity (measured by CORB score<sup>32</sup> at admission), pre-morbid mobility status (ICUMS score<sup>33</sup>, categorised as  $\leq 8$  = unable to walk without assistance from another person or chair/bed bound, 9 = able to walk independently with an assistive device, 10 = able to walk independently unaided), and number of admissions to the health service in the preceding 6-months (categorised as 0, 1, 2 and  $\geq 3$ ).

### Outcomes

Four outcome measures were used in the analysis: time to clinical stability, 30-day mortality, length of hospital stay (LOS), and readmission within 30-days. Time to clinical stability (TCS) was defined by four-hourly vital sign measurements using standardised pre-specified threshold criteria widely used in CAP studies<sup>34</sup> and measured from time of hospital admission (in days).<sup>22</sup> Thirty-day mortality was defined as a death within 30-days of admission (yes/no). Length of hospital stay was determined by time from admission to hospital discharge (in days), and included time spent in the emergency department, acute wards, intensive care unit and inpatient rehabilitation settings. Readmission to hospital within 30-days of the date of first admission was measured as a binary variable (yes/no).

### **Statistical methods**

We fitted both univariable and multivariable regression models for the exposures of interest as follows: Cox regression for TCS and LOS, and logistic regression for 30-day mortality and readmission within 30-days. All prespecified covariates were included in the multivariable models, regardless of the strength of the univariable associations. Participants who died in hospital or had active curative treatment withdrawn were excluded from the analysis of the TCS, LOS and 30-day readmission outcomes. The assumptions of the Cox regression model are discussed in more detail below.

TCS and LOS (in days) were compared between exposure groups using: i) unadjusted Kaplan-Meier curves and the log-rank test, and ii) multivariable Cox regression. Follow-up started at admission for both outcome variables, and continued until achievement of clinical stability (for the TCS outcome) or discharge from the hospital (for the LOS outcome). There was no censoring as all participants included in these models achieved clinical stability and were discharged from hospital. We used the Schoenfeld residuals to test the proportional

hazards (PH) assumption for the Cox regression models, and did not find evidence that this assumption was violated.

Hazard ratios and odds ratios with corresponding 95% confidence intervals are presented. All analyses were performed using Stata version 16.1 (Stata Statistical Software: Release 16.1, 2019; Stata Corp LP, College Station, USA).

## RESULTS

Characteristics of the study population are described in Table 1, stratified by the two exposures of interest (change of treatment teams, and admission to hospital on a Saturday or Sunday). Of the total 753 participants, 71 changed treating team during admission and 224 were admitted on a Saturday or Sunday. Those who changed team were more likely to reside in an aged care facility (28.2% vs. 21.7%), have a severe pneumonia severity score documented at admission (57.7% vs 51.3%) and have prior admissions to hospital (see Table 1). Of the 71 patients whose treating team changed, 15 were initially admitted under a specialty unit but subsequently assessed as more appropriate for care by GIM, with the remaining 56 patients transferred between different GIM units (see Figure 1). Reasons for transfer between GIM units generally reflected our organization's "3-month rule", where patients who had been admitted under the unit of the day were transferred to another unit they had been previously admitted to within the last 3 months. Individuals admitted on a Saturday or Sunday were likely to be older (33.5% vs. 25.7%  $\geq 85$  years), and require assistance to mobilise (25.9% vs. 17.2%).

Overall mortality at 30-days was 11.5% (n=83). There was no evidence of an association between change of treating team or weekend admission and 30-day mortality (Table 2).

Sixty-two individuals died in hospital or never achieved clinical stability, and were therefore

excluded from the analysis of the 30-day readmission, time from admission to discharge, and time to clinical stability outcomes.

Admission to hospital on a Saturday or Sunday resulted in a significantly longer time to clinical stability (adjusted hazard ratio (95% CI; p-value): 0.77 (0.65, 0.91; <0.01); see Table 2 and Figure 2. Note: hazard ratios <1 indicate a longer time to reach clinical stability, while hazard ratios >1 are associated with a shorter time to clinical stability). The mean predicted time from admission to clinical stability for patients admitted on Saturday or Sunday was 2.25 days (95% CI: 1.97, 2.52) vs. 1.89 days (1.72, 2.05) for those admitted Monday to Friday. Admission on a Saturday or Sunday was also associated with a longer total length of hospital stay (adjusted hazard ratio (95% CI; p-value): 0.72 (0.61, 0.85; <0.01); see Table 2 and Figure 3. Note: hazard ratios <1 indicate a longer time to discharge, while hazard ratios >1 are associated with a shorter time to discharge). Adjusted mean predicted time from admission to discharge for patients admitted on Saturday or Sunday was 7.17 days (95% CI: 5.81, 8.54) vs. 5.03 (4.33, 5.72) for those admitted Monday to Friday.

The overall number of participants who were readmitted within 30-days was 129 (18.7%). Change of treating team was also strongly associated with an increased odds of readmission at 30-days (adjusted odds ratio (95% CI; p-value): 2.13 (1.17, 3.88; 0.01), even after adjusting for history of frequent hospital admission.

## **DISCUSSION**

In this study, we demonstrated that CAP patients admitted on weekends take longer to reach clinical stability with an attendant longer hospital stay and that a change in clinical team is associated with a greater risk of 30-day readmission.

Our results are consistent with earlier studies showing longer hospital stay for weekend admissions<sup>3</sup> and to our knowledge, our study is the first to further this observation by also

showing a delay in time to clinical stability. This is important because it could indicate that treatment variations associated with weekend admission may have a more serious impact on patient well-being given that they might actually impact directly on disease recovery rather than just process factors that delay discharge.

A recent study found that patients cared for by doctors with higher schedule continuity had lower 30-day post-discharge mortality, lower readmission rates, higher rates of discharge directly home and lower 30-day post discharge costs.<sup>17</sup> Our study adds to these findings by being the first to specifically address the impact of change in treating teams on patient outcomes and specifically 30-day readmission. However, reassuringly neither of these factors had an independent association with short-term, 30-day, survival in our smaller study.

There may be several underlying factors driving our observed differences in patient flow and subsequent health care utilisation which in turn may be used to inform health service structure and resourcing. In relation to weekend admissions, understanding and addressing weekend staffing and rostering is likely to be key. Specifically, increasing medical, nursing and allied health staffing levels over weekends may assist in addressing the underlying causes that lead to a longer time to clinical stability and length of stay. Potential initiatives could include increasing the number and seniority of physicians at weekends to expedite medical decision making and progression of a patient's journey towards discharge (e.g. transition from IV to oral antibiotics).<sup>3</sup> Further, previous studies have illustrated that patients admitted with pneumonia also experience a decline in physical function, which can further delay their discharge.<sup>35,36</sup> In light of this, it is reasonable to postulate that increasing allied health staffing, in particular physiotherapy and occupational therapy at weekends to assist with baseline functional assessment and implementation of remedial interventions may accelerate discharge planning. However, our previous work in this group have shown that investing in more intensive physiotherapy for CAP patients does not lead to improved outcomes

(including LOS and readmission)<sup>23</sup> and disinvesting in weekend physiotherapy does not worsen these outcomes.<sup>37</sup>

Differences in time to clinical stability associated with weekend admissions pose interesting questions about possible variations in care on different days of the week. It has been suggested that on weekends, when more experienced senior specialist doctors are less likely to be working, that compliance with pneumonia treatment guidelines may be poorer.<sup>7,38</sup> Specifically addressing whether and what kinds of variations in patient management occurred across different days of the week was beyond the scope of this present study, but would be an important question worth addressing in future studies.

Finally, disruptions in continuity of care are credible as a driver of the higher readmission rate observed in patients who had a change in their treating team during admission. This could introduce increased risks that pertinent detailed and nuanced information is “lost” during the resultant clinical handover between treating teams. For example, understanding and addressing complex social factors relating to a patient’s values and family supports and dynamics can be critical in determining not only discharge destination but also the extent of management and risk of readmission. Continuity of care reduces this “lost information” and has been shown to be associated with fewer hospitalisations<sup>39</sup>, as well as lower mortality and readmission rates.<sup>17,40</sup> The general internal medicine units in this study specifically handed back to the previous treating unit any patients who had been admitted in the previous three months in order to try and reduce such lost information. Potential alternative solutions to this problem include ensuring patients are admitted initially to the same team as previously and higher staffing levels on weekends, both in expertise and numbers. A seven day hospital roster, whereby healthcare staff work seven consecutive days with the aim to reduce any disruptions to patient care continuity is a matter for debate. Although continuity of care is important for patient outcomes, changes in rostering that lead to greater continuity, now need

to be balanced by increasingly recognised important considerations of clinician well-being, work-life balance and the prevention of burnout. These factors can have a potential impact on workforce sustainability with physicians rostered to continuous schedules being shown to experience significantly higher burnout, work-life imbalance and job distress compared to those with an interrupted schedule.<sup>41</sup>

The strengths of our study include its prospective data collection, well defined cohort with a single primary diagnosis (based on a pre-defined case definition that did not rely on administrative data alone), well-defined exposures and outcomes, and importantly the clinical and healthcare economic relevance of the topic. The eligibility criteria for our study were explicitly broad, facilitating enrolment of a highly representative elderly, multi-morbid patient cohort, which means our study is generalisable to medical units across Australia. In addition, the use of multivariable analyses, together with a rich dataset that included a wide range of demographic, clinical and treatment covariates, allowed us to incorporate a comprehensive set of potential confounding variables in our analysis.

The primary limitation of our study, as in all uncontrolled retrospective studies, is the potential role of unmeasured confounders. Our analysis meant that we were able to control for possible confounding due to age, smoking status, residential circumstances, aggregate co-morbidity burden, pneumonia disease severity and frequency of previous recent hospital admissions. However it is always possible that the transferred patients were more prone to readmission due to a factor that was not captured in our multivariate models. In particular, although we incorporated frequency of admission in our multivariate models, organizational factors (including our organization's "3-month rule") could have meant that transferred patients were somehow inherently more prone to readmission even after controlling for

frequency of recent admission. Another important limitation of this study is the reliance on administrative data, with its associated elevated risk of errors and restrictions on the level of detail available. For example, the administrative data pertaining to transfers between treating teams does not allow us to determine the reasons underlying the rationale for such transfers. Some of these transfers may have been deliberate, such as patients who are admitted under one GIM team but are transferred across to another team who have previously cared for the patient, which aims to improve continuity of care (in this study, 66.2% of patients who had a change in treating team had recent prior admissions). Further still, some transfers between teams may have occurred as part of a redistribution of patients in order to more evenly spread the increased workload. Another possible limitation is the focus on health-service centred data instead of patient-centred outcomes such as quality of life and morbidity.

## **CONCLUSION**

This study adds to the current understanding of the impact of workflow factors on patient outcomes by illustrating the potential impact of weekend admissions on prolonging hospital stays and delaying time to clinical stability and on higher readmission rates for patients whose treating teams change during admission.

Our study provides the basis for future studies to further investigate how to best optimise inpatient care of CAP and other illnesses delivered to patients across different days and with changes in treating teams in order to better improve patient outcomes and contain healthcare system costs.

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## FIGURE LEGENDS

Figure 1.

CONSORT flow diagram of IMPROVE-GAP and this workflow factor analysis.

CAP, community-acquired pneumonia; GIM, general internal medicine

Figure 2.

Kaplan-Meier curves demonstrating time from admission to clinical stability according to a) consistency of treating team, and b) day of admission (unadjusted for potential confounders).

Time to clinical stability censored at 20 days to ensure consistent, meaningful details appear in the risk table.

Figure 3.

Kaplan-Meier curves demonstrating time from admission to discharge according to a) consistency of treating team, and b) day of admission (unadjusted for potential confounders). Length of stay censored at 20 days to ensure consistent, meaningful details appear in the risk table.

## TABLES

Table 1. Baseline characteristics by exposure variable (treating team and day of admission).

Total n=753.

Characteristic	Treating team		Day of admission	
	Same team	Changed team	Monday - Friday	Saturday - Sunday
<b>Total n (%)</b>	682	71	529	224
<b>Age group</b>				
<70	151 (22.1)	14 (19.7)	114 (21.6)	51 (22.8)
70-84	338 (49.6)	39 (54.9)	279 (52.7)	98 (43.7)
≥85	193 (28.3)	18 (25.4)	136 (25.7)	75 (33.5)
<b>Sex</b>				
Male	392 (57.5)	39 (54.9)	309 (58.4)	122 (54.5)
Female	290 (42.5)	32 (45.1)	220 (41.6)	102 (45.5)
<b>Residential status</b>				
Supported or aged care facility	148 (21.7)	20 (28.2)	112 (21.2)	56 (25.0)
Independent living	534 (78.3)	51 (71.8)	417 (78.8)	168 (75.0)
<b>Modified Charlson Index</b>				
0-1	181 (26.5)	16 (22.5)	144 (27.2)	53 (23.7)
2-4	319 (46.8)	34 (47.9)	243 (45.9)	110 (44.1)
≥5	182 (26.7)	21 (29.6)	142 (26.8)	61 (27.2)

<b>Premorbid ICU mobility score<sup>†</sup></b>				
≤8	134 (19.7)	15 (21.1)	91 (17.2)	58 (25.9)
9	206 (30.2)	23 (32.4)	166 (31.4)	63 (28.1)
10	342 (50.1)	33 (46.5)	272 (51.4)	103 (46.0)
<b>CORB score on admission</b>				
0-1	332 (48.7)	30 (42.3)	256 (48.4)	106 (47.3)
≥2	350 (51.3)	41 (57.7)	273 (51.6)	118 (52.7)
<b>English spoken at home</b>				
No	172 (25.2)	19 (26.8)	131 (24.8)	60 (26.8)
Yes	510 (74.8)	52 (73.2)	398 (75.2)	164 (73.2)
<b>Spousal support at home</b>				
No	327 (48.0)	33 (46.5)	249 (47.1)	111 (49.6)
Yes	355 (52.0)	38 (53.5)	280 (52.9)	113 (50.4)
<b>Ever smoked</b>				
No	352 (51.6)	27 (38.0)	271 (51.2)	108 (48.2)
Yes	330 (48.4)	44 (62.0)	258 (48.8)	116 (51.8)
<b>Number of admissions to hospital in prior 6-months</b>				
0	447 (65.5)	24 (33.8)	337 (63.7)	134 (59.8)
1	123 (18.0)	24 (33.8)	103 (19.5)	44 (19.6)
2	63 (9.3)	10 (14.1)	48 (9.0)	25 (11.2)
≥3	49 (7.2)	13 (18.3)	41 (7.8)	21 (9.4)

**Abbreviations:**

ICU, intensive-care unit; CORB, confusion (acute), oxygen saturation ≤90%, respiratory rate ≥30 breaths per minute, and blood pressure <90mmHg (systolic) or ≤60mmHg (diastolic).

†ICU mobility scale score: 8 = needs assistance from another person to ambulate away from the bed; 9 = able to walk >5m independently with a gait aid (walking stick or frame); 10 = able to walk >5m independently and unaided.

Table 2: Univariable and multivariable associations between the exposure variables and the outcomes for mortality at 30-days, time from admission to clinical stability and to discharge, as well as readmission at 30-days.

Outcomes	Mortality at 30-days		Time from to clinical stability		Time to discharge		Readmission at 30-days	
	<i>Odds ratio</i> <sup>†</sup> (95% CI, p-value)		<i>Hazard ratio</i> <sup>‡</sup> (95% CI, p-value)		<i>Hazard ratio</i> <sup>§</sup> (95% CI, p-value)		<i>Odds ratio</i> <sup>¶</sup> (95% CI, p-value)	
Exposure variables	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
<b>Treating team</b>								
<b>Same team</b>	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
<b>Changed team</b>	0.73 (0.30-1.73; 0.47)	0.53 (0.20-1.42; 0.21)	0.79 (0.62-1.02; 0.07)	0.80 (0.62-1.04; 0.09)	0.87 (0.68- 1.12; 0.30)	0.83 (0.64- 1.09; 0.18)	2.31** (1.33- 3.99; <0.01)	2.13* (1.17- 3.88; 0.01)
<b>Day of admission</b>								
<b>Monday-Friday</b>	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
<b>Saturday-</b>	1.16 (0.71-1.89; 0.56)	1.01 (0.58-1.76; 0.98)	0.82* (0.70-0.96; 0.02)	0.77** (0.65-0.91; <0.01)	0.76** (0.65-0.90; <0.01)	0.72** (0.61- 0.85; <0.01)	0.80 (0.52- 1.23; 0.31)	0.64 (0.40- 1.01; 0.06)

**Abbreviations:** Ref, reference; CI, confidence interval. Significance indicated: \* p≤0.05, \*\* p≤0.01

<sup>†</sup> Derived using a multivariable logistic regression model. Odds ratio >1 indicate an association of the corresponding factor with higher odds of mortality, while odds ratios <1 are associated with lower odds of mortality.

<sup>‡</sup> Derived from a multivariable Cox Regression model. Hazard ratios <1 indicate an association of the corresponding factor with a longer time to reach clinical stability, while hazard ratios >1 are associated with a shorter time to clinical stability.

<sup>§</sup> Derived from a multivariable Cox Regression model. Hazard ratios <1 indicate an association of the corresponding factor with a longer time to discharge, while hazard ratios >1 are associated with earlier discharge.

<sup>¶</sup> Derived using a multivariable logistic regression model. Odds ratio >1 indicate an association of the corresponding factor with higher odds of readmission, while odds ratios <1 are associated with lower odds of readmission.

## **Background**

The effect of workflow factors, such as timing of admission and changes in treating team, on patient outcomes remains inconclusive.

## **Aims**

We aimed to investigate the impact of weekend admission and changes in treating team on four pre-defined outcomes in patients admitted to hospital with community acquired pneumonia (CAP).

## **Methods**

We performed an observational cohort study by utilizing prospective longitudinal data collected during the IMPROVE-GAP trial, a stepped-wedge randomised study investigating an evidence-based bundle of care in the management of CAP. We assessed the effect of two exposure variables: day of admission and change of treating team, on four pre-specified outcomes: (1) length of stay, (2) time to clinical stability, (3) readmission within 30 days and (4) mortality at 30 days. Our analysis was restricted to patients with a primary diagnosis of CAP and employed multivariable Cox regression and logistic regression to adjust for potential measured confounders.

## **Results**

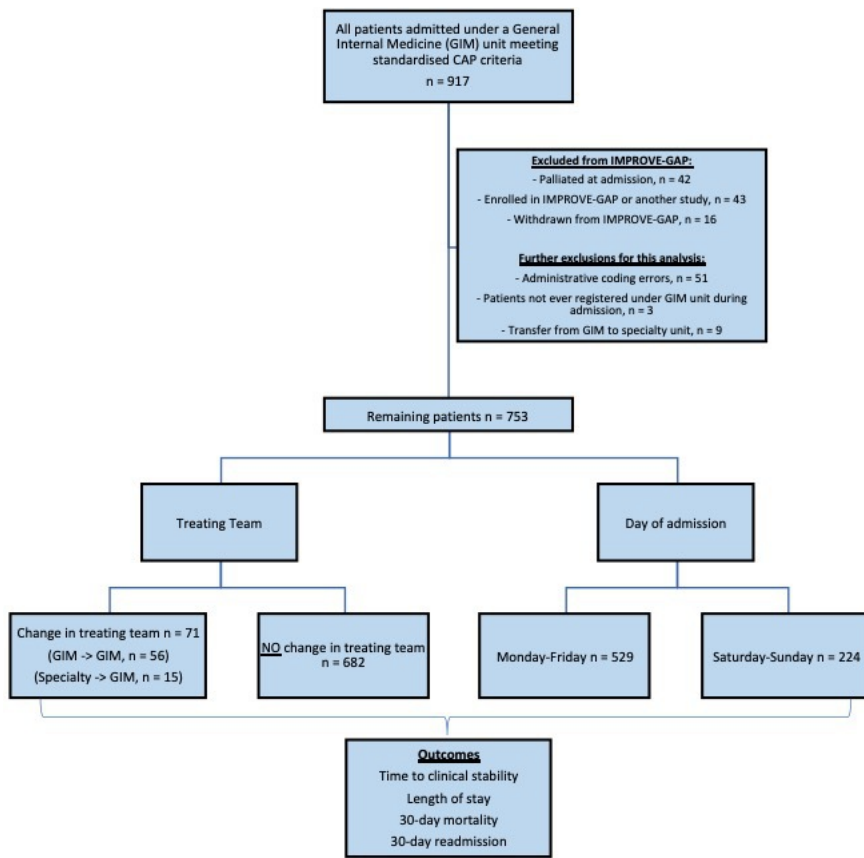
Of 753 participants, 224 (29.7%) were admitted on the weekend and 71 (9.4%) changed treating team during admission. Weekend admissions had significantly longer hospital stays than weekday admissions (hazard ratio [95% confidence interval; p-value] 0.82 [0.70-0.98; 0.03]) and took longer to reach clinical stability (0.80 [0.68-0.95; 0.01]). Change of treating team doubled the odds of readmission at 30-days (odds ratio 1.95, [1.08-3.58; 0.03]).

## **Conclusions**

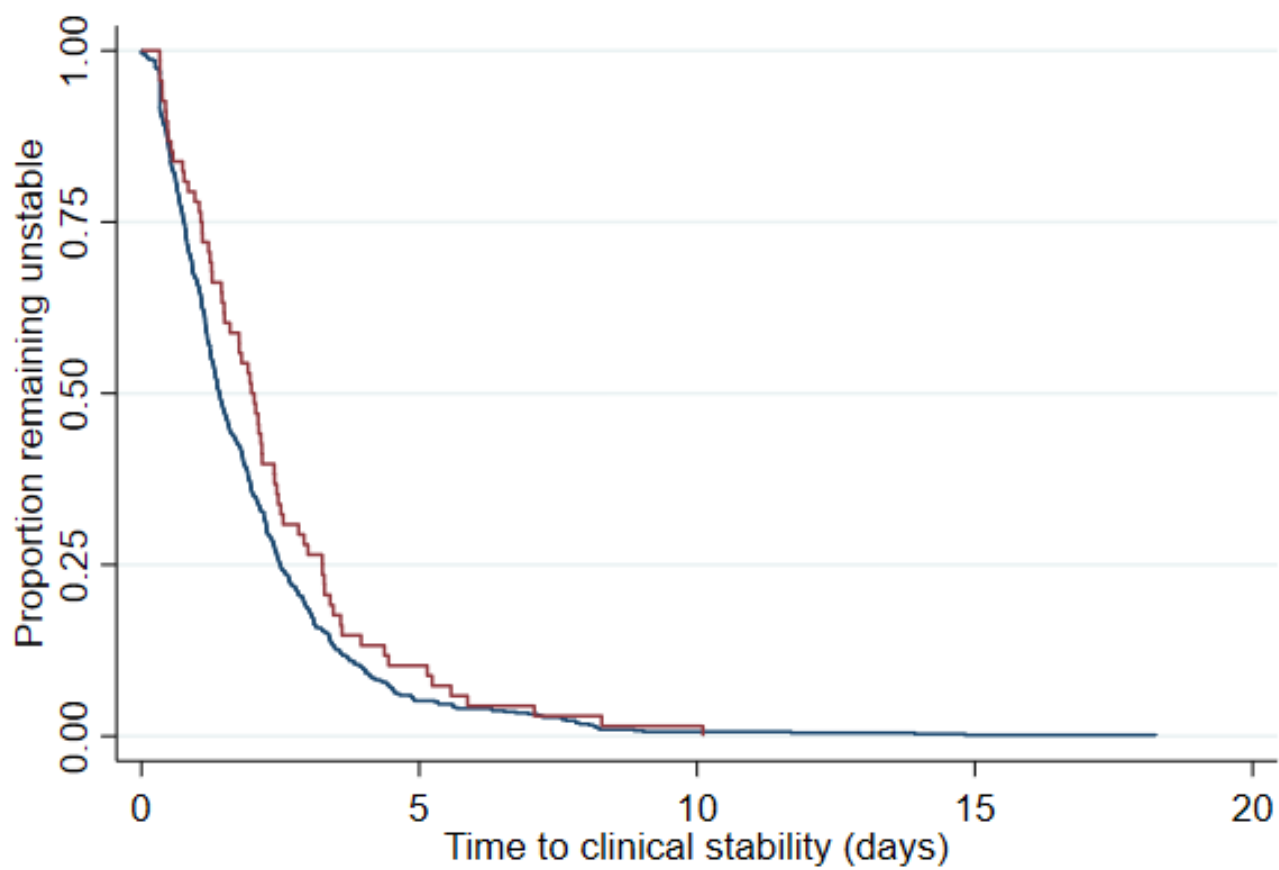
These results suggest workflow factors can negatively impact both health service and patient outcomes. Systems interventions aimed at improving out of hours service and reducing changes in treating team should be considered.

## **Key words**

Workflow, pneumonia, patient outcome, patient care team, health care costs



IMJ\_15252\_Figure 1.jpg

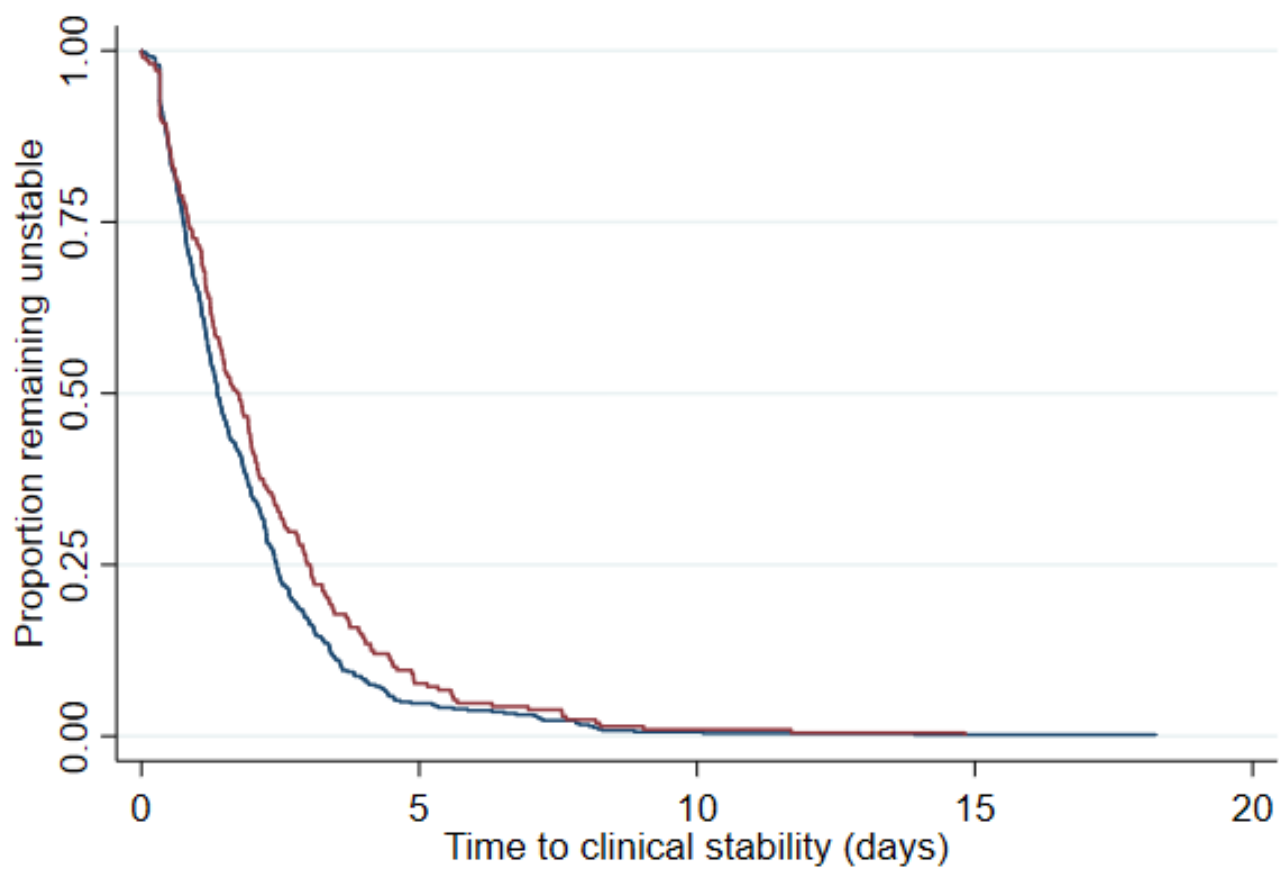


Number at risk

Same team	620	32	4	1	0
Changed team	68	7	1	0	0

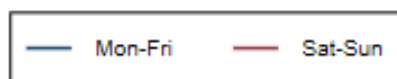


IMJ\_15252\_Figure 2a.png

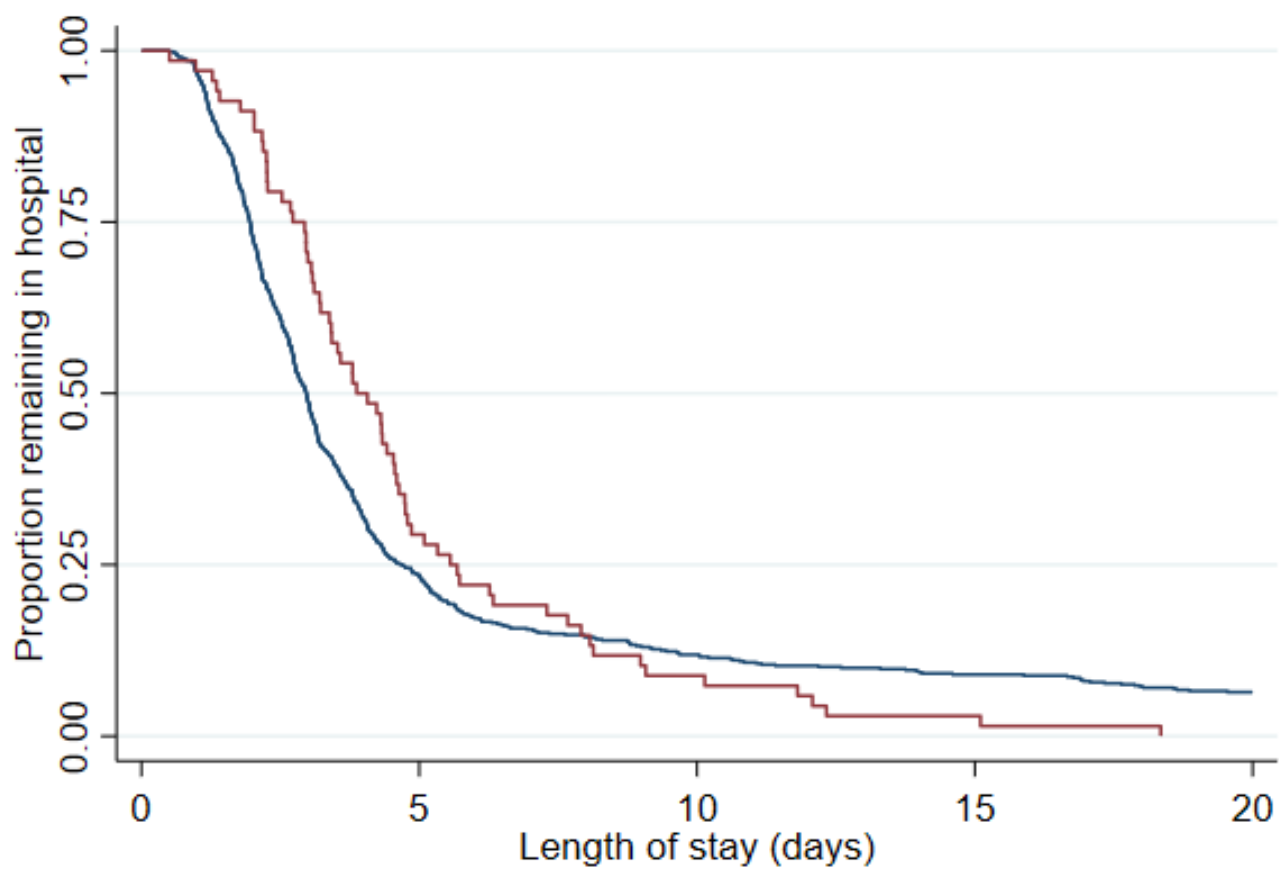


Number at risk

	0	5	10	15	20
Mon-Fri	480	23	3	1	0
Sat-Sun	208	16	2	0	0



IMJ\_15252\_Figure 2b.png

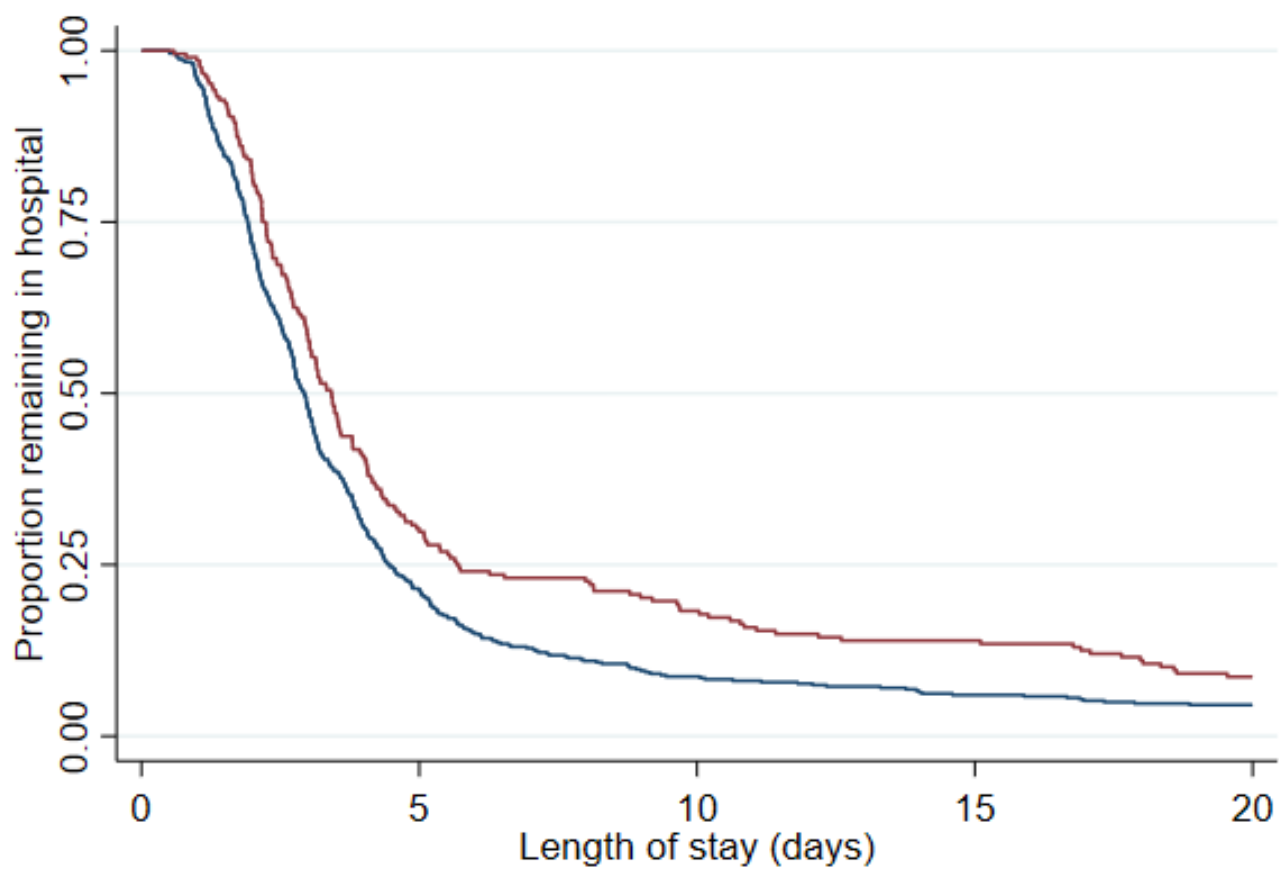


Number at risk

Same team	623	145	74	56	40
Changed team	68	20	6	2	0



IMJ\_15252\_Figure 3a.png



Number at risk

Mon-Fri	483	103	42	29	22
Sat-Sun	208	62	38	29	18



IMJ\_15252\_Figure 3b.png