Health Policy xxx (2018) xxx–xxx

Contents lists available at ScienceDirect

Health Policy

journal homepage: www.elsevier.com/locate/healthpol

The relationship between workload and length of stay in Singapore

Ke Zhou [a,*], Arpana Vidyarthi [a,b], David Matchar [a,c,d], Yin Bun Cheung [e,f], Shao Wei Lam [g], Marcus Ong [a,h,i]

[a] Program in Health Services and Systems Research, Duke-NUS Medical School, Singapore
[b] Department of Medicine, National University Health System, Singapore
[c] Department of Medicine, Duke University, Durham, NC, United States
[d] Department of Pathology, Duke University, Durham, NC, United States
[e] Center for Quantitative Medicine, Duke-NUS Medical School, Singapore
[f] Tampere Center for Child Health Research, University of Tampere and Tampere University Hospital, Finland
[g] SingHealth Health Services Research Centre, Singapore Health Services, Singapore
[h] Department of Emergency Medicine, Singapore General Hospital, Singapore
[i] Associate Director, Health Systems and Services Research, Duke-NUS Medical School, Singapore

ARTICLE INFO

Article history:
Received 7 December 2017
Received in revised form 20 February 2018
Accepted 3 April 2018

Keywords:
Physician workload
Length of stay
Inpatient mortality
30-day re-hospitalization

ABSTRACT

Prior studies link higher workload with longer length of stay (LOS) in the US. Unlike U.S. hospitals, Singaporean hospitals, like other major hospitals in the Asia-Pacific, are partially occupied by patients with non-acute needs due to insufficient alternative facilities. We examined the association between workload and length of stay (LOS) and the impact of workload on 30-day re-hospitalization and inpatient mortality rates in retrospective cohort in this setting. We defined workload as the daily number of patients per physician team. 13,097 hospitalizations of 10,000 patients were included. We found that higher workload was associated with shorter LOS (coefficient, −0.044 [95%CI, −0.083, −0.01]), especially for patients with longer stays (hazard ratios, not significantly greater than 1 before Day 4, 1.04 [95%CI, 1.01, 1.07] at Day 4 and 1.16 [95%CI, 1.10, 1.24] at Day 10), without affecting inpatient mortality (odds ratio (OR), 1.03 [95%CI, 0.99, 1.05]) or 30-day re-hospitalization (OR, 1.01 [95%CI, 0.99, 1.04]). This result differs from studies in the US and may reflect regional differences in the use of acute hospital beds for non-acute needs.

1. Introduction

The Asia-Pacific region, which is home to 61% of the world's population, is experiencing precipitous population ageing. The associated rise in demand for hospital care leads to severe hospital overcrowding in this region [1]. Public acute hospitals in Singapore, which provide 80% of acute care services for the 5.6 million people, are no exception. Their average occupancy rate is 85–95%. High occupancy rate may be associated with increased rate of hospital-acquired infection [2] and mortality [3]. In Singapore, high occupancy rate creates significant challenges to care delivery. For example, gardens, therapeutic area, and tents have been used to accommodate the high volume of patients and the median waiting time for admission was up to 7 h [4]. In addition, with rapid population ageing, the demand for acute hospital beds in Singapore is projected to at least double in the next 25 years. Building new hospitals is one approach to manage the challenge of increasing demand. However, this is expensive and may increase the demand for acute services and hence healthcare cost as "every bed built is a bed filled" without proper constraints on utilization [5].

One alternative approach to addressing increasing acute hospital demand is to explore strategies to reduce the LOS in acute hospitals without worsening patient outcomes. Several strategies have been implemented and evaluated to this end in the U.S. For example, the Prospective Payment System has significantly driven down LOS [6].

Although it is tempting to consider implementing solutions such as payment incentives directly in Singapore to meet its capacity challenges, that would be short-sighted as it does not account for the differences in the healthcare systems. One major difference is that physician workload is very high in the public hospitals in Singapore when compared to the U.S. [7,8]. Prior studies from the U.S. showed that high physician workload drives a longer LOS [9], increased 30-day re-hospitalization rate [10], increased inpatient

* Corresponding author at: Health Systems and Services Research, Duke-NUS Medical School 8 College Road, 169857, Singapore.
E-mail address: zhouke@u.duke.nus.edu (K. Zhou).

https://doi.org/10.1016/j.healthpol.2018.04.002
0168-8510/

mortality rate [11], and nosocomial infections [2], suggesting that high physician workload reduces efficiency and quality of care. If the findings could also be applied to the Singaporean context, any strategy that increases the already high physician workload would promote longer LOS and thus mitigate the effect of the effort to reduce the LOS.

However, it is possible that the dynamic between physician workload and LOS in the Singaporean context differs from the U.S., for two reasons. First, the overall LOS in Singapore is 20% longer than the US (5.8 days [12] versus 4.8 days [13]), which is partially explained by the use of acute hospitals to deliver non-acute services such as rehabilitation and wound care due to limited capacity in the non-acute sectors[14] (the number of "intermediate or long-term care facilities per 1000 population is 2.49 [15] in Singapore versus 5.33 in the U.S. [16]). There is evidence that the LOS of the patients who only receive non-acute services can potentially be safely reduced [17]. Second, in the absence of a strong incentive to expedite discharge as observed in the U.S., delay in discharge planning may occur, leading to incomplete administrative work that prohibits discharge when patients are medically fit and a bed in the non-acute facility is available [18]. Increased workload may incentivize the physicians to make proactive discharge planning and potentially reduce the LOS as organizational behavior studies show that increase in workload may increase productivity [19–21].

In order to explore the potential to reduce LOS and expand our understanding of these issues to an Asian context, we aim to examine the impact of workload on LOS at an acute care hospital in Singapore. Secondarily, we aim to understand the impact of workload on two patient outcome measures, namely 30-day re-hospitalization rate and inpatient mortality rate. We hypothesize that higher workload is associated with shorter LOS, without leading to changes to patient outcome measures. In addition, we anticipate that it is the LOS of the patients receiving non-acute services that are likely to be reduced and these patients, on average, have longer LOS than patients who only receive acute services [14,22]. Thus, we hypothesize that workload has a stronger impact on the discharge of patients whose stays are long but weaker or no impact on the discharge of those whose stays are short.

Although this study is conducted in Singapore, the findings may potentially be generalizable to health systems including Japan [23], Hong Kong [24], Taiwan [25], and South Korea [26], in which a significant proportion of the acute hospital beds are utilized for non-acute medical care or social care.

2. Method

2.1. Site and subjects

Singapore General Hospital (SGH) is the largest acute hospital in Singapore with 1700 inpatient beds, accounting for one-fifth of all acute hospital beds in the country. SGH is the base for multiple US-style residency programs that are accredited by Accreditation Council for Graduate Medical Education International (ACGME-I). It also partners with the Duke-NUS Medical School [27] which offers postgraduate education that leads to M.D. and/or Ph.D. degree, and constitutes the largest academic medical center in Singapore. The Department of Internal Medicine (DIM) in SGH provides care to general internal medicine patients. Service teams are comprised of one consultant, who may be a sub-specialist or a general internist, one to two registrars/fellows (at least post graduate year (PGY) 4), several medical officers/residents (at least PGY 2) and house officers/interns (PGY 1). New admissions are assigned to teams by turns, regardless of the variations in workload across teams.

We included all patients who were older than 18 years and were either admitted to or discharged from DIM from 1 st Jan through 31 st Dec 2013 in the study. We excluded patients whose stays are (1) extremely short (less than 1 day) as they may not have required acute hospitalization or (2) long (greater than the 99th percentile, i.e. 35 days) as these patients likely have extraordinary social or other non-medical issues delaying their discharge.

2.2. Measurement of workload

We defined workload as the number of patients per physician team on a daily basis. We used the average of daily workloads from admission to discharge as the independent variable in the analyses of LOS, inpatient mortality rate and re-hospitalization rate as the unit of analysis was patient. We used daily workload as the independent variable in the Cox proportional hazard model of discharge as the unit of analysis was patient-days [28].

2.3. Statistical analysis

We employed an ordinary least square (OLS) regression to examine the association between workload and LOS. As anecdotal accounts suggest that the rate of discharging patients decreases as workload becomes excessively high, we conducted subgroup analyses for hospitalizations with workload greater than 50th, 75th, 90th and 95th percentiles of the distribution (which corresponds to 27, 29, 30, 31 patients per team), respectively, to examine the potential differences in the direction of the association between workload and LOS as workload becomes excessively high. Assuming admission rate remains constant and discharge patterns could be modified to resemble those on high workload days, the proportion of bed days that can be potentially saved is estimated by the following equation,

$$\begin{aligned}&\text{proportion of bed days that can be saved}\\&=\frac{(\text{2 standard deviations of workload}\times\text{ the association between workload and LOS})\times\text{admission rate}}{\text{current average LOS}\times\text{admission rate}}\\&=\frac{\text{2 standard deviations of workload}\times\text{the association between workload and LOS}}{\text{current average LOS}}.\end{aligned}$$

We used logistic regressions to examine the correlations of the workload with the 30-day re-hospitalization rate and inpatient mortality rate.

To examine if the association between workload a length of stay, if any, is modified by the patient's primary diagnosis, comorbidity index, or ward class (three classes, higher class requires higher copayment rates), we included an interaction term in the above model and performed Wald test on the interaction term. For primary diagnosis, we kept the top ten common diagnoses as they are and combined the remaining cases as other diagnoses (Appendix Table 1). In order to understand whether the variations in LOS associated with workload, if any, are driven by differences in the discharge rate of all patients or a subgroup of patients of particular LOS, we used a Cox proportional hazard model [29] to examine potential interactions between the day of a patient's stay and the association between the daily workload on a given day and discharge occurring on the following day [28]. We specified the model as $\log(HR) = \beta_{WL}WL + \beta_{Day}Day +$