Association between physician continuity of care and patient outcomes in clinical teaching units: a cohort analysis

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ABSTRACT

Background:

Clinical teaching units (CTUs) provide care to patients in scheduled time-blocks with regular handoffs. The objective of this study was to determine the association between attending physician handoffs on CTUs and patient outcomes.

Methods:

We conducted a retrospective multicenter cohort study using data from three tertiary care hospitals in Calgary, Alberta between January 1, 2015 to December 31, 2017. Hospitalizations in the top ten case-mix groups were included. We have previously used this cohort to describe the association between continuity of care and utilization of routine laboratory tests. Exposure variable was the number of attending physicians seen by a patient. Outcome measures were: admission to intensive care unit (ICU); in-patient, 7- and 30-day mortality, and 7- and 30-day readmission rate. Multivariable regression statistical models adjusted for age, sex, length of stay, Charlson comorbidity index, utilization of routine laboratory tests, case-mix group, and day of week of admission were used.

Results:

Our cohort included 4324 unique patients. There were no significant differences in the incidence rate ratios (IRR) of admission to ICU, in-patient mortality, and 7- day readmission and mortality between hospitalizations with one, two, or three or more attending physicians. However, both 30-day readmission (IRR 1.33, 95% CI: 1.04 to 1.71) and mortality rates (IRR 1.53, 95% CI 1.02 to 2.30) were higher with three or more attending physicians compared to one attending physician.

Interpretation:

Increased handoffs between attending physicians on CTUs is associated with increased 30-day

readmission and mortality rates.

INTRODUCTION

Transitions of patient care through handoffs between healthcare teams are ubiquitous. In the primary care setting, outpatient physician continuity is associated with greater patient satisfaction[1], improved health promotion[2], increased adherence to medication[3], reduced emergency department[4] and hospital use[5], and lower costs[4]. Declines in continuity in the transition between community and hospital settings is associated with higher post-discharge costs and readmission rates. [6]In the setting of medical trainees[7] and nursing[8,9], breaks in continuity of care have been associated with adverse events and errors[10].

In the inpatient setting, hospitalists, usually general internists provide most general medical care in the United States. They typically work contiguous days, handing off patients at the end of their block, such that patients are likely to see more than one internist during their hospitalization[11,12]. Data on the association between these breaks in continuity of care in hospitals and patient outcomes is limited[13,14]. A recent study by Farid et al that assessed care handoffs among hospitalist physicians found no difference in mortality in the 30 days after discharge[15]. In an exploratory analysis however, patients with higher illness severity were noted to have a higher 30-day mortality with increased physician handoffs. In another study by Goodwin et al., patients cared for by hospitalists in the top quartile of continuous schedules had significantly lower post-discharge mortality, readmission rates, costs, and higher rates of discharge home, compared with patients cared for by hospitalists with discontinuous schedules[11].

In Canada, the clinical teaching unit (CTU) is a team-based structure used to deliver care to general medical patients in academic hospitals[16]. The attending physician, a general internist, serves as the most responsible physician for patient care, while simultaneously teaching learners of various skill levels, and leading multidisciplinary teams of healthcare providers[17]. The attending physicians instruct and act as role models for the future physician workforce[18]. This role requires

the execution of professional competence and is vulnerable to several unpredictable contextual factors[19]. Given the complexity of this role, similar to the American setting[12], an individual physician works a set number of contiguous days on the CTU to prevent burnout[14]. The prevalence of discontinuity of care by attending physicians on CTUs makes it important to understand its impact on patient outcomes. The objective of this retrospective cohort study was to examine the association between the number of attending physicians involved in a patient's care on the CTU, and patient outcomes in the form of admission to intensive care unit (ICU), re-admissions, and mortality.

METHODS

Setting

Our study examined data from three academic teaching hospitals in Calgary, Alberta representing six CTU teams. Attending physician handoff occurred on a fixed day of the week, usually every 7-14 days. The number of attending physicians seen by patients with the same length of stay could vary depending on the day of admission relative to the day of physician handoff, and number of contiguous days worked by their physician. CTU learner teams consisting of medical students and resident physicians changed every 28-days, with changeover days between attending physicians and learners typically being staggered to provide some continuity of care.

Study design and participants/cohort creation

We report this study in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for observational research[20]. In this retrospective cohort study, we used the same cohort that we had previously used to describe the association between health system factors and utilization of routine laboratory tests on clinical teaching units[21]. All adult (age ≥18 year) hospitalizations at the three hospitals between January 2015 to December 2017 were identified. Each hospitalization was then classified using the Case Mix group (CMG+)

classification developed by the Canadian Institute of Health Information (CIHI) [22]. The final cohort consisted of patients that represented the ten most common CMG+ groups, to facilitate comparisons within similar groups of patients based on their clinical and resource utilization characteristics.

Exposures/Variables

The exposure of interest was the number of successive primary attending physicians seen by a patient throughout their CTU admission.

Outcomes

The patient outcomes we examined were 1) need for admission to ICU, 2) re-admissions at 7- and 30-days after discharge, and 3) in-patient and mortality at 7- and 30-days after discharge.

Covariates/Controlled variables

A simple comparison of mortality rates between patients with one or more attending physicians is confounded by the fact that patients that have more severe disease are more likely to be admitted for longer, and have multiple attending physicians. We addressed this issue by adjusting for patient length of stay. In addition, to allow for comparisons between similar groups of patients, we adjusted for patient age, sex, utilization of routine laboratory tests, Charlson comorbidity index[23], and CMG+ group in all of our models. The panel of 'routine' laboratory tests included complete blood count, electrolytes, creatinine, urea, international normalized ratio, partial thromboplastin time, calcium, magnesium, phosphate, and creatine kinase.[21,24] Finally, we also adjusted for day of week of admission given its association with patient mortality[25] in prior literature.

Data sources/Measurement

We obtained data on the number of physicians involved in the care of each patient, day of the week of admission, and utilization of routine laboratory tests from our hospital electronic medical

record system (Sunrise Clinical Manager, Allscripts, Chicago, IL.). We obtained patient variables including age, sex, Charlson comorbidity index, CMG+, length of stay, admission to ICU, re-admission, and mortality rates from the discharge abstract database.

Statistical Methods

We used mixed-effects logistic regression to model the outcomes of admission to the ICU, readmission (at 7 and 30-days) and mortality (inpatient, and at 7 and 30 days), adjusting for patient age, sex, Charlson comorbidity index, length of stay on the CTU, CMG+ category, day of week of admission, and utilization of routine laboratory tests. The number of attending physicians (one, two, three or more) was classified as a categorical variable. Consistent with our earlier work [21], we examined whether the relationship between the number of attending physicians and each of the outcomes is modified by the number of tests ordered. Regression analyses were conducted at the patient level, recognizing that some patients had more than one hospitalization. P-values less than 0.05 were regarded as statistically significant and the reported 95% confidence interval estimates are two-sided. All statistical analyses were performed using Stata SE V.15.2 (Stata Corp, College Station, TX, USA).

Ethics approval

The study was approved by the institutional review board Conjoint Health Research Ethics Board of the University of Calgary with a waiver of informed consent (CHREB 19-0549).

RESULTS

Cohort characteristics:

There were 111,207 in-hospital patient days between January 2015 to December 2017 across CTUS in the three hospitals. 74,540 in-hospital patient-days that did not belong in the top ten CMG+ categories were excluded. Our final cohort included 36,667 hospital patient-days with 4324

unique patients over 5071 hospitalizations[21]. The top ten CMG+ groups were as follows: i) heart failure without coronary angiogram, ii) other/unspecified sepsis or shock, iii) chronic obstructive pulmonary disease, iv) cirrhosis/alcoholic hepatitis, v) viral/unspecified pneumonia, vi) diabetes, vii) renal failure, viii) gastrointestinal hemorrhage, ix) respiratory failure, and x) disorders of fluid or electrolyte imbalance. Cohort characteristics are described in **Table 1**. The mean [SD] age of the cohort was 63.4 [18.2] with 44.8% females. The median length of stay was 5 days. 37% of hospitalizations involved one attending physician, 41% included two, and approximately 22% of hospitalizations involved three or more attending physicians.

Outcomes:

Associations between number of attending physicians and patient outcomes are listed in **Table 2**. As compared to having one attending physician throughout a patient's hospitalization, there was no significant difference in the rates of admission to intensive care unit for patients with two, or three or more attending physicians. Similarly, with respect to inpatient mortality, and 7-day readmission and mortality rates, no significant differences were noted with two, or three or more physicians as compared to one attending physician. The post-discharge 30-day readmission and mortality rates, although not significantly different between one versus two attending physicians, were significantly increased when comparing one to three or more attending physicians, with the adjusted incidence rate ratio being 1.33 (95% CI 1.04 to 1.71) and 1.53 (95% CI 1.02 to 2.30) respectively.

INTERPRETATION

In this retrospective cohort study, we found no significant associations between attending physician handoffs and patient outcomes in the form of ICU transfer, in-patient mortality and 7-day readmissions and mortality on clinical teaching units. However, we did find modest significant increases in both 30-day readmission and mortality rates with three or more attending physicians

as compared to a single attending physician.

Research on the association between breaks in continuity of care and quality of care has been limited to specific diseases, single institutions, trainee-setting[7], or specific outcomes such as length of stay as opposed to mortality[26,27]A recent systematic review revealed that increased continuity of care by doctors, in any setting, is associated with lower mortality rate[28]. However, most studies examined continuity in the outpatient setting, or in the transition from inpatient to outpatient setting. Our findings are similar to other studies that have examined the impact of physician handoffs in the inpatient context. The study by Goodwin et al that examined hospitalist handoffs in the United States found that patients cared for by hospitalists in the highest quartile of scheduled continuity (i.e., a 7-day routine) had lower 30-day mortality, lower readmission rates, higher rates of discharge to home, and lower 30-day post-discharge costs[11]. Unlike our cohort where 7-day schedules were the norm, in this study 7-day routines were included in the highest quantile of continuity, with worse outcomes noted with more discontinuous schedules. More recently, Farid et al. examined the impact of physician handoff among hospitalized Medicare patients in the United States[15]. The authors restricted their analysis to hospitalists who worked at least seven consecutive days, and compared 30-day post-discharge mortality of patients with different probabilities of handoff based on date of patient admission relative to handover schedule. Even though they found no overall association between physician handoffs and 30-day mortality, an exploratory analysis suggested an increase in 30-day mortality for sicker patients.

The results of our study, taken together with existing literature in the inpatient setting, suggest a relationship between attending physician handoff and 30-day readmission and mortality. Even though proximal patient outcomes like need for ICU, mortality in hospital, and 7-day readmission and mortality rates seem comparable, we hypothesize that some loss of data particularly with two or more handoffs contributes to the worse outcomes seen at 30-days. Work schedules for

hospitalist physicians in the US vary greatly [12,14] in an effort to balance physician wellbeing with increasing continuity[29]. In Canada, there is no consensus on the optimum duration of service for attending physicians on CTUs, with competing arguments related to impact of continuity of care, adverse effects of physician fatigue, and perceived improvements in care because of second review with handoff [30]. Related research has shown other impacts of breaks in physician continuity such as increase in redundant use of diagnostic testing[21,31,32]. More research is needed to identify the full spectrum of downstream outcomes of breaks in attending physician continuity of care on CTUs at the patient, provider and health systems level.

There are several limitations of our study. First, it was observational, and although our analyses adjusted for patient age, sex, length of stay, Charlson comorbidity index, CMG+ classification, day of week of admission and utilization of routine laboratory tests, our conclusions are limited by the presence of potential unmeasured confounders. Second, our outcomes, although broader than mortality alone, did not include metrics for medical errors, delays in care, resource utilization, or patient satisfaction. Third, data on the quality of handoffs between physicians was lacking, which would have been helpful in interpreting the results. Fourth, although three hospitals were included in our analysis, our study was limited to a single-city, which operates using a similar format for inpatient CTUs. While the CTU is a widely used structure for the care of medical inpatients across Canada, differences between hospitals in Calgary and other cities (e.g. health record systems, patient population) may affect the applicability of our findings to other centers. Finally, patients outside of the 10 most common CMG+ categories were excluded from our final cohort. While this enabled us to make comparisons within similar patient groups, it does limit the generalizability of our findings.

In conclusion, in this retrospective cohort study conducted on inpatients CTUs at three tertiary hospitals, having three or more attending physicians compared to one was associated with a

significant modest increase in 30-day readmission and mortality. Further studies are needed to validate this finding, and examine other pertinent outcomes impacted by breaks in continuity of attending physician on CTUs.

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CONFLICT OF INTEREST SUMMARY

The authors have no relevant conflicts of interest to disclose

DATA AVAILABILITY STATEMENT

The dataset analyzed in this study is available from Alberta Health Services upon request in accordance with institutional policies and procedures.

Table 1: Patient and hospitalization characteristics of the cohort

	Complete cohort	Patients seen by one attending physician	Patients seen by two attending physicians	Patients seen by ≥ 3 attending physicians
Number (%)	5071 (100)	1856 (36.6%)	2070 (40.8%)	1145 (22.6%)
Female, No. (%)	2270 (44.8%)	818 (44.1%)	941 (45.5%)	511 (44.6%)
Age, mean (SD), years	63.4 (18.2)	58.5 (19.5)	62.7 (17.9)	68.8 (15.6)
Median length of stay, (IQR)	5.09 (2.81-9.95, IQR 7.14)	2.91 (1.81-4.67, IQR 2.86)	5.51 (3.30-8.12, IQR 4.82)	15.66 (9.44-27.69, IQR 18.25)
ICU admission, No. (%)	379 (7.5%)	114 (6.1%)	141 (6.8%)	124 (10.8%)
Charlson comorbidity index, median (IQR)	2 (2)	1 (1-3, IQR 2)	2 (1-3, IQR 2)	2 (1-3, IQR 2)
Patients seen by teams without senior residents, No. (%)	3474 (68.4%)	1360 (73.3%)	1406 (67.9%)	708 (61.8%)

IQR: Interquartile range

Table 2: Associations between attending physician continuity and patient outcomes adjusting for patient age, sex, Charlson comorbidity index, length of stay on the CTU, and CMG+ category

Patient outcomes	Adjusted incidence rate ratio [95% CI] with two attending physicians compared to one	P-value	Adjusted incidence rate ratio [95% CI] with ≥ 3 attending physicians compared to one	P-value
Admission to Intensive Care Unit	1.19 [95% CI 0.81 to 1.75]	0.369	0.61 [95% CI 0.34 to 1.09]	0.093
In-patient mortality	0.94 [95% CI 0.69 to 1.28]	0.703	1.00 [95% CI 0.71 to 1.43]	0.970
Post-discharge 7-Day mortality rate	0.90 [0.67 to 1.22]	0.515	1.18 [95% CI 0.84 to 1.67]	0.333
Post-discharge 30-Day mortality rate	1.02 [0.72 to 1.44]	0.904	**1.53 [95% CI 1.02 to 2.30]**	**0.040**
Post-discharge 7-Day readmission rate	1.07 [0.82 to 1.39]	0.616	1.17 [95% CI 0.85 to 1.62]	0.329
Post-discharge 30-Day readmission rate	1.10 [0.90 to 1.34]	0.346	**1.33 [1.04 to 1.71]**	**0.024**

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STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	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	1/2/3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4/5
Objectives	3	State specific objectives, including any prespecified hypotheses	4/5
Methods			
Study design	4	Present key elements of study design early in the paper	5/6/7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (*b*) For matched studies, give matching criteria and number of exposed and unexposed	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	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	6
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	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*) If applicable, explain how loss to follow-up was addressed (*e*) Describe any sensitivity analyses	7
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg 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	7/8
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	7/8
Outcome data	15*	Report numbers of outcome events or summary measures over time	7/8

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 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	7/8
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	7/8
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10
Generalisability	21	Discuss the generalisability (external validity) of the study results	9
Other information			
Funding	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	11

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.