

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

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## Abstract

**Background:** Hospital-based clinical teaching units (CTUs) are supervised by rotating attending physicians. Physician hand-offs in other contexts have been associated with worse patient outcomes, presumably through communication gaps. We aimed to determine the association between attending physician hand-offs on CTUs and patient outcomes including escalation of care, readmission and mortality.

**Methods:** We conducted a retrospective, multicentre cohort study using data from 3 tertiary care hospitals in Calgary between Jan. 1, 2015, and Dec. 31, 2017. We included hospital admissions in the top 10 case-mix groups. Our exposure variable was the number of attending physicians seen by a patient. Outcome measures were admission to intensive care unit (ICU); inpatient 7- and 30-day mortality; and 7- and 30-day readmission rate. We used multivariable regression statistical models adjusted for patient age, sex, length of stay, Charlson Comorbidity Index, case-mix groups, senior resident presence, team handovers and team transfers.

**Results:** Our cohort included 4324 unique patients. There were no significant differences in the incidence rate ratios (IRRs) of admission to ICU, inpatient 7- and 30-day mortality, and 7- and 30-day readmission rates among 1 or 2 physicians. However, we noted a significant increase in 30-day readmission rate (IRR 1.37, 95% confidence interval 1.05–1.78) in patients who had 3 or more attending physicians compared with those who had 1 attending physician.

**Interpretation:** We found that 2 or more physician hand-offs on CTUs had a modestly greater association with patient readmission at 30 days. More research is needed to explore this finding and to evaluate associated patient and resource outcomes with physician hand-offs.

Transitions of patient care through hand-offs between health care teams are ubiquitous, particularly in hospitals. Hospitalists, usually internists, provide most of the general medical care to patients admitted to hospital. They typically work contiguous days, handing off patients at the end of their block, such that patients are likely to see more than 1 internist during their hospital admission.<sup>1,2</sup> Data on the association between breaks in continuity of care in hospitals and patient outcomes are limited.<sup>3,4</sup> A 2021 cross-sectional study that assessed care hand-offs among hospitalist physicians in the United States found no difference in postdischarge 30-day mortality.<sup>5</sup> However, an exploratory analysis within this study found that patients with higher illness severity had a higher 30-day mortality with increased physician hand-offs. A 2020 retrospective cohort study involving patients cared for by hospitalists in the top quartile of continuous schedules in Texas had significantly lower postdischarge mortality, readmission rates, costs and higher rates of discharge home than patients who were cared for by hospitalists with discontinuous schedules.<sup>1</sup>

In Canada, the clinical teaching unit (CTU) is a team-based structure that delivers care to general medical patients in academic hospitals.<sup>6</sup> The attending physician

serves as the most responsible physician for patient care, while simultaneously teaching learners of various skill levels and leading multidisciplinary teams of health care providers.<sup>7</sup> The attending physicians instruct and act as role models for the future physician workforce.<sup>8</sup> This role requires the execution of professional competence and is vulnerable to several unpredictable contextual factors.<sup>9</sup> Given the complexity of this role, an individual physician works a limited number of contiguous days to prevent burnout.<sup>4</sup> The prevalence of discontinuity of care by attending physicians on CTUs makes it important to understand its impact on patient outcomes. We aimed to evaluate the association between the number of

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attending physicians involved in a patient's care on the CTU, and patient outcomes in the form of admission to intensive care unit (ICU), readmissions and mortality.

## Methods

### Setting

Our study evaluated data from 3 academic teaching hospitals in Calgary, Alberta, representing 6 CTU teams. Attending physician hand-off 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 hand-off and number of contiguous days worked by their physician. Clinical teaching unit learner teams comprising medical students and resident physicians changed every 28 days, with changeover days between attending physicians and learners typically being staggered. In addition to handovers occurring between learners on the same CTU team, occasionally patients were transferred from one team to the other to help maintain optimal team census. Senior medical residents are typically second- or third-year internal medicine residents who work closely with the attending physician to provide oversight on patient care and medical education for junior learners. Of the 3 hospitals, only 1 had regularly scheduled senior residents during the day owing to the smaller size of our training program relative to the number of hospitals.

### Study design and participants

We report the results of this study in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline for observational research.<sup>10</sup> We used the same cohort that we had employed previously to describe the association between health system factors and use of routine laboratory tests on CTUs.<sup>11</sup> We identified all adult (aged  $\geq 18$  yr) hospital admissions on the CTUs at the 3 hospitals between January 2015 and December 2017. We selected this study period because the CTU structure had been stable during these years. Since then, our CTUs have undergone several cycles of structural changes to accommodate increasing volumes of patients. Each hospital admission was then classified using the Case Mix Groups+ (CMG+) classification developed by the Canadian Institute for Health Information (CIHI).<sup>12</sup> Using CMG+ facilitates the grouping of medical inpatients based on their clinical characteristics. Patients are assigned to 1 of these categories based on their *International Statistical Classification of Diseases and Related Health Problems, 10th Revision*, Canadian version (ICD-10-CA) diagnostic code, age group, comorbidity level and level of interventions including requirement for ICU. Our final cohort comprised patients who represented the 10 most common CMG+ groups. We used the CMG+ group as a confounder in our statistical model to allow us to attribute changes in patient outcomes to continuity of care within groups of similar patients. We included only the top 10 groups to allow for sufficient numbers of patients in each group to help with the stability of our statistical models.

### Exposure

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

### Outcomes

The patient outcomes we evaluated were admission to ICU, readmissions at 7 and 30 days after discharge, and inpatient mortality and mortality at 7 and 30 days after discharge.

### Covariates/controlled variables

A comparison of mortality rates between patients with 1 or more attending physicians is confounded by the fact that patients who 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. To allow for comparisons between similar groups of patients, we adjusted for patient age, sex, Charlson Comorbidity Index<sup>13</sup> and CMG+ group in all of our models. We additionally adjusted for continuity of care at the level of learner teams by adjusting for the presence of a senior resident, scheduled 28-day handovers occurring with learner changes on teams and any transfers of care between CTU teams.

### Data sources

We obtained data on the number of physicians involved in the care of each patient and the number of CTU teams involved from our hospital electronic medical record system (Sunrise Clinical Manager, Allscripts, Chicago). We obtained patient variables including age, sex, Charlson Comorbidity Index, CMG+, length of hospital stay, admission to ICU, readmission and mortality rates from the Discharge Abstract Database (CIHI). We obtained data on the presence of senior residents and CTU team handover dates from the Postgraduate Medical Education Office at the University of Calgary.

### Statistical analysis

We used mixed-effects logistic regression to model the outcomes of admission to ICU, readmission (at 7 and 30 d) and mortality (inpatient, and at 7 and 30 d), adjusting for patient age, sex, Charlson Comorbidity Index, length of stay on the CTU, CMG+ category, presence of senior resident on the CTU team, CTU team handover and CTU team transfers of care. We classified the number of attending physicians (1, 2, 3 or more) as a categorical variable. We conducted regression analyses at the patient level, and we used a mixed-effects model to account for clustering of observations within each patient. We regarded  $p$  values that were less than 0.05 as statistically significant, and the reported confidence interval (CI) estimates are 2-sided. We used Stata SE version 15.2 (Stata Corp) to perform all of the statistical analyses.

### Ethics approval

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

Results

There were 111 207 in-hospital patient-days between January 2015 to December 2017 across CTUs in the 3 hospitals. We excluded 74 540 in-hospital patient-days that did not belong in the top 10 CMG+ categories. Our final cohort included 36 667 hospital patient-days with 4324 unique patients over 5071 hospital admissions<sup>11</sup> (Figure 1). The top 10 CMG+ groups were as follows: heart failure without coronary angiogram, other or unspecified sepsis or shock, chronic obstructive pulmonary disease, cirrhosis or alcoholic hepatitis, viral or unspecified pneumonia, diabetes, renal failure, gastrointestinal hemorrhage, respiratory failure and disorders of fluid or electrolyte imbalance. Cohort characteristics are described in Table 1. The mean (standard deviation [SD]) age of the cohort was 63.4 (SD 18.2) years, and 44.8% were females. The median length of hospital stay was 5.09 (interquartile range [IQR] 2.81–9.95) days. For hospital admissions, 36.6% involved 1 attending physician, 40.8% included 2 and 22.6% involved 3 or more attending physicians. Of the 5071 unique hospital visits during the study period, 92% were with the same CTU team, with a transfer between teams occurring only 7.5% of the time.

The whole statistical model, including adjusted and unadjusted estimates for all variables, is included in Appendix 1, available at [www.cmajopen.ca/content/11/1/E40/suppl/DC1](http://www.cmajopen.ca/content/11/1/E40/suppl/DC1). Associations between the number of attending physicians and patient outcomes are listed in Table 2. When comparing 1 versus 2 attending physicians throughout a patient's hospital stay, we did not find any significant differences in any of the outcomes of admission to ICU, inpatient mortality, 7- and 30-day mortality after discharge and readmission rates. However, when

we compared 3 or more attending physicians to 1 attending physician for a hospital admission, we noted a significant decrease in association with admission to ICU (incidence rate ratio [IRR] 0.48, 95% CI 0.27–0.85, ), and a significant increase in 30-day readmission rate (IRR 1.37, 95% CI 1.05–1.78) with 3 or more attending physicians.

Interpretation

In this retrospective cohort study, we found no significant association between 1 and 2 attending physicians on patient outcomes in the form of ICU transfer, inpatient mortality, and 7- and 30-day readmissions and mortality on CTUs. However, we did find a significant decrease in association with 3 or more attending CTU physicians and ICU stay, and a modest significant increase in 30-day readmission with 3 or more attending physicians compared with a single attending physician. We hypothesize that, although we saw no difference in outcomes with 1 hand-off, some loss of information that occurred with 2 or more hand-offs may have contributed to increased readmission rate at 30 days. The decreased association between 3 or more CTU attending physicians and ICU admission may be explained by ICU transfers that occurred early in the admission course and reduced the opportunity for handovers between CTU attending physicians (i.e., ICU transfer serves as a competing risk to CTU physician hand-off). Other explanations for this association could be potentially reduced chances of missing important acute details with review from more physicians, or greater chances of having more goals of care conversations with involvement of more attending physicians that reduces the likelihood of the patient accepting ICU interventions.

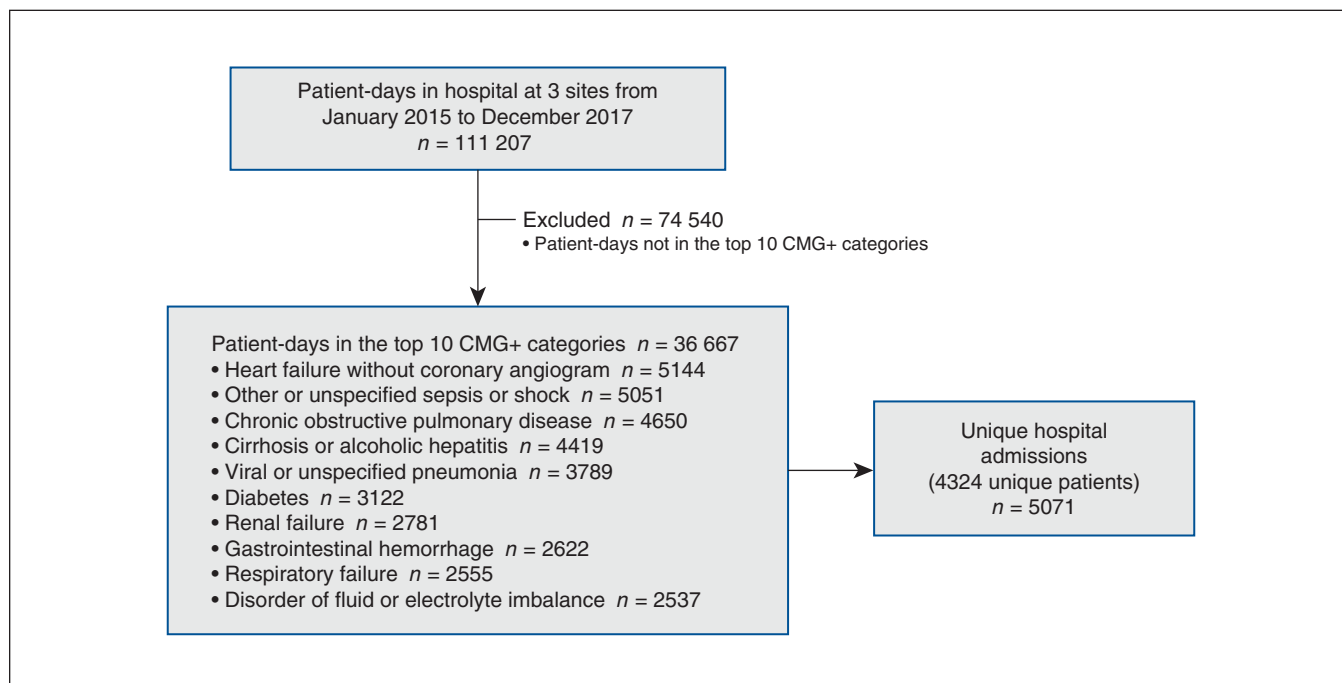


Figure 1: Flow chart showing cohort creation. Note: CMG+ = Case Mix Groups+.

**Table 1: Characteristics of patients and the cohort admitted to hospital clinical teaching units**

Characteristic	No. (%)* of patients in the cohort n = 5071	No. (%)* of patients seen by 1 attending physician n = 1856	No. (%)* of patients seen by 2 attending physicians n = 2070	No. (%)* of patients seen by ≥ 3 attending physicians n = 1145
Female sex	2270 (44.8)	818 (44.1)	941 (45.5)	511 (44.6)
Age, yr; mean ± SD	63.4 (18.2)	58.5 (19.5)	62.7 (17.9)	68.8 (15.6)
Length of stay, d; median (IQR)	5.09 (2.81–9.95)	2.91 (1.81–4.67)	5.51 (3.30–8.12)	15.66 (9.44–27.69)
ICU admission	379 (7.5)	114 (6.1)	141 (6.8)	124 (10.8)
Charlson Comorbidity Index, median (IQR)	2 (2)	1 (1–3)	2 (1–3)	2 (1–3)
Patients seen by teams without senior residents	3474 (68.4)	1360 (73.3)	1406 (67.9)	708 (61.8)

Note: ICU = intensive care unit, IQR = interquartile range, SD = standard deviation.  
\*Unless stated otherwise.

**Table 2: Associations between attending physician continuity and patient outcomes, adjusting for patient age, sex, Charlson Comorbidity Index, length of stay on the clinical teaching unit, Case Mix Groups+ category and learner-team continuity of care**

Patient outcome	Adjusted IRR (95% CI) with 2 attending physicians versus 1	Adjusted IRR (95% CI) with ≥ 3 attending physicians versus 1
Admission to ICU	1.08 (0.74–1.58)	0.48 (0.27–0.85)
Inpatient mortality	0.94 (0.69–1.29)	0.95 (0.64–1.40)
Postdischarge 7-d mortality rate	0.90 (0.66–0.1.23)	1.15 (0.78–1.68)
Postdischarge 30-d mortality rate	1.01 (0.71–1.44)	1.40 (0.90–2.18)
Postdischarge 7-d readmission rate	1.07 (0.83–1.40)	1.16 (0.82–1.65)
Postdischarge 30-d readmission rate	1.11 (0.91–1.35)	1.37 (1.05–1.78)

Note: CI = confidence interval, ICU = intensive care unit, IRR = incidence rate ratio.

Since our data set did not allow us to determine the timing of ICU transfer in relation to CTU admission, this finding will need to be evaluated further through a dedicated study.

Research on the association between breaks in continuity of care and quality of care has been limited to specific diseases, single institutions, trainee setting<sup>14,15</sup> or specific outcomes such as length of stay as opposed to mortality.<sup>16,17</sup> A 2018 systematic review showed that increased continuity of care by doctors, in any setting, was associated with a lower mortality rate.<sup>18</sup> However, most studies have evaluated continuity in the outpatient setting or in the transition from inpatient to outpatient setting. Our findings are similar to those of other studies that have evaluated the impact of physician hand-offs in hospitals. The 2020 retrospective cohort study that evaluated hand-offs by hospitalists in the US 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 costs after discharge.<sup>1</sup> The 7-day routines that were included in the highest quartile of continuity in that study are similar to the 7- to 14-day scheduled routines of CTU attending physicians at our centre. A 2021 cross-sectional study evaluated the impact of physician hand-off

among Medicare patients admitted to hospital in the US.<sup>5</sup> The authors restricted their analysis to hospitalists who worked at least 7 consecutive days and compared 30-day postdischarge mortality of patients with different probabilities of hand-off based on date of patient admission relative to handover schedule. Similar to our study, they found no overall association between physician hand-offs and 30-day mortality, although an exploratory analysis suggested an increase in 30-day mortality for patients with more severe illness.

The results of our study, taken together with existing literature, suggest that with relatively continuous work schedules of around 7 days, hand-offs between attending physicians in hospitals seem to have no significant negative impact on most proximal patient outcomes. With 2 or more hand-offs, some communication gaps may contribute to a higher 30-day readmission rate. Work schedules for hospitalist physicians vary<sup>2,4</sup> in an effort to balance physician well-being with increasing continuity of care.<sup>19</sup> In Canada, there is no consensus on the optimum duration of service for attending physicians on CTUs, with competing arguments related to the impact of continuity of care, adverse effects of physician fatigue and perceived improvements in care because of second

review with hand-off.<sup>20</sup> Related research has shown other impacts of breaks in physician continuity such as increases in redundant use of diagnostic testing.<sup>11,21,22</sup> 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 levels.

### Limitations

Our study was observational and, although our analyses adjusted for patient age, sex, length of stay, Charlson Comorbidity Index, CMG+ classification and continuity of care at the learner-team level, our conclusions are limited by the presence of potential unmeasured confounders. Our outcomes did not include metrics for medical errors, delays in care, resource use or patient satisfaction. We found that data about the quality of hand-offs between physicians were lacking. Although we included 3 hospitals in our analysis, our study was limited to a single city, which operates using a similar format for CTUs. We excluded patients who were outside the 10 most common CMG+ categories from our final cohort. Although this enabled us to make comparisons within similar groups, it did limit the generalizability of our findings. We were unable to identify patients with more severe illness in our data set, and it is possible that the results may be different for a cohort that included these patients. We did not have data on the timing of ICU transfers relative to CTU admission, which would have helped interpret the identified association. Finally, the data set we used is older to avoid capturing the system disruptions that occurred subsequently.

### Conclusion

We found that having 3 or more attending physicians compared with 1 was associated with a significant modest increase in 30-day readmission. Further studies are needed to validate this finding and to evaluate other pertinent outcomes impacted by breaks in continuity of attending physician on CTUs.

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**Contributors:** Anshula Ambasta and Irene Ma conceived of the project. Anshula Ambasta applied for ethics approval and obtained data. Anshula Ambasta and Tyler Williamson worked on the statistical methods, and Tyler Williamson and Onyebuchi Omodon completed the data analysis. Anshula Ambasta wrote the first version of the manuscript. All of the authors contributed equally to revisions of the manuscript, gave final approval of the version to be published and agreed to be accountable for all aspects of the work.

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