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Critical care transition programs and the risk of readmission or death after discharge from ICU

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Take-home message: Implementing a multidisciplinary critical care transition program to serially evaluate patients after discharge from ICU was not associated with patient readmission to ICU or mortality. Alternative strategies are needed to improve the quality of care for patients discharged from ICU.

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Abstract *Purpose:* Critical care transition programs have been widely implemented to improve the safety of patient discharge from ICU, but have undergone limited evaluation. We sought to evaluate implementation of a critical care transition program on patient readmission to ICU (72 h) and mortality (14 days). *Methods:* Interrupted time series analysis of 32,234 consecutive adult patients discharged alive from medical-surgical ICUs in eight hospitals in two cities between January 1, 2002 and January 1, 2012. A multidisciplinary ICU provider team (physician, nurse, respiratory therapist) that serially evaluated each patient after ICU discharge was implemented in three hospitals in one city (study group), but not the five hospitals in the other city (control group). Temporal changes were examined using multivariable, segmented linear regression models. *Results:* After implementation of the program, there was an immediate non-significant decrease in the absolute proportion of patients readmitted to ICU in the study group (−0.4 %, 95 % CI −1.7 to +1.0 %) and a non-significant increase in the absolute proportion of patients readmitted to ICU in the control group (+1.0 %, 95 % CI −0.3 to +2.2 %). Subsequently, there were non-significant changes in the absolute proportion of patients readmitted to ICU in both the study (+0.1 % per quarter; 95 % CI, −0.1 to +0.2 %) and control (−0.1 per quarter; 95 % CI, −0.2 to +0.1 %) groups over time. No significant changes were observed in mortality. The results were stable across patient subgroups. *Conclusions:* Implementation of a critical care transition program was not associated with patient readmission to ICU or mortality.

Keywords Intensive care unit · Patient discharge · Mortality · Readmission · Patient handoff

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Introduction

The transition of patient care between the Intensive Care Unit (ICU) and hospital ward is a vulnerable period in healthcare delivery associated with medical errors, adverse events, increased costs and dissatisfied patients [1–7]. This may be attributed to multiple factors including a severely ill patient population requiring complex care, reduction in monitoring capacity outside the ICU, and the participation of multiple professionals with different norms and practices and the resulting communication failures [8].

In response to these challenges, hospitals have implemented critical care transition programs to provide support services for patients with resolving critical illness as their care is transitioned from the ICU to a hospital ward [9]. The structure and processes of programs vary, but include medical emergency teams, critical care outreach teams and ICU liaison nurse programs, which follow patients after discharge from ICU. A systematic review identified nine reports of before-and-after studies that suggested potential reductions in the risk of ICU readmission and hospital mortality following implementation of critical care transition programs [10]. While this literature is promising, methodological limitations of before-and-after studies, and the resource-intensive nature of transition programs, suggest further evaluation is warranted [10, 11].

We took advantage of a natural experiment [12] within a geographically defined healthcare system, where critical care transition teams were implemented in hospitals in one city, but not those of a nearby city with similar population demographics to compare readmission to ICU and mortality among patients discharged alive from ICU.

Materials and methods

We used a quasi-experimental design and interrupted time series analysis with a concurrent control group to evaluate whether readmission to ICU and mortality among patients discharged alive from ICU changed after implementation of a critical care transition program [11]. Study methods were conducted and reported in accordance with recommendations for interrupted time series analysis proposed by Jandoc et al. [13]. The Health Research Ethics Boards at the University of Calgary and University of Alberta approved this study.

Intervention

A critical care transition program was implemented in three hospitals between 2004 and 2006. The program comprised an independent (not involved in ICU care or discharge decision-making) multidisciplinary ICU team (physician, nurse, respiratory therapist) that provided standardized support services for all patients discharged from ICU to a hospital ward, 24 h per day 7 days per week. Following discharge, members of the team serially evaluated each patient a minimum of once every 12 h. The team operated in a consultative fashion providing the primary hospital ward team with advice and support, re-engaging the ICU provider team if needed and facilitating readmission of patients with clinical deterioration. Patients were followed for a minimum of two consecutive evaluations (24 h) and signed off when deemed stable.

Study population and setting

We identified consecutive adult patients discharged alive from eight medical-surgical ICUs in eight hospitals in two cities in Alberta, Canada, from January 1, 2002 to January 1, 2012, 2 years prior to implementation of the critical care transition program in the first hospital and 5 years after implementation of the program in the last hospital. The three hospitals located in one city implemented the same standardized critical care transition program (study group). The five hospitals located in the other city did not implement the program (control group). The study and control groups were selected because the two cities have similar metropolitan populations ($\sim$1.2 million) and the hospitals (8 hospitals, 129 ICU beds, 4529 hospital beds) are managed by the same organization, thereby controlling for potential confounding effects of geography, temporal trends within the healthcare system, and hospital characteristics. The ICUs are closed medical-surgical units, staffed by accredited intensive care physicians, and include vascular surgery, thoracic surgery, trauma and transplant (bone marrow in one study group ICU, liver in one control group ICU) patients.

Outcome measures

The primary outcome was readmission to ICU within 72 h of discharge from ICU. The secondary outcome was mortality within 14 days of ICU discharge. We chose these outcomes (and measurement time points) because they were the most commonly reported outcomes in previous studies of critical care transition programs, were objective and feasible to measure (whether preventable or not preventable), and measured at time points we believe maximized the likelihood of detecting any effect of implementing a critical care transition program [10, 14, 15]. We examined readmission to ICU within 7 days of discharge from ICU and mortality within 30 days of ICU as tertiary outcomes.

Data sources and study variables

We used data from two clinical and administrative databases that have previously been used for program evaluation and research [16, 17]. The ICU databases prospectively capture demographic, clinical, and outcome data for all patients admitted to and discharged from the ICU. The administrative databases capture data on all hospitalized patients, including vital status, dates of admission and discharge, up to 25 Canadian Enhancement of International Statistical Classification of Diseases, 10th Revision, diagnostic codes. We identified patient and hospital variables previously reported to be associated with readmission to ICU or mortality after patient discharge from ICU [8, 14].

Statistical analyses

We performed segmented linear regression analysis of interrupted time series data to test the hypothesis that implementation of a critical care transition program was associated with changes in readmission and mortality among patients discharged alive from ICU (SAS 9.3; SAS Institute, NC, USA). We restricted the analyses to patients' initial discharge from ICU within a given hospital stay because discharges following readmission are likely to be distinctly different in their processes and outcomes. We developed two models (one for readmission, one for mortality) that included terms that described the baseline trend and estimated changes in the level and trend of readmission/mortality after program implementation [18]. Data were aggregated into 3-month intervals (quarters) to allow for sufficient numbers of readmissions and deaths for stable estimates and adequate number of time points for interpreted time series analysis [18]. We used the segmented linear regression approach recommended by Wagner et al. [18] because insufficient time periods were available to allow for autoregressive integrated moving average models [19], and this approach is commonly used in health services research and amenable to intuitive graphical presentation [13, 20]. We excluded outcome values from the 3-month period during which the intervention was implemented to allow for a period of institutional adjustment prior to evaluation.

We used generalized estimating equation models to account for correlation among observations (i.e., practices within a given ICU/hospital) and to obtain quarterly rates of readmission/mortality adjusted for patient and hospital characteristics (Table 1) (backward elimination model building approach) [21–23]. We developed segmented linear regression models with the adjusted quarterly rates of readmission/mortality included as the dependent variable. A year variable (calendar year) and time of year variable (yearly quarters) were included in the models to account for potential secular trends [24]. Within each hospital, temporal time trends were evaluated and an interrupted time series analysis performed before data were merged into the study and control groups, which were analyzed separately. No evidence of secular trends was observed and interrupted time series analysis of individual hospitals was consistent with that of the aggregate cohort. There was no evidence of autocorrelation of the error terms in the regression models (Durbin–Watson statistic).

Pre-specified subgroup analyses were performed according to patient (reason for ICU admission, number of comorbidities, severity of illness, length of ICU stay) and hospital (tertiary vs. community) characteristics hypothesized to modify the association between a critical care transition program and readmission/mortality. Sensitivity analyses were conducted to evaluate the robustness of the findings by using aggregated raw data (instead of adjusted data), conducting segmented linear regression on the 95 % confidence intervals of the adjusted quarterly rates to account for uncertainty in the analyses, testing different models to evaluate potential lagged effects and aggregating data into 6-month intervals. At the request of the reviewers' hospital length of stay following ICU discharge was included as tertiary outcome measure and a subgroup analysis was performed according to the duration of mechanical ventilation.

Results

Study population

From January 1, 2002 to January 1, 2012, 32,234 patients were discharged alive from the eight medical-surgical ICUs to a hospital ward within the eight hospitals. The median age was 58 years [interquartile range (IQR) 45–72 years], 42 % were female, 71 % had one or more comorbidities, 57 % had a medical reason for ICU admission and a median admission APACHE II score of 19 (IQR 14, 24). The median length of ICU stay was 77 h (IQR 40–167) with 31 % of patients discharged between 1801 and 0759 hours. Patient characteristics were similar for both the study group ($n = 12{,}940$) and the control group (19,294) and the pre-implementation ($n = 12{,}432$) and post-implementation ($n = 19{,}802$) periods with a few exceptions (Table 1).

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Table 1 Patient and hospital characteristics

Characteristics	Study group		Control group	
	Pre-implementation ($n = 4872$)	Post-implementation ($n = 8068$)	Pre-implementation ($n = 7560$)	Post-implementation ($n = 11,734$)
Patient				
Age, median (IQR), years	58 (42,72)	58 (44,70)	61 (46,73)	59 (46,72)
Female	2069 (42 %)	3367 (42 %)	3192 (42 %)	4992 (43 %)
Comorbidities				
Congestive heart failure	678 (14 %)	968 (12 %)	1278 (17 %)	1504 (13 %)
Coronary artery disease	703 (14 %)	606 (8 %)	1217 (16 %)	1414 (12 %)
Chronic lung disease	951 (20 %)	1412 (18 %)	2295 (30 %)	3563 (30 %)
Diabetes	927 (19 %)	1744 (22 %)	1990 (26 %)	3128 (27 %)
Liver disease	315 (6 %)	611 (8 %)	679 (9 %)	1137 (10 %)
History of malignancy	636 (13 %)	1078 (13 %)	1051 (14 %)	1569 (13 %)
HIV	13 (0.3 %)	39 (0.5 %)	21 (0.3 %)	81 (0.7 %)
Neurological disease	571 (12 %)	783 (10 %)	671 (9 %)	862 (7 %)
Renal insufficiency	444 (9 %)	666 (8 %)	1038 (14 %)	1299 (11 %)
Any comorbidity	3195 (66 %)	5324 (66 %)	5763 (76 %)	8665 (74 %)
Charlson score[a], median (IQR)	2 (1,4)	2 (1,4)	2 (1,4)	2 (1,4)
Reason for ICU admission				
Medical	3136 (65 %)	5238 (65 %)	2782 (58 %)	7260 (62 %)
Surgical	1662 (35 %)	2807 (35 %)	2001 (42 %)	4474 (38 %)
APACHE II Score on ICU admission, median (IQR)	18 (13,24)	18 (13,24)	19 (15,24)	19 (14,24)
Hospital stay prior to ICU admission, median hours (IQR)	3 (0,37)	4 (1,29)	4 (0,32)	5 (0,35)
ICU length of stay, median hours (IQR)	73 (38,167)	87 (43,183)	73 (35,163)	76 (40,161)
Eligible for readmission to ICU according to patient goals of care on ICU discharge	4871 (100 %)	7832 (97 %)	NA	NA
APACHE II score on ICU discharge, median (IQR)	15 (11,19)	14 (10,18)	NA	NA
Hospital				
Time of year for discharge				
January–March	1032 (21 %)	1952 (24 %)	2133 (28 %)	2920 (25 %)
April–June	1339 (27 %)	2081 (26 %)	2192 (29 %)	2939 (25 %)
July–September	1296 (27 %)	2000 (25 %)	1546 (21 %)	2853 (24 %)
October–December	1205 (25 %)	2035 (25 %)	1689 (22 %)	3022 (26 %)
Day of week for discharge[b]				
Weekday	3545 (73 %)	6060 (75 %)	5620 (74 %)	8871 (76 %)
Weekend	1327 (27 %)	2008 (25 %)	1940 (26 %)	2863 (24 %)
Time of day for discharge				
08:00–18:00	3045 (63 %)	5131 (64 %)	5760 (75 %)	8529 (73 %)
18:01–07:59	1827 (37 %)	2937 (36 %)	1854 (25 %)	3205 (27 %)
Hospital type				
Community care	2106 (43 %)	4034 (50 %)	4628 (61 %)	7800 (66 %)
Tertiary care	2766 (57 %)	4034 (50 %)	2932 (39 %)	3934 (34 %)
Number of hospital beds				
<600	1467 (30 %)	2283 (28 %)	2001 (26 %)	3628 (31 %)
≥600	3405 (70 %)	5785 (72 %)	5559 (74 %)	8106 (69 %)
Number of ICU beds				
≤10	639 (13 %)	1751 (22 %)	2001 (26 %)	3628 (31 %)
>10	4233 (87 %)	6317 (78 %)	5559 (74 %)	8106 (69 %)

IQR interquartile range, *NA* not available

[a] Charlson score calculated among patients with one or more comorbidities

[b] Weekday defined Monday 0800 hours through Friday 1800 hours. Weekend defined Friday 1801 hours through Monday 0759 hours

Readmission to ICU

At the start of the study period, 3.7 % [95 % confidence interval (CI) 2.6 to 4.8 %] of patients in the study group and 4.2 % (95 % CI 3.1 to 5.2 %) of patients in the control group were readmitted to ICU within 72 h of discharge (Table 2; Fig. 1). After implementation of the critical care transition program, there was an immediate non-significant decrease in the absolute proportion of patients readmitted to ICU in the study group (−0.4 %, 95 % CI −1.7 to +1.0 %) and a non-significant increase in the absolute proportion of patients readmitted to ICU in

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Table 2 Time trends in readmission and mortality after patient discharge from ICU

	ICU readmission within 72 h, % (95 % CI)		Mortality within 14 days, % (95 % CI)	
	Study group	Control group	Study group	Control group
Beginning of study	3.7 (2.6, 4.8)	4.2 (3.1, 5.2)	4.8 (4.0, 5.6)	3.6 (2.8, 4.4)
Baseline trend change quarter-to-quarter	0.0 (−0.2, 0.1)	0.0 (−0.1, 0.1)	−0.1 (−0.2, 0.0)	0.1 (0.0, 0.2)
Immediate change post-implementation	−0.4 (−1.7, 1.0)	1.0 (−0.3, 2.2)	0.2 (−0.8, 1.1)	0.4 (−0.6, 1.4)
Change in trend post-implementation	0.1 (−0.1, 0.2)	−0.1 (−0.2, 0.1)	0.1 (0.0, 0.2)	−0.1 (−0.2, 0.0)
End of study	3.6 (2.7, 4.5)	3.6 (2.7, 4.5)	3.4 (2.8, 4.0)	4.2 (3.5, 4.9)

CI confidence interval

the control group (+1.0 %, 95 % CI −0.3 to +2.2 %). Subsequently, there were non-significant changes in the absolute proportion of patients readmitted to ICU in both the study (+0.1 % per quarter; 95 % CI −0.1 to +0.2 %) and control (−0.1 per quarter; 95 % CI −0.2 to +0.1 %) groups. At the end of the study, 3.6 % (95 % CI 2.7 to 4.5 %) of patients in both the study and control groups were readmitted to ICU within 72 h of discharge.

Mortality

At the start of the study period, 4.8 % (95 % CI 4.0 to 5.6 %) of patients in the study group and 3.6 % (95 % CI 2.8 to 4.4 %) of patients in the control group died within 14 days of discharge from ICU (Table 2; Fig. 1). After implementation of the critical care transition program, there were immediate non-significant increases in the absolute proportion of patients who died following discharge from ICU in both the study (+0.2 %, 95 % CI −0.8 % to 1.1 %) and control (+0.4 %, 95 % CI −0.6 to +1.4 %) groups. Subsequently, there was a non-significant increase in the absolute proportion of patients that died following ICU discharge in the study (+0.1 % per quarter; 95 % CI, 0.0 to +0.2 %, $p = 0.2984$) group and a significant decrease among those in the control (−0.1 per quarter; 95 % CI, −0.2 to 0.0 %, $p = 0.0236$) group. At the end of the study, 3.4 % (95 % CI, 2.8 to 4.0 %) of patients in the study group and 4.2 % (95 % CI 3.5 to 4.9 %) in the control group died within 14 days of discharge from ICU.

Secondary Analyses

The duration of hospital length of stay [median (IQR) days] following patient discharge from ICU was similar in the study (9 [4, 22] versus 10 [4, 24]) and control (9 [5, 20] versus 10 [5, 22]) groups before and after implementation of the critical care transition programs. Figure 2 summarizes the results of the subgroup analyses. Results were similar when analyses were stratified according to reason for ICU admission, severity of illness, comorbidities, duration of mechanical ventilation, length of ICU stay, and type of hospital. Evaluation of readmission at 14 days after ICU discharge and mortality 28 days after ICU discharge produced similar results.

Sensitivity analyses

The results were robust to sensitivity analyses that included using aggregated raw data (Supplementary File Table 1 and Fig. 1), conducting segmented linear regression on the 95 % confidence intervals of the adjusted quarterly rates to account for uncertainty in the analyses (Supplementary File Fig. 2), testing different models to evaluate potential lagged effects (Supplementary File Table 2) and aggregating data into 6-month intervals.

Discussion

We found that implementing a critical care transition program that employed a multidisciplinary ICU team to serially evaluate patients discharged from ICU was not associated with patient readmission to ICU or mortality. The results were stable across a number of subgroup and sensitivity analyses. Our study raises questions about the effectiveness of critical care transition programs to improve the quality of care for patients discharged from ICU.

Critical care transition programs have been widely implemented. A survey in England reported the proportion of hospitals with a critical care transition program increased from 3 % in 1996 to 78 % in 2004 [25]. Studies employing qualitative methods have suggested these programs improve quality of patient care and comfort among less experienced ward nurses [26, 27]. Studies employing quantitative methods have reported mixed results. Gao et al. conducted an interrupted time-series analysis comparing a 1-month period before and a 3-month period after implementation of critical care outreach services that included a transition program and reported no significant change in readmission to ICU within 48 h of discharge or hospital mortality [28]. A

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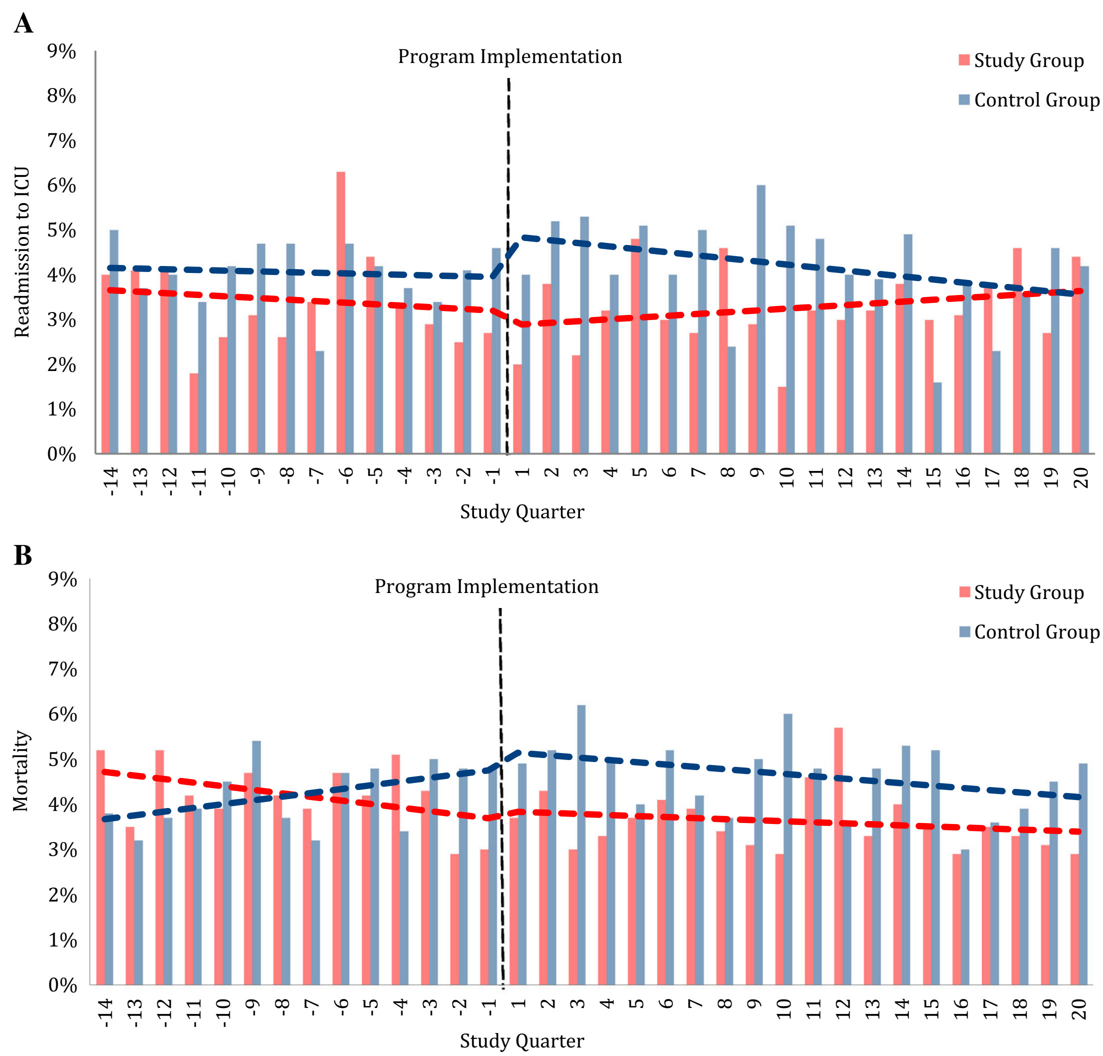

* Data are provided by quarter. Bars indicate the adjusted proportion of events per quarter; dashed horizontal lines the adjusted overall mean; the black dashed lines the quarter in which the critical care transition program was implemented.

† Patients discharged within 3 months of program implementation (study quarter 0) were excluded from analysis to allow for a period of institutional adjustment prior to evaluation.

Fig. 1 Trends in patient outcomes over time. **a** Readmission to ICU within 72 h of discharge. **b** Mortality within 14 days of discharge from ICU

systematic review and meta-analysis of nine before-and-after designed studies by Niven et al. reported a significant reduction in the risk of ICU readmission, but not hospital mortality following implementation of a critical care transition program [10]. Benefits appeared to be stable across different program structures.

Why did we find no significant impact of implementing a critical care transition program on ICU readmission and mortality among patients discharged alive from ICU? Several possible explanations need to be considered. First, perhaps the literature has been overly optimistic in previous evaluations, most studies employing before-and-after study designs in single hospitals that are at increased risk of bias [11]. Second, perhaps we studied the wrong patient population, although subgroup analyses restricted to patients with the largest number of comorbidities, highest acuity of illness and longest durations of mechanical ventilation and ICU stay produced similar results. Third, perhaps the program employed the wrong intervention. The ICU discharge process is

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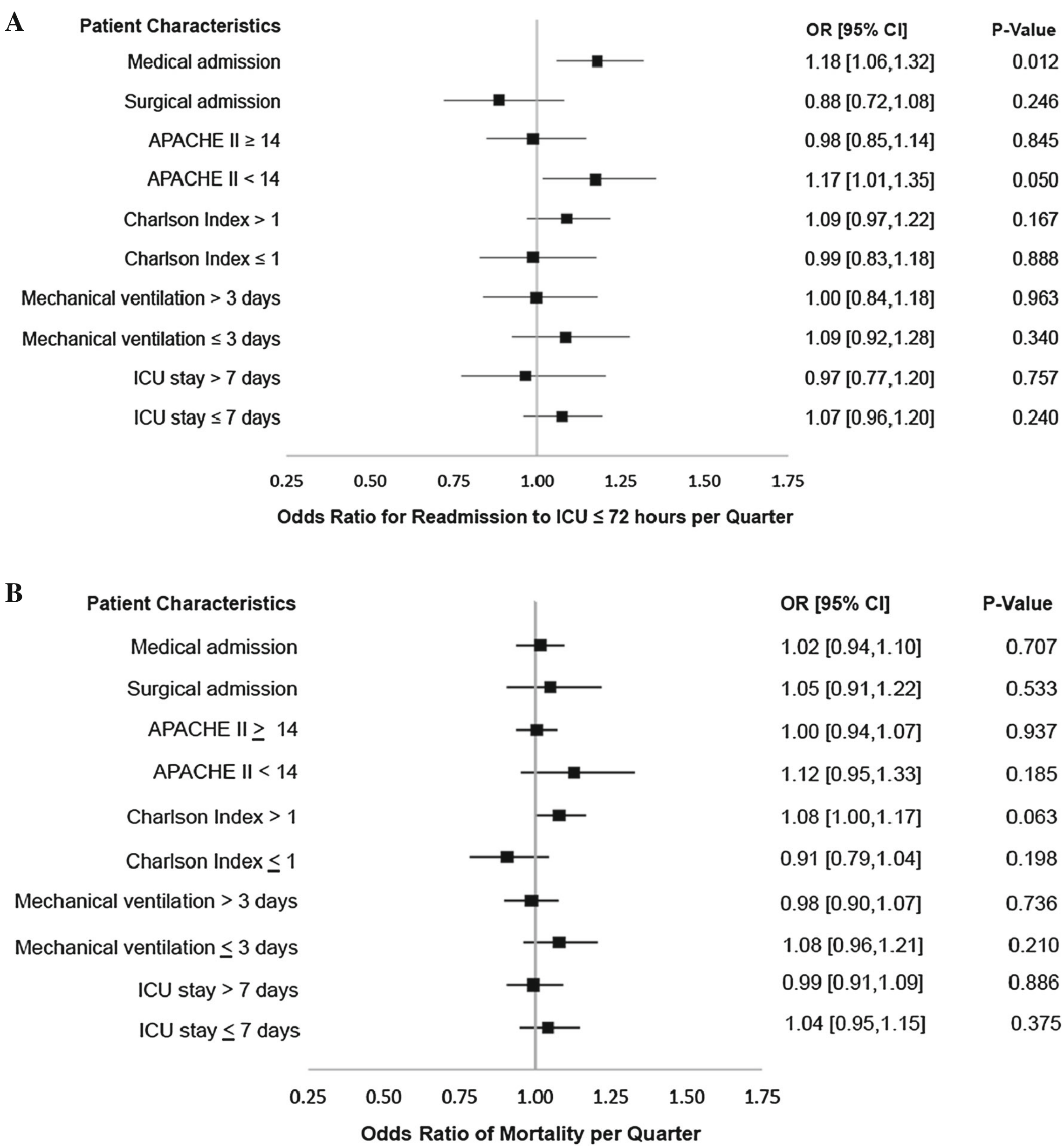

* Each OR represents the (multivariable adjusted) quarterly change in the odds of readmission to ICU (mortality) after implementation of the critical care transition program in the study group; an OR greater than 1 indicates increasing odds of readmission to ICU (mortality) over time and an OR of less than 1 reflects decreasing odds of readmission to ICU (mortality) over time. P values refer to the significance of the interaction between the given subgroup and time.

† APACHE II score calculated on the day of patient discharge from ICU.

Fig. 2 Patient characteristics associated with changes in the odds of readmission to ICU and mortality after implementation of the critical care transition program. **a** Readmission to ICU within 72 h of discharge. **b** Mortality within 14 days of discharge from ICU

complex [8], it may be unrealistic to expect a single health service intervention to meaningfully impact care [29] and different combinations of interventions and implementation strategies tailored to local needs may be needed [30]. And fourth, perhaps we measured the wrong outcomes. Although ICU readmission and mortality are

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common, practical and objective metrics [15], they may not be sufficiently sensitive to detect important changes in care or sufficiently specific to detect effects of a critical care transition program and may be disproportionally influenced by patient (e.g., natural history of illness), and hospital (e.g., organization of ward care) factors. It is unclear what proportion of ICU readmissions and deaths can be avoided by preventing errors, facilitating continuity of care, providing early detection and management of clinical deterioration, and not offering readmission to patients unlikely to benefit. In which case, what clinically important measures should be considered when evaluating the care of patients discharged from ICU—adverse events, patient/family reported experiences, lengths of stay, hospital readmissions?

What should hospitals do with the data presented? We believe that organizations should evaluate the effectiveness of their own critical care transition programs. These are resource-intensive initiatives and if ineffective represent important opportunity costs [31]. A more effective strategy may be to consider multi-dimensional approaches that could include: (1) risk stratification to estimate individual patient risk and guide discharge decision making; [14] (2) goals of care reconciliation to help patients and their families review goals of care before ICU discharge and ensure that treatment plans are consistent with patients' clinical circumstances and preferences; [32] (3) synthesis and communication of data for providers to present and prioritize patient information in a standardized fashion to highlight urgent issues and avoid redundant tests and treatments; [33, 34] (4) synthesis and communication of data for patients and families to provide a patient-centered record that contains essential information about the patient's health and healthcare and engages and empowers patients/families in the transition process; [35] (5) patient needs assessment to facilitate early institution of appropriate evaluations (e.g., mobility) and supports (e.g., walking assists) to facilitate recovery; [36] and (6) transfer checklist to standardize the ICU discharge process and ensure that all essential steps are completed before patients leave the ICU [37]. Many of these elements have been individually developed, tested and implemented by organizations [8], but combining them into a coordinated complex intervention that is tailored to the needs of individual institutions may be more effective [29].

Our study needs to be interpreted within the context of its limitations. First, we have no data on the care provided by the critical care transition program (i.e., number, duration and nature of visits). The structure and processes for the program were standardized, but our study evaluated the effectiveness (not efficacy) of the program in a real world context. Second, despite evaluating over 30,000 patients, we are not able to exclude small, but clinically important changes in patient outcomes. For example, the adjusted 95 % CIs included an immediate post-implementation absolute reduction of 1.7 % in readmission to ICU and 0.8 % in mortality. These observations are in the context of relatively low baseline proportions of patients being readmitted to ICU or dying and therefore potentially limit opportunities for improvement. Third, although we used a robust quasi-experimental design with a concurrent control group, it is possible that other activities may have occurred during the study that could have affected the readmission of patients to ICU and mortality. A more robust study design would be a cluster randomized control study, which is unlikely to be conducted in the near future [11]. And fourth, our study was performed in hospitals using an intensive care physician-led model of ICU care within a publicly funded healthcare system. Allocation of resources and processes for ICU discharge may vary across healthcare jurisdictions; therefore, the results may not apply to other institutions. However, the challenges of safely transitioning patients from the ICU to the hospital ward are likely common across healthcare organizations [8].

Conclusions

In summary, we found that implementation of a critical care transition program that employed a multidisciplinary ICU team to serially evaluate each patient discharged from ICU until they were deemed stable was not associated with patient readmission to ICU or mortality. These results raise questions about the effectiveness of critical care transition programs to improve the quality of care for patients discharged from ICU. We recommend that hospitals evaluate the effectiveness of their own programs and consider alternative strategies to address the multi-dimensional challenges of ICU discharge.

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Compliance with ethical standards

Conflicts of interest Funding sources had no role in the design, conduct, or reporting of this study and we are unaware of any conflicts of interest.

References

1. Bell CM, Brener SS, Gunraj N, Huo C, Bierman AS, Scales DC, Bajcar J, Zwarenstein M, Urbach DR (2011) Association of ICU or hospital admission with unintentional discontinuation of medications for chronic diseases. JAMA 306:840–847
2. Eijsbroek H, Howell DC, Smith F, Shulman R (2013) Medication issues experienced by patients and carers after discharge from the intensive care unit. J Crit Care 28:46–50
3. McLaughlin N, Leslie GD, Williams TA, Dobb GJ (2007) Examining the occurrence of adverse events within 72 hours of discharge from the intensive care unit. Anaesth Intensive Care 35:486–493
4. Horwitz LI, Moin T, Krumholz HM, Wang L, Bradley EH (2008) Consequences of inadequate sign-out for patient care. Arch Intern Med 168:1755–1760
5. Li P, Stelfox HT, Ghali WA (2011) A prospective observational study of physician handoff for intensive-care-unit-to-ward patient transfers. Am J Med 124:860–867
6. Coleman EA, Berenson RA (2004) Lost in transition: challenges and opportunities for improving the quality of transitional care. Ann Intern Med 141:533–536
7. Kahn JM, Angus DC (2011) Going home on the right medications: prescription errors and transitions of care. JAMA 306:878–879
8. Stelfox HT, Lane D, Boyd JM, Taylor S, Perrier L, Straus S, Zygun D, Zuege DJ (2015) A scoping review of patient discharge from intensive care: opportunities and tools to improve care. Chest 147:317–327
9. Chaboyer W, James H, Kendall M (2005) Transitional care after the intensive care unit: current trends and future directions. Critical Care Nurse 25:16–18 **(20–12, 24–16 passim; quiz 29)**
10. Niven DJ, Bastos JF, Stelfox HT (2014) Critical care transition programs and the risk of readmission or death after discharge from an ICU: a systematic review and meta-analysis. Crit Care Med 42:179–187
11. Shadish WR, Cook TD, Campbell DT (2002) Experimental and quasi-experimental de- signs for generalized causal inference. Houghton-Mifflin, Boston
12. Dunning T (2012) Natural Experiments in the Social Sciences: A Design-Based Approach. Cambridge University Press, Cambridge
13. Jandoc R, Burden AM, Mamdani M, Levesque LE, Cadarette SM (2015) Interrupted time series analysis in drug utilization research is increasing: systematic review and recommendations. J Clin Epidemiol 68(8):950–956
14. Hosein FS, Bobrovitz N, Berthelot S, Zygun D, Ghali WA, Stelfox HT (2013) A systematic review of tools for predicting severe adverse events following patient discharge from intensive care units. Crit Care 17:R102
15. Hosein F, Roberts DJ, Turin T, Zygun D, Ghali WA, Stelfox HT (2014) A meta-analysis to derive literature-based benchmarks for readmission and hospital mortality after patient discharge from intensive care. Crit Care 18:2558
16. Chiasson TC, Manns BJ, Stelfox HT (2009) An economic evaluation of venous thromboembolism prophylaxis strategies in critically ill trauma patients at risk of bleeding. PLoS Med 6:e1000098
17. Stelfox HT, Hemmelgarn BR, Bagshaw SM, Gao S, Doig CJ, Nijssen-Jordan C, Manns B (2012) Intensive care unit bed availability and outcomes for hospitalized patients with sudden clinical deterioration. Arch Intern Med 172:467–474
18. Wagner AK, Soumerai SB, Zhang F, Ross-Degnan D (2002) Segmented regression analysis of interrupted time series studies in medication use research. J Clin Pharm Ther 27:299–309
19. Carroll N (2008) Application of segmented regression analysis to the Kaiser Permanente Colorado Critical drug interaction program. Proceedings of the Fifthteenth Annual Western Users of SAS Software Conference. Universal City, California, USA, 5–7 November, 2008
20. Zhang F, Wagner AK, Soumerai SB, Ross-Degnan D (2009) Methods for estimating confidence intervals in interrupted time series analyses of health interventions. J Clin Epidemiol 62:143–148
21. Zeger SL, Liang KY (1986) Longitudinal data analysis for discrete and continuous outcomes. Biometrics 42:121–130
22. Carlin JB, Wolfe R, Brown CH, Gelman A (2001) A case study on the choice, interpretation and checking of multilevel models for longitudinal binary outcomes. Biostatistics 2:397–416
23. Hu FB, Goldberg J, Hedeker D, Flay BR, Pentz MA (1998) Comparison of population-averaged and subject-specific approaches for analyzing repeated binary outcomes. Am J Epidemiol 147:694–703
24. Carroll N (2006) Application of segment regression analysis to the Kaiser Permanente Colorado Critical Drug Interaction Program. Proceedings of the Fifthteenth Annual Western Users of SAS Software Conference. Universal City, California, USA, 5–7 November, 2008
25. McDonnell A, Esmonde L, Morgan R, Brown R, Bray K, Parry G, Adam S, Sinclair R, Harvey S, Mays N, Rowan K (2007) The provision of critical care outreach services in England: findings from a national survey. J Crit Care 22:212–218
26. Plowright C, Fraser J, Smith S, Buras-Rees S, Dennington L, King D, MacLellan C, Seymour P, Scott G, Brindle A (2006) Perceptions of critical care outreach within a network. Nurs Time 102:36–40
27. Athifa M, Finn J, Brearley L, Williams TA, Hay B, Laurie K, Leen T, O'Brien K, Stuart M, Watt M, Leslie G (2011) A qualitative exploration of nurse's perception of Critical Outreach Service: a before and after study. Aust Crit Care 24:39–47
28. Gao H, Harrison DA, Parry GJ, Daly K, Subbe CP, Rowan K (2007) The impact of the introduction of critical care outreach services in England: a multicentre interrupted time-series analysis. Crit Care 11:R113
29. Medical Research Council (2000) Developing and evaluating complex interventions: new guidance. MRC, London
30. Leape LL (2014) The checklist conundrum. New Engl J Med 370:1063–1064
31. Bonafide CP, Localio AR, Song L, Roberts KE, Nadkarni VM, Priestley M, Paine CW, Zander M, Lutts M, Brady PW, Keren R (2014) Cost-benefit analysis of a medical emergency team in a children's hospital. Pediatrics 134:235–241
32. Heyland DK, Barwich D, Pichora D, Dodek P, Lamontagne F, You JJ, Tayler C, Porterfield P, Sinuff T, Simon J (2013) Failure to engage hospitalized elderly patients and their families in advance care planning. JAMA Intern Med 173:778–787

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33. Starmer AJ, Spector ND, Srivastava R, West DC, Rosenbluth G, Allen AD, Noble EL, Tse LL, Dalal AK, Keohane CA, Lipsitz SR, Rothschild JM, Wien MF, Yoon CS, Zigmont KR, Wilson KM, O'Toole JK, Solan LG, Aylor M, Bismilla Z, Coffey M, Mahant S, Blankenburg RL, Destino LA, Everhart JL, Patel SJ, Bale JF Jr, Spackman JB, Stevenson AT, Calaman S, Cole FS, Balmer DF, Hepps JH, Lopreiato JO, Yu CE, Sectish TC, Landrigan CP, Group IPS (2014) Changes in medical errors after implementation of a handoff program. New Engl J Med 371:1803–1812
34. Romano MJ, Segal JB, Pollack CE (2015) The association between continuity of care and the overuse of medical procedures. JAMA Intern Med 175:1148–1154
35. Rao JK, Anderson LA, Inui TS, Frankel RM (2007) Communication interventions make a difference in conversations between physicians and patients: a systematic review of the evidence. Med Care 45:340–349
36. Walsh TS, Salisbury LG, Merriweather JL, Boyd JA, Griffith DM, Huby G, Kean S, Mackenzie SJ, Krishan A, Lewis SC, Murray GD, Forbes JF, Smith J, Rattray JE, Hull AM, Ramsay P, Investigators R (2015) Increased hospital-based physical rehabilitation and information provision after intensive care unit discharge: the RECOVER randomized clinical trial. JAMA Intern Med 175:901–910
37. Gawande A (2010) The checklist manifesto: how to get things right. Profile, London

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