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Multidisciplinary Critical Care and Intensivist Staffing: Results of a Statewide Survey and Association With Mortality

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Abstract

Purpose: The role of multidisciplinary teams in improving the care of intensive care unit (ICU) patients is not well defined, and it is unknown whether the use of such teams helps to explain prior research suggesting improved mortality with intensivist staffing. We sought to investigate the association between multidisciplinary team care and survival of medical and surgical patients in nonspecialty ICUs. **Materials and Methods:** We conducted a community-based, retrospective cohort study of data from 60 330 patients in 181 hospitals participating in a statewide public reporting initiative, the California Hospital Assessment and Reporting Taskforce (CHART). Patient-level data were linked with ICU organizational data collected from a survey of CHART hospital ICUs between December 2010 and June 2011. Clustered logistic regression was used to evaluate the independent effect of multidisciplinary care on the in-hospital mortality of medical and surgical ICU patients. Interactions between multidisciplinary care and intensity of physician staffing were examined to explore whether team care accounted for differences in patient outcomes. **Results:** After adjustment for patient characteristics and interactions, there was no association between team care and mortality for medical patients. Among surgical patients, multidisciplinary care was associated with a survival benefit (odds ratio 0.79; 95% confidence interval (CI), 0.62-1.00; $P = .05$). When stratifying by intensity of physician staffing, although the lowest odds of death were observed for surgical patients cared for in ICUs with multidisciplinary teams and high-intensity staffing (odds ratio, 0.77; 95% CI, 0.55-1.09; $P = .15$), followed by ICUs with multidisciplinary teams and low-intensity staffing (odds ratio 0.84, 95% CI 0.65-1.09, $p = 0.19$), these differences were not statistically significant. **Conclusions:** Our results suggest that multidisciplinary team care may improve outcomes for critically ill surgical patients. However, no relationship was observed between intensity of physician staffing and mortality.

Keywords

ICU outcomes, multidisciplinary critical care, ICU organization, ICU staffing

A large body of literature focusing on structural aspects of intensive care has shown that care directed by critical care-trained physicians (intensivists) improves patient survival.[1] This observation has lent support to policy initiatives for quality in the intensive care unit (ICU) such as Leapfrog intensivist physician standard.[2] However, more recent studies examining the association between intensivist staffing and mortality have had mixed results.[3-6] For example, Wallace et al recently showed that increased exposure to an intensivist at night conferred no additional survival benefit, and Levy et al found that the odds of hospital mortality were higher for those patients managed by intensivists than those who were not.[7,8] A possible explanation for this pattern of results is that other structural factors mediate or modify the influence of intensivist staffing on patient outcomes.

One potential complement to intensivist care is the multidisciplinary team model of care[9,10] or care provided by a coordinated group of practitioners that may include physicians, nurses, pharmacists, respiratory therapists, or other critical care staff. Although this team model of ICU care is endorsed by the

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Society of Critical Care Medicine and the Joint Commission,[11,12] few data provide empirical evidence of its impact on patient outcomes. In an analysis limited to noncardiac, nonsurgical patients, Kim and colleagues used administrative data to show that the apparent 30-day survival benefit of intensivist-led care models was largely explained by multidisciplinary care.[13] The objective of our study was to examine the independent impact of multidisciplinary care on the in-hospital mortality of not only medical but also surgical ICU patients. As a secondary aim, we also sought to evaluate whether the presumed benefit of intensivist staffing could be explained by multidisciplinary care in each patient group. We hypothesized that intensivist-led multidisciplinary care would be associated with improved survival.

Materials and Methods

Study Setting and Patient Data

We conducted a retrospective cohort study using patient data from a community-based sample of 181 hospitals participating in a statewide public reporting initiative, the California Hospital Assessment and Reporting Taskforce (CHART). CHART is a nonprofit organization that convenes clinicians, hospital leaders, insurers, purchasers, and patients to decide what aspects of hospital care will be publicly reported by California hospitals. The ICU performance used in this study was reported to CHART by volunteer hospitals from January through December 2010. Each hospital reports on the first 100 consecutively discharged patients each quarter. Collectively, CHART hospitals had 85% of discharges from all California acute care hospitals in this time frame. The CHART board approved participation of the hospitals in the study.

CHART uses the patient-level variables in the Mortality Probability Model (MPM_0-III) to risk-adjust mortality rates but recalibrates the model's coefficients with each reporting period. Risk-adjustment variables include 3 physiologic variables within 1 hour of ICU admission, 3 acute and 5 chronic diagnoses, age, cardiopulmonary resuscitation within 24 hours of ICU admission, mechanical ventilation within 1 hour of ICU admission, medical or unscheduled surgical admission, and variables adjusting for "zero factor" (ie, no risk factors other than age) and full code status.[14] Data are collected by trained abstractors and are periodically audited for accuracy. Data abstractors at each hospital also collected information on the ICU type to which each patient was admitted and whether or not a patient received surgery prior to ICU admission. This enabled distinction between medical and surgical patients in the participating ICUs.

Intensive Care Unit Organizational Data

In order to gather information on the participating ICUs' care models, we developed a 34-question, web-based survey using examples of similar instruments from previous studies as guides.[8,15-17] Our instrument was pretested for face and content validity with a group of 8 critical care nurse practitioners, fellows, and attending physicians. Cognitive interviewing[18] was conducted with 5 additional ICU providers. Finally, the survey was reviewed by a committee of California clinicians and 2 experts in the field of ICU health services research. Informed consent was obtained from survey respondents at the time of distribution.

Of the 195 California hospitals submitting patient-level data to CHART in 2010, 3 were excluded for having no patient data abstracted from a self-reported medical ICU (MICU), surgical ICU (SICU), or mixed medical–surgical ICU (M/SICU). The survey was subsequently administered to a physician or nurse director from each of the MICUs, SICUs, and M/SICUs in the remaining 192 hospitals between December 2010 and June 2011. More specialized units (eg, burn units) were not studied because the number of such units would be small, and MPM mortality predictions may be less accurate in highly specialized units.[19] Completed survey responses were obtained from at least 1 ICU in 181 (94%) hospitals.

Respondents were asked to indicate whether their ICU was open, closed, or mixed, and, if open or mixed, to choose from mandatory, elective, or selective intensivist consultation. The ICUs were classified as high-intensity (closed or mandatory intensivist consultation) or low-intensity (all other models), consistent with previous research.[1] Respondents were next asked whether a multidisciplinary care team "comprised of physicians and other health care professionals" rounded on ICU patients ("yes" or "no"). In an effort to gather more descriptive information on team composition, we asked respondents to specify selected team members who rounded and their frequency of participation in rounds. However, the base training of the physicians who directed rounds (eg, pulmonary, surgery, or emergency) was not known. To account for different care models for medical and surgical patients in any 1 ICU, survey questions were asked about each patient group separately within every ICU.

Statistical Analysis

To compare characteristics of responding and nonresponding hospitals, we used Fisher exact test or chi-square, and Wilcoxon rank-sum test or t test, as appropriate. We adjusted for patient factors outlined in the MPM_0-III[14] and used generalized estimating equations with robust standard errors to account for unit-level clustering. We created 2 models examining the effects of multidisciplinary team care alone and intensivist staffing alone in medical and surgical patients. We also controlled for ICU and hospital characteristics such as ICU type, hospital size, and teaching status in fully adjusted models. To account for heterogeneity in the definition of multidisciplinary care, we conducted 1-way sensitivity analyses, varying both the participants and frequency of rounding by core team members, thereby defining various team constructs as predictors for the team care variable. Then, to explore the secondary hypothesis that the degree of association between multidisciplinary team care and mortality varied according to whether or not an intensivist also contributed to

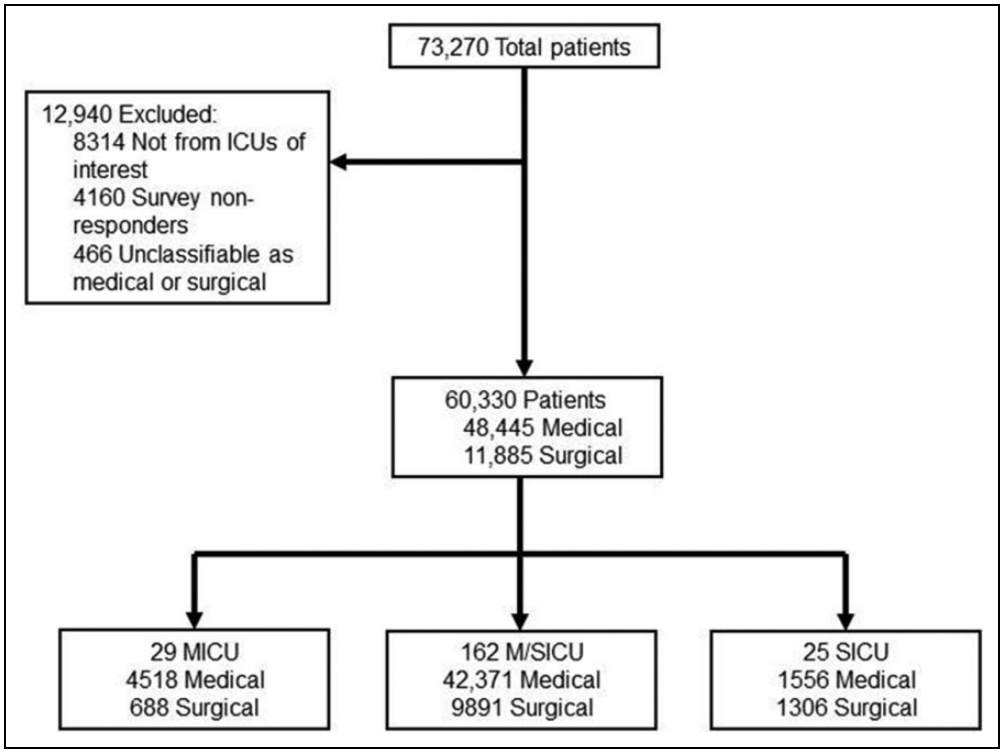

Figure 1. Patient Flow Chart

care, we created a third model to evaluate for interaction between team care and intensivist staffing for each patient group.

All analyses were performed with Stata 11.1 (StataCorp, College Station, Texas). This project was approved by the Committee for Human Research at the University of California, San Francisco (10-02767). A P value of $\leq .05$ was considered significant.

Results

In 2010, 73 270 patients from 195 hospitals composed our total patient cohort (Figure 1). We excluded patients who were not admitted to the 3 ICU types of interest and from 15 ICUs in 11 hospitals with survey nonresponse. After further excluding patients who could not be classified as medical or surgical, the study cohort consisted of 60 330 patients from 216 ICUs in 181 hospitals. Of these, 48 445 (80%) were medical patients and 11 885 (20%) were surgical patients. Patient characteristics are presented in Table 1. Medical patients were more likely to present with acute nonrespiratory organ dysfunction and chronic organ failure, whereas surgical patients were more likely to require acute mechanical ventilation. No patients were missing an outcome. The mean observed hospital mortality rate for all patients was 12%.

Hospital characteristics by response to survey are summarized in Table 2. Information on multidisciplinary care was missing from 4 hospitals for medical patients and from 5 hospitals for surgical patients. In all, 3 ICUs from 2 hospitals were missing an intensity of staffing response for medical patients, and 2 ICUs from 2 hospitals were missing an intensity of staffing response for surgical patients.

Overall, 153 (74%) ICUs had multidisciplinary team care for medical patients and 148 (71%) ICUs had such care for surgical patients. High-intensity staffing was more common for medical patients than for surgical patients (37% and 22% of ICUs, respectively). Additional members of multidisciplinary teams and their frequency of participation in rounds are shown in Supplementary Table S1. In all, 69 (45%) of the 153 ICUs with multidisciplinary care for medical patients also had high-intensity medical staffing and 44 (30%) of the 148 ICUs with multidisciplinary care for surgical patients also had high-intensity surgical staffing (Table 3). Both multidisciplinary care and high-intensity physician staffing were more common in Accreditation Council for Graduate Medical Education (ACGME) residency-sponsoring hospitals and in larger hospitals. The combination of multidisciplinary care and high-intensity staffing was more common in MICUs and SICUs than in mixed M/SICUs.

In multivariate analysis, there was no association between team care alone and mortality for medical patients (Table 4). Similarly, there was no association between high-intensity staffing alone and mortality for either medical or surgical patients. For surgical patients cared for by a multidisciplinary team, however, there was a 21% reduction in the odds of death (Table 4, adjusted odds ratio [AOR] 0.79; 95% confidence interval [CI] 0.62-1.00). Adjustment for hospital and ICU characteristics did not significantly change the direction of the findings in this patient group (AOR 0.80; 95% CI 0.63-1.02). There was substantial variability in both the definition of a multidisciplinary

Table 1. Patient Characteristics.[a]

Variable	Medical Patients	Surgical Patients	*P* Value
Age, mean (SD)	63.9 ± 17.8	64.8 ± 16.3	<.001
Full code, %	90.5	96.3	<.001
Mechanical ventilation within 1 hour of ICU, %	23.6	31.1	<.001
Acute diagnoses, %			
Acute renal failure	18.5	7.5	<.001
Cardiac dysrhythmia	17.8	8.1	<.001
Cerebrovascular incident	7.1	2.1	<.001
Chronic diagnoses, %			
Chronic renal failure	10.6	6.1	<.001
Cirrhosis	2.4	0.9	<.001
Metastatic neoplasm	6.5	12.3	<.001
CPR within 24 hours before ICU, %	4.4	1.4	<.001
Unadjusted in-hospital mortality	13.5	5.7	<.001

Abbreviations: SD, standard deviation; ICU, intensive care unit; CPR, cardiopulmonary resuscitation.
[a] Chi-square used for categorical variables and *t* test for continuous variables.

Table 2. Hospital Characteristics[a] by Response to Survey.[b]

Characteristics	Responders (n = 181)	Nonresponders (n = 11)	*P* Value[c]
Total hospital beds			
<100	19 (10)	2 (18)	.7
100-400	123 (68)	7 (64)	
≥400	39 (22)	2 (18)	
Control			
Nonprofit	134 (73)	8 (73)	.9
Public	24 (13)	2 (18)	
Investor	23 (13)	1 (9)	
California region			
Northern	51 (28)	6 (55)	.2
Central	39 (22)	1 (9)	
Southern	91 (50)	4 (36)	
ACGME residency sponsoring institution	45 (25)	1 (9)	.5
Joint commission hospital accreditation	172 (95)	11 (100)	.4
Total ICU beds	30.9 ± 26.8	23.9 ± 17.5	.5

Abbreviations: SD, standard deviation; ICU, intensive care unit.
[a] Values are given as No (%) or mean ± SD. Percentages may not sum to 100 due to rounding.
[b] n = 192.
[c] Fisher exact test or chi-square used for categorical variables and Wilcoxon rank sum test or *t* test for continuous variables.

Table 3. Number and Percentage of ICUs With MDC by Intensity of Physician Staffing.

	Medical Patients			Surgical Patients		
	Number (%) of MICUs with MDC	Number (%) of M/SICUs with MDC	Number (%) of SICUs with MDC	Number (%) of MICUs with MDC	Number (%) of M/SICUs with MDC	Number (%) of SICUs with MDC
Low intensity	7 (32)	66 (57)	9 (60)	8 (57)	82 (72)	13 (65)
High intensity[a]	15 (68)	48 (41)	6 (40)	6 (43)	31 (27)	7 (35)
Unknown	0 (0)	2 (2)	0 (0)	0 (0)	1 (1)	0 (0)
Total	22 (100)	116 (100)	15 (100)	14 (100)	114 (100)	20 (100)

Abbreviations: ICU, intensive care unit; MICUs, medical intensive care units; SICUs, surgical intensive care units; M/SICUs, mixed medical–surgical intensive care units; MDC, multidisciplinary team care.
[a] Closed or mandatory intensivist consultation.

Table 4. Adjusted Associations[a] Between Structural Predictors and Mortality by Patient Type.

Model	Predictor	OR (95% CI)	*P* Value
Multidisciplinary team care alone			
Medical patients	No multidisciplinary care	1 (reference)	
	Multidisciplinary care	0.98 (0.87-1.11)	.80
Surgical patients	No multidisciplinary care	1 (reference)	
	Multidisciplinary care	0.79 (0.62-1.00)	.05
Intensity of physician staffing alone			
Medical patients	Low intensity	1 (reference)	
	High intensity	1.04 (0.92-1.17)	.52
Surgical patients	Low intensity	1 (reference)	
	High intensity	0.92 (0.69-1.22)	.56
Interaction between multidisciplinary care and intensity of physician staffing			
Medical patients			.57
Surgical patients			.02
	No multidisciplinary care and low intensity	1 (reference)	
	Multidisciplinary care and low intensity	0.84 (0.65-1.09)	.19
	No multidisciplinary care and high intensity		[b]
	Multidisciplinary care and high intensity	0.77 (0.55-1.09)	.15

Abbreviations: CI, confidence interval; OR, odds ratio; MPM_0-III, Mortality Probability Model.
[a] Estimates are adjusted for variables in the recalibrated MPM_0-III.
[b] Too few hospitals (2) to accurately estimate outcomes.

team and the frequency of team members' presence on rounds. As a result, sample sizes for each particular type of team construct were small. The most common team construct for critically ill surgical patients consisted of a physician, nurse, pharmacist, and respiratory therapist who rounded together at least 5 days per week in 34 (23%) ICUs and less than 5 days per week in 16 (11%) ICUs. With these small sample sizes, we were unable to show a distinct survival benefit attributable to any one team construct.

There was evidence supporting an interaction between intensity of physician staffing and multidisciplinary care for surgical patients ($P = .02$), but not for medical patients ($P = .57$). Additional support for this interaction was demonstrated by assessing the 3-way interaction between team care, intensity of physician staffing, and patient type ($P = .002$). When we simultaneously evaluated multidisciplinary care teams and high-intensity physician staffing in a stratified model, the lowest observed odds of death were for surgical patients cared for in ICUs with both high-intensity staffing and multidisciplinary care (Table 4, AOR 0.77; 95% CI 0.55-1.09, $P = .15$), followed by ICUs with multidisciplinary care teams and low-intensity staffing (AOR 0.84, 95% CI 0.65-1.09, $P = .19$), although these results did not reach statistical significance.

Discussion

To our knowledge, our study is the first to characterize the association between multidisciplinary team care, intensivist care, and survival in both medical and surgical ICU patients. In our statewide, community-based sample of hospitals, we found that surgical patients benefited from care provided by a multidisciplinary critical care team. However, high-intensity staffing in conjunction with team care provided no additional survival benefit.

Several mechanisms may explain these results. Multidisciplinary rounds may help to reduce ICU complications through adherence to evidence-based preventative measures.[20,21] Team care may also facilitate assessment and management of commonly encountered ICU conditions such as mechanical ventilation and delirium.[22,23] The presence of pharmacists on ICU rounds has been associated with fewer adverse drug events, which may have an impact on mortality.[24-26] The participation of nurses on rounds may maximize patient safety by ensuring thorough communication of patient status to other providers.[27,28] Effective communication may then foster an open, collaborative approach to critical care delivery that results in improved patient outcomes.[29]

However, the reasons for the observed benefit of the team care model only in surgical ICU patients are unclear. We were unable to replicate the results of Kim et al showing that daily rounds by a multidisciplinary team was associated with lower mortality in medical ICU patients.[13] Our use of in-hospital mortality rather than their 30-day mortality may have resulted in discharge bias,[30-32] as there is variation in long-term acute care facility transfer rates[33,34] that may favor the transfer of medical patients with chronic critical illness, thereby improving hospital mortality indices. It is also possible that standardized care protocols for medical critical illness (eg, acute respiratory distress syndrome and sepsis) are more widely implemented.[35] The use of such well-established house staff, nurse, or respiratory therapy-driven protocols in the care of medical ICU patients may, over time, have supplanted the advantage conferred by the mere presence of a multidisciplinary team in this patient group.[35-39] In contrast, surgical patients may be less frequently exposed to standardized ICU care protocols and therefore derive greater benefit from the best clinical practices that are facilitated by multidisciplinary rounds.

Little is known about the optimal composition of the multidisciplinary team in critical care, and our study further demonstrates that the significance of team care may differ based on patient population. Critically ill surgical patients may be a distinct group whose care needs differ from those of medical ICU patients. Although an organized, team approach to critical care is widely advocated,[9-12,40] there is considerable variation in constructs, functions, and modes of delivery, which may bias the results of studies examining its contribution to improved ICU care. In our study, we did have more detailed information on team composition than did Kim et al. However, when varying the definition of team care in sensitivity analyses, we were unable to identify a specific team construct that was responsible for improved surgical patient outcomes, likely because there were many different team constructs and none accounted for more than 23% of our sample. The core ICU team may consist of the physician, nurse, pharmacist, and respiratory therapist, but the team members may vary from patient to patient in any one ICU and at different times during the care process. Such heterogeneity challenges our ability to understand and analyze the optimal delivery of team care overall.[41] For instance, the relative contribution of the surgeon to the multidisciplinary critical care team is difficult to delineate[42] but may be an influential factor in the improved survival of this patient group. Furthermore, measuring actual team function, or the quality of teamwork behaviors, is an added level of complexity that can also affect the impact of groups of caregivers on critical care outcomes.[43-45]

In contrast to some previous reports, we did not identify an independent mortality benefit associated with intensivist staffing. However, in these largely before and after studies, the role of a multidisciplinary care team in conjunction with high-intensity staffing was not systematically evaluated.[46-48] In addition, there are other studies that have also found no survival benefit from high-intensity staffing for both medical and surgical patients.[3,6,49,50] A recent meta-analysis reported that the mortality benefit of high-intensity staffing differed not only by type of ICU but also by decade of publication.[51] These inconsistent results suggest a lack of understanding as to how intensivists improve outcomes for diverse ICU populations in a changing critical care climate.

There are several other limitations to our study. Information about structure and organization was obtained via survey so respondents may have misclassified their ICU care models. Second, we did not have organizational data on 11 hospitals that did not complete the survey. Although respondents did not differ in a significant way from nonrespondents, and we had a very high survey response rate, nonresponse bias cannot be ruled out. Finally, we were unable to control for transfers into ICUs, which have been shown to have a negative impact on the accepting centers' outcome measures.[52,53]

Conclusions

Our community-based study suggested improved outcomes for critically ill surgical patients cared for by multidisciplinary care teams. Older studies have proposed that coordinated team care is beneficial for mixed medical–surgical ICU patient populations irrespective of intensity of physician staffing,[29,54,55] and our study suggests that such multidisciplinary care is perhaps even more valuable for contemporary critically ill surgical patients.

Our results, however, do not necessarily negate the importance of multidisciplinary care for medical patients or intensivist staffing for all patients. These structural characteristics are still important for patient care and likely result in the more consistent use of evidence-based practices or preventative process measures,[56,57] particularly in ICUs where standardized protocols have not yet been implemented or where ICU resources are scarce. Rather our study confirms that in an era in which the demand for intensivist care exceeds supply,[58,59] a single approach to staffing and structure may not be applicable to all patients in any ICU and certainly may not be the only means of achieving high quality critical care.[17] Since there is unlikely to be one "best" way to staff our ICUs, future studies examining every aspect of ICU structure and organization are necessary to develop an integrated understanding of how staffing affects outcomes for a diverse, and ever-changing, critically ill patient population.[60,61]

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Declaration of Conflicting Interests

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Supplemental Material

The online table is available at http://jic.sagepub.com/supplemental

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