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Association between Hospital Staffing Models and Failure to Rescue

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INTRODUCTION

Improving surgical safety is at the forefront of several regional and national quality improvement collaboratives. Failure to rescue (FTR), defined as death following a major post-operative complication, is an important quality measure that has emerged from this effort [1, 2]. It is now endorsed by National Surgical Quality Improvement Program, the Agency for Healthcare Research and Quality, the National Quality Forum and publically reported on hospitalcompare.gov [3, 4]. FTR is considered the principal driver of variation in surgical hospital mortality [5]. As such, hospitals are now charged with improving FTR rates as a means of facilitating safer surgical practices [6].

Despite increased attention to FTR, the optimal environment and staffing strategy for improved rescue is unclear. Previous studies have shown that certain macrosystem characteristics, such as hospital size and occupancy rate, are associated with FTR rates [7]. However, these factors are not easily modifiable and do not present actionable insights for hospital administrators or clinicians to improve rescue rates. Further, many of these studies are based on administrative claims data or single institution experiences [5]. Additional microsystem characteristics, such as the use of intensivists or rapid response teams (RRTs), have been cited as a contributor to decreased hospital mortality. For example, Pronovost et al performed a systematic review which reported a lower relative risk of mortality (0.71, 95% CI 0.62 – 0.82) in intensivist-staffed hospitals [8]. Likewise, several prior studies showed that initiation of a RRT resulted in decreased cardiac arrests and hospital mortality [9–11]. However, the relative contribution of these microsystem characteristics in reducing FTR rates remains unknown.

In this study, we used a prospectively maintained, clinically audited database to examine the variation of mortality and FTR across Michigan hospitals. We then sought to identify specific microsystem characteristics that are associated with FTR rates by surveying hospital representatives participating in a statewide surgical quality collaborative.

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There are no relevant conflicts of interest to declare.

METHODS

Data Source and Study Population

This is a retrospective cohort study performed using the Michigan Surgical Quality Collaborative (MSQC) database, which represents a partnership between 52 Michigan hospitals, the American College of Surgeons (ACS), and the Blue Cross Blue Shield Michigan/ Blue Care Network (BCBSM/BCN). MSQC is a prospective, multicenter clinical registry that was created to provide feedback for quality improvement. Specially trained data managers collect patient demographics, preoperative comorbidities, operative variables and 30-day morbidity and mortality. All information from the database is de-identified. The specific methods for patient selection, data collection, and data definitions have been previously described [12–15]. For this study, we included all patients who underwent major general or vascular surgery between the years 2008 - 2012. We defined major surgery as one of 42 surgical procedures that carry a mortality risk of greater than 1%. We identified a total of 44,567 patients meeting these criteria. MSQC data collection is institutional review board (IRB)-exempt, and the current study was performed with University of Michigan IRB review, from a limited data set derived from the MSQC database.

Hospital Characteristics

We surveyed hospital representatives at all MSQC participating hospitals during the February and June 2013 MSQC triannual meeting regarding available resources and staffing. Specific survey items included: type of intensive care unit (ICU) model utilized ("closed" or "open"), percentage of intensivists who were board certified, presence of hospitalists and residents, utilization of advanced practice providers (APPs), presence of overnight coverage, and 24-hour rapid response teams (RRTs). Overnight coverage was defined as the presence of an in-house advance practice provider or hospitalist overnight. Each patient observation contained a unique hospital identifier that was linked to our administered hospital resource survey.

Outcomes

Our primary outcomes for this study were 30-day mortality, major complications and FTR rates among Michigan hospitals. These outcomes were calculated at the hospital level. We defined FTR as mortality in a patient with at least 1 major complication. Major complications included deep incisional and organ-space infections, acute renal failure and/or insufficiency, post-operative bleeding requiring transfusion, myocardial infarction, cardiac arrest, pneumonia, pulmonary embolism, stroke, unplanned intubation, and septic shock. Hospitals were then ranked according to FTR rates and divided into 3 equal sized groups (tertiles). We then examined survey responses from hospitals in the low, middle and high FTR tertiles.

Statistical Analysis

All comparisons were made between the low and high FTR tertiles. Patient characteristics and comorbidities were compared using chi-square or analysis of variance or Kruskal-Wallis test where appropriate. We then compared the incidence of complications and failure to rescue rates between the low and high FTR tertiles. Next, we examined the differences in hospital staffing characteristics based on the survey items described above. All statistical analysis was performed using SAS Version 9.4 (SAS Institute, Cary, NC) or STATA Version 14 (Stata Corp, College Station, TX).

RESULTS

Hospital Mortality, Major Complication, and Failure to Rescue

Failure to rescue rates varied by more than two-fold across all hospitals (Figure 1). FTR rates were 8.6% in the low FTR tertile, 16.5% in the middle FTR tertile and 19.9% in the high FTR tertile ($p < 0.001$). Hospital mortality ranged from 3.6% to 4.7% across FTR tertiles ($p < 0.001$). The overall complication rates among the three groups varied significantly (17.1% vs 19.4% vs 24.0%, $p < 0.001$). The hospital tertile with the highest rate of complications (24%) had the lowest FTR rate (8.6%). Hospitals with the lowest rate of complications (17.1%) had the highest FTR rate (19.9%).

Select patient characteristics are shown in Table 1. The low FTR hospitals tended to treat younger patients, a greater percentage of African American patients and those with 3 or more comorbidities when compared to high FTR hospitals (all $p < 0.001$). Low FTR hospitals also had a higher average RVU than high FTR hospitals (24.09 vs 22.93, $p < .001$). Low FTR hospitals had a higher rate of overall complications including infection, pneumonia, post-operative reintubation, pulmonary embolism, acute renal failure, and myocardial infarction (Table 2). Low FTR hospitals also had a higher rate of blood transfusion (12.45%) compared to high FTR hospitals (6.95%), OR 0.53 (95% CI 0.45 – 0.55).

Hospital Characteristics Associated with Failure to Rescue

We found several hospital characteristics that were associated with failure to rescue rates (Table 3). Low FTR hospitals tended to have a greater proportion of board-certified intensivists (88%% vs 60%, $p < 0.001$) and a closed model ICU (56% vs 20%, $p < 0.001$). Low FTR hospitals tended to have more inpatient support and reported higher rates of employing hospitalists (85 vs 20%, $p < 0.001$) and residents (62 vs 40%, $p < 0.01$). Low FTR hospitals also reported greater use of nurse practitioners (50% vs 18%, $p < 0.001$) and physician assistants (50% vs 25%, $p < 0.001$). Hospitals that reported using none of these providers all fell in the high FTR group. Low FTR hospitals also reported higher rates of overnight coverage (75% vs 45%, $p < 0.001$) and RRTs (90% vs 60%, $p < 0.001$) when compared to high FTR hospitals.

DISCUSSION

In this study, we found that failure to rescue rates and hospital staffing models vary widely across hospitals. First, hospitals with lower FTR rates were more likely to have board certified intensivists and a closed model ICU. Second, these hospitals had more inpatient support in terms of hospitalists, advanced practice providers, residents and the presence of overnight coverage. Third, hospitals with low FTR rates reported increased use of rapid response teams compared to hospitals without these resources. These findings may provide concrete, organizational resources for hospitals seeking to improve rescue rates.

First, in this statewide cross-sectional analysis, we found a benefit to having board-certified intensivists and a closed ICU model. These findings are consistent with previous studies which show that hospitals with intensivist staffing have a lower mortality than those without and that transition from an open to a closed ICU model reduces mortality [8, 16]. A more recent study of ICU staffing in trauma care showed that surgical intensivists had a distinct mortality benefit [17]. However, most of the previous studies supporting closed model, intensivist-run ICUs are single-center, before-after analyses with a limited ability to adjust for case-mix or examine temporal trends. In contrast, a multi-center, cross-sectional study found that high-intensity daytime physician staffing was not associated with lower risk-adjusted ICU mortality [18]. There is also emerging evidence that simply hiring an intensivist to create a “closed” ICU or to satisfy an external benchmark does not improve outcomes [19]. These results provide context to the existing intensivist staffing literature, which demonstrates a variable mortality benefit [20, 21]. While it may not directly be a causative factor, intensivist staffing may serve as a surrogate for physician interactions within a hospital. For instance, hospitals with established intensivists may be more likely to have a culture conducive to collaboration and co-management of patients. Taken together, these data suggest that solely increasing the number of board certified intensivists or transitioning to a closed ICU model alone may not have a dramatic impact on hospital mortality.

Second, focusing on the members and structure of provider teams may provide an additional strategy for improving hospital rescue rates. This may be an especially important avenue for improving rescue, as residents and APPs are often the main providers of direct, day-to-day care for patients. We found that low FTR hospitals had more inpatient support in terms of hospitalists, APPs and residents. This strategy is supported by Kim et al, who showed that using a multidisciplinary care model for daily rounds was associated with lower ICU mortality [22]. They demonstrated that hospitals without the ability to implement high-intensity physician staffing could still achieve significant mortality reductions by implementing a team-based multidisciplinary approach. Additionally, APPs have specifically been shown to improve aspects of care that may contribute to improved rescue. Fry et al found that patient and family satisfaction were significantly improved in acute care NP practices [23]. Patient and family satisfaction may be surrogates for a healthy safety culture in which patients and families feel comfortable participating on rounds or speaking up in circumstances of uncertainty. In addition to an improved safety environment, APP involvement in patient care may also promote adherence to clinical guidelines. Gracias et al show that adherence to clinical guidelines was higher in a unit having acute care NPs compared with a unit that did not [24]. While the ideal team member components may still be unclear [25], using a team approach in general is an important contributor to improved patient safety and rescue.

Lastly, we found that hospitals with lower FTR rates were more likely to have RRTs compared to hospitals with higher FTR rates. Current literature is mixed in terms of the effectiveness of RRTs and their role remains controversial. Previous systematic reviews and meta-analyses have reported significant reductions in in-hospital cardiac arrests and hospital mortality after the introduction of RRTs [9–11]. Recent studies, however, have shown a questionable mortality benefit in the implementation of RRTs [26]. It has been proposed that the differentiating factor between an effective and non-effective RRT may be the quality or composition of the team. For example, Wakeam et al found that having an intensivist-staffed RRT was associated with hospitals that had lower than average FTR rates [4]. Their study suggests that intensivist participation on the RRT may be a distinguishing factor of a high-performance rescue response. Rather than focusing on the staffing makeup of an RRT, perhaps greater attention should be placed on how an RRT is integrated into the special needs of an individual hospital.

There are several limitations to this study that are worth noting. First, this was an observational study using a large database, which may have coding and recording errors. However, the MSQC database is clinically audited and prospectively collected, which decreases data errors. For example, we found that low FTR hospitals have significantly higher complication rates than high FTR hospitals. While this finding is different from our previous work, miscoding is unlikely given the rigorous data collection and audit system in MSQC. Alternatively, we found low FTR hospitals care for higher proportions of high risk patients and the observed differences in complication rates may be related to imperfect risk adjustment (Table 1). Second, this study is limited to one state and may not be nationally generalizable. Although, MSQC member hospitals are comprised of a wide range of community and academic medical centers. The composition and scope of practice is similar to other states. Third, unit level characteristics were ascertained through a self-reported survey, which may introduce reporting bias. Many such surveys in MSQC rely on self-report. Given the strong culture developed in the collaborative, our experience is such that these data are reliable [12, 13]. There is also literature supporting the reliability of self-reported data [27]. Finally, we do not have the date of adoption of particular resources, such as RRTs or night time staffing. While we cannot account for the date of adoption, we have previously found that outcomes are unlikely to change dramatically shortly after significant changes in staffing, such as ICU staffing. [19]

Prior literature is unclear regarding specific, modifiable organizational characteristics that can be used for improving FTR rates [28]. Because FTR is publically reported and may be incorporated into payment programs, it is essential to provide a guide for practice improvement to hospitals seeking to improve FTR performance. We have outlined several important hospital staffing and organizational features that characterize low and high performing hospitals. Patient rescue relies on a complex interaction of providers acting to provide optimal care. The organizational factors we identify are important, but perhaps equally important are the human factors associated with rescue. This aspect of patient care may be better elucidated by qualitative studies, with semi-structured interviews and focus groups, to help identify cultural approaches to patient safety and rescue [29]. Our current work is thus focused on the more nuanced factors, such as teamwork and collaboration, that influence a hospital's global safety culture. The Perioperative Evaluation of Rescue by Fostering Engagement, Communication and Teamwork (PERFECT) initiative is an ongoing, multi-institutional qualitative study aimed at understanding key elements of successful rescue. Based on findings in the initial investigational period, this study will design an intervention for improving rescue that will be implemented at select hospitals. In addition to documenting the problem of failure to rescue, we must understand where and why failures occur and ultimately implement strategies for prevention.

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REFERENCES:

1. Silber JH, Romano PS, Rosen AK et al. Failure-to-rescue: comparing definitions to measure quality of care. Med Care 2007; 45: 918–925. [PubMed: 17890988]
2. Ghaferi AA, Birkmeyer JD, Dimick JB. Variation in hospital mortality associated with inpatient surgery. N Engl J Med 2009; 361: 1368–1375. [PubMed: 19797283]
3. Sheetz KH, Dimick JB, Ghaferi AA. Impact of Hospital Characteristics on Failure to Rescue Following Major Surgery. Ann Surg 2016; 263: 692–697. [PubMed: 26501706]
4. Wakeam E, Asafu-Adjei D, Ashley SW et al. The association of intensivists with failure-to-rescue rates in outlier hospitals: results of a national survey of intensive care unit organizational characteristics. J Crit Care 2014; 29: 930–935. [PubMed: 25073984]
5. Ghaferi AA, Birkmeyer JD, Dimick JB. Complications, failure to rescue, and mortality with major inpatient surgery in medicare patients. Ann Surg 2009; 250: 1029–1034. [PubMed: 19953723]
6. Wakeam E, Hevelone ND, Maine R et al. Failure to rescue in safety-net hospitals: availability of hospital resources and differences in performance. JAMA Surg 2014; 149: 229–235. [PubMed: 24430015]
7. Ghaferi AA, Osborne NH, Birkmeyer JD, Dimick JB. Hospital characteristics associated with failure to rescue from complications after pancreatectomy. J Am Coll Surg 2010; 211: 325–330. [PubMed: 20800188]
8. Pronovost PJ, Angus DC, Dorman T et al. Physician staffing patterns and clinical outcomes in critically ill patients: a systematic review. Jama 2002; 288: 2151–2162. [PubMed: 12413375]
9. Maharaj R, Raffaele I, Wendon J. Rapid response systems: a systematic review and meta-analysis. Crit Care 2015; 19: 254. [PubMed: 26070457]
10. Winters BD, Weaver SJ, Pfoh ER et al. Rapid-response systems as a patient safety strategy: a systematic review. Ann Intern Med 2013; 158: 417–425. [PubMed: 23460099]
11. Chan PS, Jain R, Nallmothu BK et al. Rapid Response Teams: A Systematic Review and Meta-analysis. Arch Intern Med 2010; 170: 18–26. [PubMed: 20065195]
12. Campbell DA Jr, Kubus JJ, Henke PK et al. The Michigan Surgical Quality Collaborative: a legacy of Shukri Khuri. The American Journal of Surgery 2009; 198: S49–S55. [PubMed: 19874935]
13. Campbell DA Jr., Englesbe MJ, Kubus JJ et al. Accelerating the pace of surgical quality improvement: the power of hospital collaboration. Arch Surg 2010; 145: 985–991. [PubMed: 20956768]
14. Harbaugh CM, Terjimanian MN, Lee JS et al. Abdominal aortic calcification and surgical outcomes in patients with no known cardiovascular risk factors. Ann Surg 2013; 257: 774–781. [PubMed: 23001086]
15. Kanters A, Mullard AJ, Arambula J et al. Colorectal cancer: Quality of surgical care in Michigan. Am J Surg 2016.
16. Ghorra S, Reinert SE, Cioffi W et al. Analysis of the effect of conversion from open to closed surgical intensive care unit. Ann Surg 1999; 229: 163–171. [PubMed: 10024095]

17. Nathens AB, Rivara FP, MacKenzie EJ et al. The impact of an intensivist-model ICU on trauma-related mortality. Ann Surg 2006; 244: 545–554. [PubMed: 16998363]
18. Costa DK, Wallace DJ, Kahn JM. The Association Between Daytime Intensivist Physician Staffing and Mortality in the Context of Other ICU Organizational Practices: A Multicenter Cohort Study. Crit Care Med 2015; 43: 2275–2282. [PubMed: 26308426]
19. Nagendran M, Dimick JB, Gonzalez AA et al. Mortality Among Older Adults Before Versus After Hospital Transition to Intensivist Staffing. Med Care 2016; 54: 67–73. [PubMed: 26492215]
20. Checkley W, Martin GS, Brown SM et al. Structure, process, and annual ICU mortality across 69 centers: United States Critical Illness and Injury Trials Group Critical Illness Outcomes Study. Crit Care Med 2014; 42: 344–356. [PubMed: 24145833]
21. Yoo EJ, Edwards JD, Dean ML, Dudley RA. Multidisciplinary Critical Care and Intensivist Staffing: Results of a Statewide Survey and Association With Mortality. J Intensive Care Med 2016; 31: 325–332. [PubMed: 24825859]
22. Kim MM, Barnato AE, Angus DC et al. The effect of multidisciplinary care teams on intensive care unit mortality. Arch Intern Med 2010; 170: 369–376. [PubMed: 20177041]
23. Fry M Literature review of the impact of nurse practitioners in critical care services. Nurs Crit Care 2011; 16: 58–66. [PubMed: 21299758]
24. Gracias VH, Sicoutris CP, Stawicki SP et al. Critical care nurse practitioners improve compliance with clinical practice guidelines in “semiclosed” surgical intensive care unit. J Nurs Care Qual 2008; 23: 338–344. [PubMed: 18521045]
25. Gershengorn HB, Wunsch H, Wahab R et al. Impact of nonphysician staffing on outcomes in a medical ICU. Chest 2011; 139: 1347–1353. [PubMed: 21393397]
26. Chan PS, Khalid A, Longmore LS et al. Hospital-wide code rates and mortality before and after implementation of a rapid response team. Jama 2008; 300: 2506–2513. [PubMed: 19050194]
27. Ghaferi AA, Osborne NH, Dimick JB. Does voluntary reporting bias hospital quality rankings? J Surg Res 2010; 161: 190–194. [PubMed: 19932907]
28. Kao LS. Rescuing failures: can large data sets provide the answer? JAMA Surg 2014; 149: 124. [PubMed: 24337548]
29. Sinuff T, Cook DJ, Giacomini M. How qualitative research can contribute to research in the intensive care unit. J Crit Care 2007; 22: 104–111. [PubMed: 17548020]

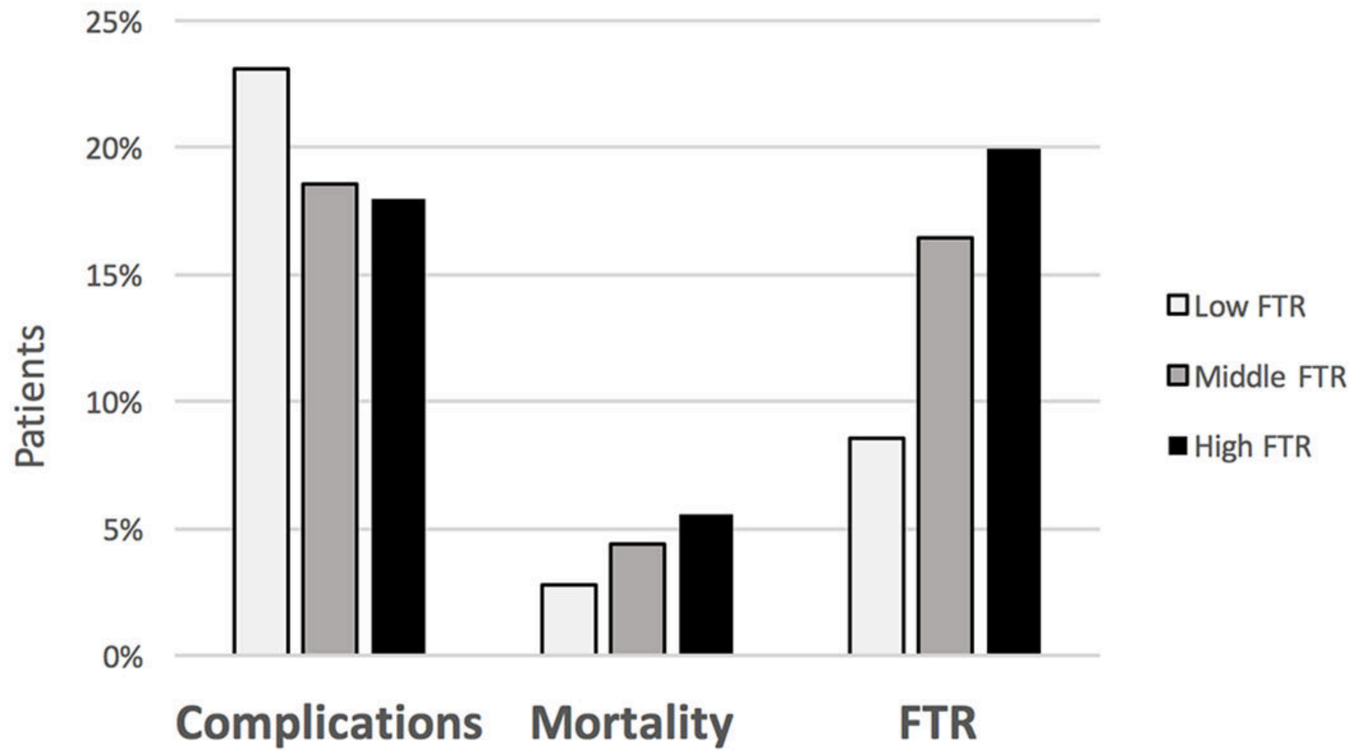

Figure 1. Rates of complications, mortality and failure to rescue (FTR)

Rates of complications, mortality and failure to rescue (FTR) are shown across low, middle and high FTR tertiles. The FTR rate varied more than two-fold between low and high FTR hospitals.

Table 1.

Patient Characteristics across Hospital Tertile of FTR

Characteristic	Low FTR	Middle FTR	High FTR	p value
n	6,878	22,237	15,452	
Median age, y	65	67	66	<.001
Gender, % male	50%	51%	53%	<.001
African American, %	31%	11%	8%	<.001
3+ comorbidities, %	26%	21%	20%	<.001
Average RVU	24.09	23.07	22.93	<.001

Table 2.

Incidence of Major Complications stratified by Hospital FTR Tertile

	Low FTR	Middle FTR	High FTR	Odds Ratio for High vs. Low FTR (95% CI)		
	percent of patients					
Incidence of major complication					95% lb	95% ub
Deep Incisional SSI	1.29%	1.56%	1.12%	0.86	0.67	1.12
Organ/Space SSI	2.92%	2.81%	1.77%	0.60	0.50	0.72
Pneumonia	4.89%	3.26%	3.64%	0.74	0.64	0.85
Unplanned Intubation - Postop	3.68%	3.43%	3.09%	0.83	0.71	0.97
Pulmonary Embolism	0.90%	0.70%	0.41%	0.45	0.32	0.64
Acute Renal Insufficiency and/or Failure	2.04%	1.38%	1.42%	0.70	0.56	0.86
Stroke/CVA	0.64%	0.69%	0.60%	0.94	0.66	1.35
Cardiac Arrest req. CPR - Postop	1.05%	1.13%	1.14%	1.09	0.83	1.43
Myocardial Infarction - Postop	1.42%	1.43%	0.74%	0.51	0.39	0.67
Transfusions w/in first 72 hrs postop	12.45%	7.91%	6.95%	0.53	0.48	0.58
Sepsis	4.14%	4.73%	3.64%	0.87	0.75	1.01
Severe Sepsis	2.78%	2.64%	2.82%	1.01	0.85	1.21

Table 3.

Differences in Hospital Characteristics between Low, Medium and High FTR Hospitals

		FTR Tertile			
		Low (n=11)	**Middle (n=11)**	**High (n=10)**	**p - value**
ICU Staffing Model	% Closed	56	36	20	<.001
Intensivists	%Board Certified	88	72	60	<.001
Physician Providers	%Hospitalists	85	55	20	<.001
	%Residents	62	45	40	<.01
Advanced Practice Providers	% Nurse Practioners	50	45	18	<.001
	% Physician Assistants	50	55	25	<.001
	% None	0	0	20	<.001
Overnight Coverage	% Yes	75	55	45	<.001
Rapid Response Team	% Yes	90	72	60	<.001