Journal of HOSPITAL MEDICINE www.journalofhospitalmedicine.com

ORIGINAL RESEARCH

Characteristics of Intensive Care Units in Michigan: Not an Open and Closed Case

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The Michigan Health and Hospital Association (MHA) Keystone ICU study was supported by a grant (1UC1HS14246) from the Agency for Healthcare Research and Quality.

Disclosure: R.C.H. attests that the authors had access to all the study data, take responsibility for the accuracy of the analysis, and had authority over manuscript preparation and the decision to submit the manuscript for publication. The authors declare the following conflicts of interest in relationship to this research publication: R.C.H. has received honoraria for consulting from MHA; S.M.B. has received grant support from Robert Wood Johnson Foundation (RWJ) and Agency for Healthcare Research and Quality (AHRQ) to improve quality of care; a career development award from the National Heart, Lung, and Blood Institute (NHLBI); and honoraria for consulting from MHA; C.A.G., S.A.F., and S.W., none; A.D.A. is an advisor to Merck, Astra Zeneca, and Amgen pharmaceuticals, and has received grants from the California Healthcare Foundation, AHRQ, and NHLBI for research to improve quality of care; and P.J.P. is an advisor to the Leapfrog Group and has grants from MHA to improve the quality of care for patients in Michigan.

OBJECTIVE: Delivery of critical care by intensivists has been recommended by several groups. Our objective was to understand the delivery of critical care physician services in Michigan and the role of intensivists and nonintensivist providers in providing care.

DESIGN: Descriptive questionnaire.

PARTICIPANTS AND SETTING: Intensive care unit (ICU) directors and nurse managers at 96 sites, representing 115 ICUs from 72 hospitals in Michigan.

MEASUREMENTS AND RESULTS: The primary outcome measure was the percentage of sites utilizing a closed vs. an open model of ICU care. Secondary outcome measures included the percentage of ICUs utilizing a high-intensity service model, hospital size, ICU size, type of clinician providing care, and clinical activities performed. Twenty-four (25%) sites used a closed model of intensive care, while 72 (75%) had an open model of care. Hospitals with closed ICUs were larger and had larger ICUs than sites with open ICUs ($P < 0.05$). Hospitalists serving as attending physicians were strongly associated with an open ICU (odds ratio [OR] = 12.2; 95% confidence interval [CI] = 2.5-60.2), as was the absence of intensivists in the group (OR = 12.2; 95%CI = 1.4-105.8), while ICU and hospital size were not associated. At 18 sites (20%) all attendings were board certified in Critical Care. Sixty sites had less than 50% board-certified attending physicians.

CONCLUSIONS: The closed intensivist-led model of intensive care delivery is not in widespread use in Michigan. In the absence of intensivists, alternate models of care, including the hospitalist model, are frequently used. ***Journal of Hospital Medicine*** **2010;5:4–9.** © *2010 Society of Hospital Medicine.*

KEYWORDS: **care standardization, leadership, multidisciplinary care, teamwork.**

Organization of physician services in intensive care units (ICUs) varies widely and influences mortality, morbidity, and costs of care. Intensive care provided by intensivists in a high-intensity physician staffing model, in which intensivists are the sole attending physicians or consult on all patients, has been associated with desirable outcomes such as decreased length of stay, resource utilization, and mortality.[1-4] As a result, higher intensity ICU models have been recommended by various healthcare agencies, including the National Quality Forum and the Leapfrog Group.[5-7]

One national survey indicated that 47% of ICUs surveyed had some intensivist coverage and only 4% of intensive care units met Leapfrog high-intensity model standards.[8] However, only one-third of ICUs responded to this survey, smaller ICUs were overrepresented, and the survey may not have reflected the influence of newer policy initiatives because it was conducted in 1997. Though the attributes by which intensivists improve patient outcomes is unknown, researchers have suggested it is by having a knowledgeable physician present in the ICU, having a physician communicate with other clinicians and families, and by having a physician who manages the ICU by writing policies and procedures and administrative activities.[9]

2010 Society of Hospital Medicine DOI 10.1002/jhm.567
Published online in wiley InterScience (www.interscience.wiley.com).

Results have been conflicting as patients managed by intensivists have also been found to have an increased mortality, particularly when managed on an elective consultation basis in an open ICU, where patient orders are written by several physician specialties.[10,11] Alternative ICU staffing models, such as the use of hospitalists, have been utilized to compensate for the intensivist workforce shortage. Hospitalists often provide ICU care, although they are seldom board-certified in critical care. Hospitalist care has been shown to provide clinical and efficiency benefits such as decreased length of hospital stay.[12-14]

Understanding the manner in which critical care is currently delivered, particularly the utilization of intensivist and nonintensivist care providers, can provide insights into subsequent allocation of a limited intensivist workforce as nonintensivist care providers such as hospitalists become more available. To understand how intensivists and other practitioners, such as hospitalists, deliver critical care in Michigan, we performed a cross-sectional survey of Michigan hospitals participating in the Keystone ICU project, a statewide quality-improvement initiative.

Methods

The hospitals involved and the methods of Keystone ICU have been published previously.[15] The Keystone ICU project is a collaborative quality improvement initiative first organized in October 2003 by the Michigan Health and Hospitals Association (MHA) Keystone Center for Patient Safety and Quality. At its inception, 103 ICUs voluntarily agreed to participate in Keystone ICU and reported data representing 85% of ICU beds in Michigan. Nonparticipating hospitals ($n = 37$) were smaller, 79% having fewer than 100 beds, many of which did not have ICUs. All ICUs from the 72 hospitals participating in the Keystone ICU project as of July 2005 were asked to complete surveys as part of ongoing data collection.

Keystone ICU sought to improve safety culture, increase adherence to evidence-based practices among patients receiving mechanical ventilation, and reduce central line–associated bloodstream infections and ventilator-associated pneumonia through a number of interventions. Keystone also encouraged teams to standardize their physician staffing, and presented teams with evidence regarding the benefits of ICU physician staffing. Because many of the ICUs were small and believed it was not practical to staff their ICUs with intensivists, Keystone encouraged ICUs to create as many of the attributes of intensivist staffing as possible: having someone present who is knowledgeable, able to manage at the unit level, and who communicates well with clinicians and families.[9] As part of this project, we developed a survey to describe the physician staffing in Michigan ICUs. Additional elements of the survey sought to ascertain how medical decision-making occurred, which decisions were made by what types of clinicians, and who performed various procedures in the ICU.

Survey Development

The survey for this study was developed based on expert opinion and on previous work by the research team (A.D.A., P.J.P., S.A.F.). The survey was pilot tested in a small group of non-Michigan hospitals and found to be understandable and readable. The survey was then revised and disseminated to all hospitals participating in the Keystone ICU project. Construct validity was determined by review of literature and discussion with the research team (A.D.A., P.J.P., S.A.F., R.C.H.). Content validity was determined by the pilot test, which included interviews with the individuals who pilot-tested the survey. The survey sought to describe the organization of ICU physician services (including both intensivist and nonintensivist). A copy of the survey is available upon request.

Survey Protocol

Surveys were sent by e-mail to the official nurse and/or physician project leader at each site in July 2005 from contact information provided by MHA. Another copy of the survey was emailed to ICUs that did not respond to the initial survey after 3 months and, if needed, a third survey was sent at 6 months with a follow-up telephone call by 1 of the investigators (R.C.H.). The completed surveys were returned to MHA for compilation and analysis. The research project was reviewed by the University of Michigan Institutional Review Board and determined to be exempt from ongoing IRB review per federal exemption category 45 CFR 46.101.(b). The funder was not involved in the design of the study, collection, analysis, and interpretation of the data, or the decision to approve publication of the finished manuscript.

Statistical Analysis

Survey respondents were first characterized using simple univariable and bivariable methods. When appropriate, groups were compared based on chi-square, Mann-Whitney U test, or *t* test. Additionally, a series of multivariable analyses was performed, which sought to understand structural factors associated with the presence of higher-intensity models, as well as use of hospitalists or intensivists. Results of the multivariate analysis are reported as odds ratios (ORs) and 95% confidence intervals (CIs). The critical region was defined as an alpha of ≤ 0.05. Statistical analysis was performed using SAS (version 9.1; SAS Institute, Inc., Cary, NC).

Results

Response Rate

Ninety-seven responses were received, including at least 1 response from every Keystone ICU hospital located in Michigan. Because our goal was to describe the organization of ICU physician services in non-Federal hospitals, 1 Michigan VA hospital was eliminated from further consideration. Four hospitals with more than 1 ICU, which delivered care

2010 Society of Hospital Medicine DOI 10.1002/jhm.567
Published online in wiley InterScience (www.interscience.wiley.com).

TABLE 1. Organizational Characteristics in Michigan Intensive Care Units

	Closed ICUs (n = 24) [n (%)]	Open ICUs (n = 72) [n (%)]	Intensivist Decision-making (n = 30) [n (%)]	Shared Decision-making (n = 31) [n (%)]	Nonintensivist Decision-making (n = 34) [n (%)]
ICU beds (mean ± SD)	21.8 ± 15.3*	15.2 ± 13.0*	21.3 ± 18.7*	19.2 ± 13.4	10.5 ± 5.2*
Hospital beds (mean ± SD)	489.8 ± 295.3*	326.3 ± 222.6*	460.8 ± 222.3*	408.6 ± 259.7	247.8 ± 230.0*
Nonintensivist attendings					
Hospitalist	—	34 (47.2)	9 (30)	14 (45.1)	13 (38.2)
Primary care physician	—	55 (76.4)	11 (36.7)	23 (74.2)	27 (79.4)
Cardiologist	—	54 (75)	10 (33.3)	25 (80.6)	23 (67.6)
Pulmonologist	—	34 (47.2)	9 (30)	15 (48.3)	15 (44.1)
Other IM specialist	—	48 (66.7)	11 (36.7)	25 (80.6)	17 (50)
Surgeon	—	59 (81.9)	14 (46.7)	25 (80.6)	27 (79.4)
Critical care board certification (% of attending physicians)			(n = 28)	(n = 31)	(n = 33)
100	11 (45.8)	7 (10.1)	11 (39.3)	6 (19.4)	0 (0)
75	3 (12.5)	6 (8.7)	7 (25.0)	2 (6.5)	0 (0)
50	2 (8.3)	4 (5.8)	3 (10.7)	2 (6.5)	1 (3.0)
<50	8 (33.3)	52 (75.4)	7 (25.0)	21 (67.7)	32 (97.0)
ICU administration					
ICU director financial support	18 (75.0)	49 (68.1)	25 (83.3)	23 (74.2)	18 (52.9)
Meeting with ICU team	21 (87.5)	56 (77.8)	26 (86.7)	27 (87.1)	23 (67.7)
M&M sessions	9 (37.5)	33 (45.8)	16 (53.3)	12 (38.7)	14 (41.2)

NOTE: Some responses were left blank, yielding a total <96.

Abbreviations: ICU, intensive care unit; IM, internal medicine; M&M, morbidity and mortality; SD, standard deviation.

*$P < 0.05$ by paired t tests: Closed ICU vs. open ICU, intensivist decision-making vs. nonintensivist decision-making.

identically in all of their ICUs, provided 1 response and were counted as 1 site. As a result, 96 survey responses representing 115 ICUs in 72 Michigan hospitals were each counted as 1 site in the analysis. This included responses from ICUs not included in earlier analyses, which joined Keystone ICU after earlier work had been underway.[15]

Baseline Demographics

The mean (standard deviation [SD]) hospital size represented in the survey was 280 (22) beds, with a median of 249 (range, 40-1031) beds. The mean size (SD) of the ICU was 13.3 (7.0) beds, median 12 beds, range 4 to 42 beds. There were 16 ICUs dedicated exclusively to the care of medicine patients, 14 dedicated surgical units, 8 dedicated cardiac ICUs, and 3 dedicated Neuro ICUs. The remainder had a mixed patient population. Seventy-one ICUs (74%) cared for medical patients, 69 (72%) cared for surgical patients, 64 (67%) cared for cardiac patients, and 52 (53%) cared for neurological patients.

ICU Staffing Models

To better understand the role of intensivists in critical care delivery in Michigan, we examined differences in sites where patients are managed as closed sites exclusively by intensivists (closed ICU sites) in comparison to ICUs that had multiple attending specialties (open ICU sites). In addition, ICU sites where intensivists made most clinical decisions—a circumstance likely reflecting a "high-intensity staffing" model of care[5]—were compared with ICUs sites where decision-making was made by nonintensivists or was shared (Table 1). Twenty-four of 96 (25%) ICU sites were "closed," and only intensivists served as the attending of record. Hospitals with closed ICUs or in which intensivists made most clinical decisions were larger and had larger ICUs than sites with open ICUs or with nonintensivist decision-making ($P < 0.05$). These 24 closed sites represented 17 of 72 hospitals (24%), with the remainder of hospitals (76%) not having closed ICUs. Intensivists participated in rounds in 43 of 72 sites (60%) that were not closed. House officer participation in the care of ICU patients was not related to the presence or absence of intensivists ($\chi^2 = 0.04$; $P = 0.847$), although the average size of hospitals with house officers was larger than those without house officers ($P < 0.0001$).

Multivariate analysis determined that the presence of hospitalists serving as attending physicians was strongly associated with an open ICU (OR = 12.2; 95%CI = 2.5-60.2), as was the absence of intensivists at the site (OR = 12.2; 95%CI = 1.4-105.8), while ICU and hospital size were not associated. When the analyses were limited to hospitals with intensivists (n = 69), decision-making by intensivists was not associated with ICU or hospital size (OR = 1.0; 95%CI = 1.0-1.0); or whether hospitalists acted as attendings (OR = 0.7; 95%CI = 0.2-2.0).

2010 Society of Hospital Medicine DOI 10.1002/jhm.567
Published online in wiley InterScience (www.interscience.wiley.com).

TABLE 2. Medical Decision-Making in Michigan Intensive Care Units

	Decision-making		
	Intensivist n (%)	Nonintensivist n (%)	Shared n (%)
Ventilator management	62 (66.7)	24 (25.8)	7 (7.5)
Choice of ventilator weaning strategies	64 (68.8)	24 (25.8)	5 (5.4)
Decision to extubate	63 (68.5)	24 (26.1)	5 (5.4)
Choice of sedation or paralytic agents	56 (65.1)	24 (27.9)	6 (7.0)
Choice of vasopressor agents	47 (51.1)	25 (27.1)	20 (21.7)
Decision to call other consultants (eg, cardiology, infectious diseases)	19 (20.4)	31 (33.3)	43 (46.2)
Choices related to more general medical management (eg, antibiotics, diabetes management)	30 (32.2)	25 (26.9)	38 (40.1)
Family meetings, code status discussions	26 (28.6)	26 (28.6)	39 (42.8)

NOTE: Some responses were left blank, yielding a total <96.

Board Certification and ICU Administration

Only 18 sites (20%) acknowledged that 100% of their ICU attending physicians were board-certified in critical care, with nearly two-thirds of sites having fewer than 50% critical-care board-certified attending physicians (Table 1). The medical director of the ICU met for an administrative meeting with the ICU team of nurses, respiratory therapists, and other personnel on a regular (ie, at least quarterly) basis at 77 sites (80%) and held regular morbidity and mortality sessions to discuss ICU care with other physicians who work in the ICU at 43 sites (45%). The majority of sites (n = 67; 70%) provided salary support for the ICU medical director.

Critical-care board-certification was more common at sites with closed ICUs and at sites where decision-making was performed by intensivists ($P < 0.001$). However, board-certification was not uniform in closed ICUs (100% certification = 46%, >50% certification = 67%) or in ICUs where intensivists made most decisions (100% certification = 39%, >50% certification = 75%).

Hospitals in which hospitalists served as attending physicians were less likely to have 50% or greater critical-care board-certification in their ICU (OR = 0.13; 95%CI = 0.03-0.50). ICU size, hospital size, and years in practice were not associated with critical-care board-certification. Hospital size, ICU size, and the presence of intensivists or hospitalists were not associated with whether the medical director receives support from the hospital.

Physician Extenders

Nineteen sites (20%) reported the utilization of advanced practice nurses; 15 sites (16%) reported use of physician assistants; and 7 sites (7%) reported use of both advance practice nurses and physician assistants to provide intensive care. Physician extenders were not more likely to work in closed ICUs (10/24) than in open ICUs (14/72) ($\chi^2 = 3.63$; $P = 0.57$).

Of the 27 sites reporting use of advanced practice nurses or physician assistants, the role of physician extenders was described as being similar to physicians in 8 sites (30%), somewhat autonomous but with limitations in 18 (67%), and in a role closer to a ward clerk or assistant in 1 site (4%). The activities of physician extenders included writing orders at 24 of these 27 sites (89%); writing progress notes at 25 sites (92%); communicating with consultants at 24 (89%) and with primary care physicians at 22 sites (82%); and coordinating discharge plans at 20 sites (74%). Physician extenders rounded alone at 16 sites (33%).

Clinical Activities

Intensivists participated in daily rounds at most sites (n = 67; 70%). Nonintensivists served as attending of record in 72 (75%) sites. Nonintensivist physicians participating in daily patient rounds were: surgeons (n = 66; 68% of sites), primary care physicians (n = 61; 64%), nonpulmonary internal medicine specialists (n = 53; 55%), cardiologists (n = 58; 60%), non-critical-care pulmonologists (n = 39; 41%), and hospitalists (n = 36; 38%). Intensivists were the primary decision-makers at 30 sites (31%), nonintensivists at 34 (35%), and decision making was shared at 31 (32%).

At more than one-half of sites, decisions regarding mechanical ventilation, the use of sedatives or paralytics, and the choice of vasopressor agents were made by intensivists, with other decisions—such as the decision to call consultants, choice of antibiotics, or family meetings—shared between intensivists and nonintensivists more than 40% of the time (Table 2). During regular working hours, invasive procedures were performed by multiple clinicians, including house officers, intensivists, surgeons, and anesthesiologists and were not the province of any particular type of clinician (Table 3).

Regardless of the staffing model employed, the majority of sites (88%) provided care on a call-based, rather than

2010 Society of Hospital Medicine DOI 10.1002/jhm.567
Published online in wiley InterScience (www.interscience.wiley.com).

TABLE 3. Performance of Procedures in Michigan Intensive Care Units

Procedure	Hospitalist n (%)	Intensivist n (%)	Surgeon n (%)	Anesthesiologist n (%)	House Officer or Other MD n (%)	Other non-MD n (%)
Arterial line placement	15 (15.6)	50 (52.1)	40 (41.7)	31 (32.3)	59 (61.4)	7 (7.3)
Femoral venous line placement	14 (14.6)	54 (56.3)	42 (43.8)	17 (17.7)	55 (57.3)	4 (4.2)
Subclavian or internal jugular line placement	14 (14.6)	54 (56.2)	47 (49.0)	25 (26.0)	62 (64.6)	5 (5.2)
Pulmonary artery catheterization	8 (8.3)	56 (58.3)	24 (25.0)	21 (21.9)	54 (56.2)	2 (2.1)
Intubation	14 (14.6)	47 (49.0)	14 (14.6)	74 (77.1)	42 (43.8)	15 (15.6)
Bronchoscopy	2 (2.1)	67 (69.8)	17 (17.7)	5 (5.2)	29 (30.2)	0 (0)

TABLE 4. Nighttime Admission and Cross-coverage in Michigan ICUs

Care Provider	Nighttime Admissions n (%)	Cross-coverage n (%)
Emergency room physician	13 (13.5)	8 (8.3)
House physician	15 (15.6)	17 (17.7)
House officer	42 (43.8)	37 (38.5)
ICU nurse	5 (5.2)	10 (10.4)
PA or NP	8 (8.3)	5 (5.2)
Intensivist in person	8 (8.3)	—
Intensivist by telephone	—	28 (29.2)
Other	9 (9.4)	9 (9.4)

Abbreviations: ICU, intensive care unit; NP, nurse practitioner; PA, physician assistant.

shift-based system. Nighttime admissions and cross-coverage issues were handled by house officers at more than one-third of sites, with nonintensivist house physicians performing these tasks at 15% of sites (Table 4). Intensivists managed cross-coverage issues by telephone at 29% of sites, and saw new admissions in person after hours at 8% of sites. Intensivists did not deliver care in scheduled shifts at any of these sites.

Discussion

As all Keystone ICU participating sites responded to the questionnaire, we believe these results to be representative of critical care practice in the state of Michigan at the present time. Michigan ICU staffing structures are variable. Only a minority (25%) of Michigan Keystone ICU sites operated in an environment where intensivists are the only attending physicians of record. Although intensivists rounded in 60% of sites not utilizing a closed model, 75% of sites had nonintensivist attending physicians, with primary care physicians and hospitalists commonly providing ICU services. The utilization of hospitalists to provide critical care services was found in the absence of intensivists, regardless of hospital or ICU size.

Closed ICUs were seen in larger hospitals and in larger ICUs. This finding is similar to data obtained on a national level.[8-16] A high-intensity model of care was also uncommon, although decision-making was at least shared between intensivists and nonintensivists at two-thirds of sites. These findings are in keeping with the observation that intensivist-directed care advocated by the Leapfrog Group has not been widely implemented,[17] including in Michigan, a regional rollout leader for the Leapfrog Group.

Fewer ICUs reported utilizing a nonintensivist model than was reported in the survey by Angus et al.,[8] where approximately one-half of ICUs delivered care in this manner. This survey was performed in 1997, prior to the launch of the Leapfrog Group effort, and may have reflected a relative over representation of smaller, general ICUs. Our study is the first statewide analysis of critical care practices in the post–Leapfrog Group era. Our finding that an array of approaches to critical care delivery existed in Michigan, even when intensivists rounded on patients, is similar to that found among Leapfrog-compliant hospitals sampled from several regions of the United States.[18]

Other than intensivists, surgeons, primary care, and hospitalist physicians provided care in Michigan ICUs. The hospitalist movement is relatively new.[19] However, in our survey 37.5% of sites had hospitalists serving as attending physicians. Although the closed ICU model was more prevalent in larger ICUs and hospitals, the use of a hospitalist model to staff ICUs was not related to hospital size, but was instead a function of whether or not intensivists were present in a given setting. In lieu of a projected shortage of intensivists, we believe this confirms the crucial role that hospitalists will play in the provision of critical care services in the future.

The attributes of intensivist care that led to improved outcomes in previous studies[1-4] are unknown. To the extent that the involvement of intensivists on an elective rather than mandatory consultative basis may explain the higher mortality found in 1 recent study,[10–11] we hypothesize that having a knowledgeable physician present who communicates with clinicians and families and manages at the unit

2010 Society of Hospital Medicine DOI 10.1002/jhm.567
Published online in wiley InterScience (www.interscience.wiley.com).

level is an important factor leading to improved outcomes. While hospitalists can have these attributes, their knowledge of specific critical care therapies and technologies may vary with the extent of their ICU training and experience. Further research should seek to quantify the attributes by which intensivists are associated with improved outcomes and seek ways to foster those attributes among hospitalists who participate in critical care delivery. Central to this will be ensuring that training programs ensure competency in critical care therapies and technologies among hospitalists and other non-ICU physicians.

We recognize several limitations in this study. First, the validity of the survey may introduce misclassification of ICU staffing. However, the survey instrument was informed by previously-validated instruments and experts in ICU physician staffing and hospitalist care. Second, we did not link variation in staffing to outcomes. While such analysis is important, it is beyond the scope of this survey. Third, our study was conducted in 1 state and the results may not be generalizable across the United States. Nevertheless, Michigan is a large state with a diverse array of hospitals, and as our study sample broadly represented this diversity, we believe our results are likely to be generalizable.

In conclusion, few ICUs in Michigan are closed and many utilize nonintensivist critical-care providers such as hospitalists, primary care providers, and physician extenders to deliver clinical care. Our findings have significant implications for future efforts at a national level that involve the training of hospitalists and their acceptance as critical care practitioners. We suggest future research involving intensive care delivery focus on the feasibility of training sufficient hospitalists to satisfy a growing need for critical care that cannot be filled by intensivists, along with strategic planning to insure the model of care provided is commensurate with the complexity of illness. Although this approach appears to be occurring in Michigan on an ad hoc basis, we believe coordination between larger, intensivist-run ICUs and smaller, nonintensivist-run ICUs should be formalized in order to optimize the delivery of intensive care.[25]

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Published online in wiley InterScience (www.interscience.wiley.com).