The Association Between Visiting Intensivists and ICU Outcomes*

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Objectives: We hypothesized that intensivists unfamiliar with an ICU team and the context of that ICU would affect patient outcomes. We examined differences in mortality when ICU patients were admitted under intensivists routinely working in that ICU and compared with those admitted by intensivists familiar with an ICU elsewhere in the same hospital.

Design, Settings, and Patients: A 5-year natural experimental crossover study involving patients admitted to four ICUs in a large U.K. teaching hospital.

Interventions: During a period of service reconfiguration, intensivists routinely rostered to work in one ICU worked in another of the hospital's four ICUs. "Home" intensivists were those who continued to work in their usual ICU; "visitor" intensivists were those who delivered care in an unfamiliar ICU. Patient data were obtained from electronic patient records to provide analysis on sex, age, admission Sequential Organ Failure Assessment score, date and time of admission, and admission type (elective, transfer, or unplanned).

Measurements and Main Results: We analyzed 9,981 admissions to four separate ICUs over a 5-year period. In total, 34.5% of patients were admitted by intensivists working in nonfamiliar surroundings. Visitor intensivists admitted patients with similar age and gender distributions but with greater physiologic derangement (mean Sequential Organ Failure Assessment score, 4.1 ± 2.8 vs 3.9 ± 2.8; $p < 0.001$) than home intensivists. Overall ICU mortality rates were higher in visitor intensivists, albeit not significantly so (11.5% vs 10.2%; $p = 0.052$). However, when the ICUs were analyzed separately, visitor mortality rates were found to be significantly higher than for home intensivists in two of the four ICUs ($p = 0.017, 0.006$). A multivariable analysis adjusting for confounding factors and the clustering of consultants revealed that the overall mortality rate was significantly higher for visitors (odds ratio, 1.18; 95% CI, 1.02–1.37; $p = 0.024$). A significant interaction between the ICU and visitor status was also detected ($p = 0.046$), with the visitor effect remaining significant in the two ICUs identified previously (both $p = 0.009$).

Conclusions: Visitor intensivists in some ICUs were associated with higher mortality. The reasons are unknown but could relate to intensivists' practices, unfamiliarity with the patients, or the interaction with the interprofessional team. (*Crit Care Med* 2017; 45:949–955)

Key Words: critical care; critical care outcomes; models: organizational; mortality; patient care management

A substantial literature indicates that intensivist-directed care results in better outcomes for critically ill patients than that directed by nonintensivists. However, "the intensivist" may not be an homogenous intervention since competencies may vary between individuals and the delivery of care is usually by others. A key intervention that may improve survival is the integrating ability of the intensivist to lead and coordinate treatment. Differing perceptions of communication between doctors and nurses have been shown to influence the understanding of patient care goals (1) and improved communication through the use of daily check and prompts lists have reduced mortality and length of stay (2). Adverse events, associated with higher mortality, may arise from lapses in communication (3). However, the role of the intensivist extends beyond communicating only with nursing staff. Intensivists are primarily responsible for supportive rather than curative interventions (4)—integral to their role is their interaction with the right clinicians, at the right time to improve the patient's condition.

Many studies suggest lower mortality in intensivist-staffed ICUs (5–8), and that the mechanism might be more reliable delivery of best practice care (9). In 2008, Levy et al (10) used a

*See also p. 1095.

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propensity score to identify a higher case mix-adjusted mortality rate among patients receiving intensivist-directed care than for those in small ICUs whose care was managed by nonintensivists. There may be an alternative explanation: intensivist-staffed ICUs and small ICUs had more effective teams and that outcomes were worse where ICUs were unfamiliar with the intensivist (or vice versa).

In order to examine the effect of changing the intensivist-ICU interaction on patient outcome, we took an opportunity to evaluate a natural experiment created by service reconfiguration that required experienced intensivists to work in different ICUs within the same hospital. We hypothesized that changing the intensivist to one who already worked in the hospital but within a different ICU would increase mortality.

MATERIALS AND METHODS

Setting

The ICUs in this study were based in a university teaching hospital providing a population of approximately 1.5 million with a wide range of tertiary services including solid organ and bone marrow transplantation. Elective orthopedic surgery, noncardiac thoracic surgery, and pediatrics are not represented but the hospital provides a Grown-Up Congenital Heart service to a small number of older adolescents. The study was performed as part of a service evaluation and exempt from ethical review.

We studied admissions to four geographically distinct ICUs (liver/specialty ICU, general/trauma/burns ICU, neuro-ICU, and cardiac ICU) within the hospital comprising a total of 72 beds, the characteristics and specialties housed within each unit are summarized in **Table 1**. Each ICU had its own team of doctors, nurses, and allied health professionals, but within a unified critical care directorate and administrative structure.

The hospital was scheduled to relocate to a single-site and so colocate four physically separate ICUs into a new building with a single 100-bed ICU. In preparation for this move, between September 1, 2004, and August 31, 2009, intensivists were rostered for periods of 6 months to carry out some of their rostered clinical duties in a unit in which they did not usually work, to develop new cross-specialty models of working, which would permit critically ill patients to be admitted to the next available bed anywhere across the floor. We studied all ICU admissions during this period. Outside this 5-year period, intensivists worked in only one of the four ICUs. The periods when an intensivist was rostered in their usual place of work, we classified as "home"; when they were working in an unfamiliar ICU, we classified them as "visitors."

A total of 10 rosters, each 6 months long, were produced during the study. Rosters were written by a "Rota Coordinator." The decision of which intensivists became visitors was made by the Rota Coordinator when the roster was drawn up. Intensivists were free to decline to be rostered to a particular ICU and could negotiate where they were next placed. They attempted to ensure that all intensivists had their "turn" in an unfamiliar ICU. In general, two intensivists were taken out of their home environment and moved to provide care on one of the other ICUs for an average roster of once every 6 weeks in a 6-month block. All intensivists had received training in the relevant areas prior to their permanent appointment to the hospital and were supported by home team colleagues. The amount of support received was at the request of the particular intensivist and could range from no support to receiving advice about patient management at the bedside.

Intensivists were responsible for all admission and discharge decisions and worked for blocks of 7 days 8 AM to 6 PM, and four nights on-call from home; the other three nights were covered by colleagues (who could either be home or visitors also on-call from home). Multidisciplinary ward rounds were led by the intensivist 7 days a week. All overnight admissions were discussed with the intensivist on duty. In our hospital, the Consultant Intensivist (Attending) led a team of doctors (usually one middle grade with > 4 postgraduate years of practice and at least one other doctor who was less experienced). In the U.K. health system, Consultants practice independently but within the general constraints of the hospital such as formulary, equipment, and staff. Consultant intensivists are responsible for the majority of clinical care (admission and discharge decisions, organ support, diagnostics, communication, prescribing, and overall strategy) but work closely with the referring specialties on a daily basis using a semi-closed model of care.

There were 27 intensivists employed by the Institution at the start of the study; eight new appointments were made during the study. No specific changes in nursing staffing or admission criteria occurred during this period.

Variables

The primary exposure variable was the status of the admitting intensivist. We defined this as "home" when the admitting intensivist was working in their usual ICU and "visitor" when the admitting intensivist usually worked in another ICU in the hospital. Two intensivists worked equally (as defined by days covered in ICU) in more than one ICU and were excluded; their admissions were excluded from the analysis, as their home could not be classified.

Confounding variables were abstracted from the electronic medical record. Given the diversity of the patient population in this study, we adjusted for the severity of critical illness using the Sequential Organ Failure Assessment (SOFA) score (11) which performs comparably to Simplified Acute Physiology Score II and Acute Physiology and Chronic Health Evaluation (APACHE) II/III (12, 13) and has adequate performance in trauma patients (14). It also has the advantage that it is applicable to critically ill patients from all specialties. APACHE II was not used as it does not account for cardiac surgery, solid organ, and bone marrow transplantation or transfers from other ICUs (15).

The SOFA components recorded electronically were ventilation status, worst P/F ratio, highest inotrope use, bilirubin, platelet count, and creatinine; Glasgow Coma Score and blood pressure (BP) were not captured by the electronic system. We did not include the neurologic component in our SOFA calculations. As the cardiovascular component of the SOFA score 0 for a mean BP over 70 mm Hg and 1 for a mean BP less than 70 mm Hg, missing BP measurements in patients not treated with vasoactive drugs were scored as 0.5.

The intensivist level confounder considered was experience, defined as the number of years' practice as a Consultant (attending) in ICU in our hospital, and excluding years in training or work as a consultant in other institutions.

Statistical Methods

Initially, the overall ICU mortality rate was compared between patients admitted by home and visiting intensivists using a Fisher exact test. This analysis was then split by ICU, in order to identify whether a visitor effect was present in any individual ICU. A range of other confounding factors was compared between home and visiting intensivists for the cohort as a whole and within each ICU. Categorical variables were compared using Fisher exact test. Ordinal and continuous variables were compared using Mann-Whitney *U* tests and reported as medians and quartiles. For the SOFA score, where significant differences were detected between groups that were too small to be reflected in the median score, the mean ± SD was used, in order to highlight the size and direction of the difference.

In order to account for the potential confounding effects of patient age, gender, and SOFA score, the type of admission, the experience of the consultant, and the clustering of the data within ICU and intensivist, generalized estimating equations (GEEs) (16) were used. As such, the subject variable was a combined variable of admitting consultant and ward, the within-subject variable was the chronologic patient admission order, and an exchangeable correlation structure was assumed. This treated all patients admitted to a specific ward by a specific consultant as a cluster and accounted for correlations between the outcomes of these patients.

Two models were produced, both of which had ICU mortality as the dependent variable. The first included the visitor status and the potentially confounding factors being considered as independent variables, as well as all two-way interactions with the ICU ward, with the exception of the ICU ward*visitor interaction. This allowed the overall visitor effect to be assessed, after accounting for the clustering in the data and a range of potentially confounding factors. A second model was then produced which included the ICU ward*visitor interaction to test whether the visitor effect differed across the ICU wards. Prior to this analysis, Hosmer and Lemeshow tests were performed individually for the continuous variables, which were converted to categorical variables where poor fit was detected.

Since not all intensivists rotated to other wards, there was the potential for selection bias. For example, those intensivists who perceived that they would perform poorly outside their home ICU or who were confident in their skills may have opted out or in as visitors. In order to test whether any significant selection bias had occurred, intensivists were divided into those who visited other ICUs and those who did not, with the home mortality rates of the two groups compared by univariable and multivariable analysis, as detailed previously.

All analyses were performed using IBM SPSS 22 (IBM, Armonk, NY), with p value of less than 0.05 deemed to be indicative of statistical significant throughout.

RESULTS

Combined Results From All ICUs

There were 11,688 admissions to all ICUs combined over the 5-year period; 849 admissions were excluded where the admitting intensivist was not recorded and 858 admissions were excluded as patients were admitted by one of two intensivists who worked equally in all ICUs. After exclusions, data were available for 9,981 admissions from 34 consultants (mean, 294 per consultant; range, 58–552). Six thousand one hundred fifty-six (61.7%) were male, the median age was 61.0 (range, 14–96; interquartile range [IQR], 47–71), the median SOFA score was 3.5 (range, 1–19; IQR, 1.5–6.0). The overall ICU mortality rate was 10.7% ($n = 1{,}064$).

There were 3,446 (34.5%) admissions by visiting intensivists and 6,535 (65.5%) by home intensivists. Visiting intensivists admitted patients with significantly higher SOFA score (mean ± SD, 4.1 ± 2.8 vs 3.9 ± 2.8; $p < 0.001$) and admitted a smaller proportion of patients during the night (20.2% vs 21.9%; $p = 0.045$). There were no significant differences in the average ages of patient admitted by each set of intensivists (median 61 yr in both groups, $p = 0.773$) (Table 1).

Analysis by ICU

There were 2,609 admissions to the liver/specialty ICU, 1,806 to the general/trauma/burns ICU, 1,785 to neuro-ICU, and 3,781 to the cardiac ICU. Mortalities varied widely between ICUs because of the different specialties housed within. The mortality in liver/specialty ICU was 15.9%, general/trauma/burns ICU 21.0%, neuro-ICU 7.1%, and cardiac ICU 3.8%. The proportion of elective, emergency, and transfers from other hospitals was also widely variable across the ICUs and is summarized, along with other factors, in Table 1.

The visiting intensivists in general/trauma/burns and cardiac ICUs admitted patients who had a significantly higher SOFA score (4.0 ± 2.8 vs 3.5 ± 2.7; $p < 0.001$ and 5.0 ± 2.2 vs 4.8 ± 2.3; $p < 0.001$). Visiting intensivists had lower median experience on all ICUs with the exception of general/trauma/burns ICU. Both home and visitors admitted patients with a similar age and sex distribution for their ICU.

Intensivist Working Patterns

During the study, 34 intensivists worked in the hospital; five had their home in the liver/specialty ICU; general/trauma/burns ICU had 10 home intensivists; neuro-ICU had eight home intensivists, and cardiac ICU had 11. Their median length of experience was 6.1 years (IQR, 2.7–9.8 yr).

There were a total of 3,650 day and night sessions covered in the 5 years of the study. Home intensivists provided 2,387 sessions (65%) in the liver/specialty ICU, 2,322 (64%) in the general/trauma/burns ICU, 1,766 (48%) in the neuro-ICU, and 2,246 (62%) in the cardiac ICU.

TABLE 1. Admission Characteristics Compared by ICU and Home/Visitor

Characteristic	Overall		Liver ICU	
Specialties housed within	–		Liver transplant/medicine/emergency referrals, bone marrow transplant, specialty medicine	
No. of beds	72		16	
	Home	Visitor	Home	Visitor
Admissions	6,535	3,446	1,489	1,120
Patient age, median (IQR)	61 (47–71)	61 (48–71)	60 (48–70)	59 (47–70)
p	0.773		0.820	
Gender (male), n (%)	4,073 (62.3)	2,083 (60.4)	841 (56.5)	636 (56.8)
p	0.069		0.905	
Type of admission, n (%)				
Elective	3,177 (48.6)	1,758 (51.0)	755 (50.7)	551 (49.2)
Unplanned	2,417 (37.0)	1,224 (35.5)	626 (42.0)	499 (44.6)
Transfer	941 (14.4)	464 (13.5)	108 (7.3)	70 (6.3)
p	0.069		0.343	
Experience of intensivists (yr)[a], median (IQR)	6 (3–10)	5 (3–8)	6 (5–8)	5 (3–9)
p	0.572		0.517	
Admission Sequential Organ Failure Assessment score, median (IQR)	2 (1–2)	2 (1–2)	5 (3–7)	4 (3–7)
p	**< 0.001**[b]		0.323	
Night admissions, n (%)	1,431 (21.9)	695 (20.2)	441 (29.6)	327 (29.2)
p	**0.045**		0.828	
Weekend admissions, n (%)	954 (14.6)	479 (13.9)	298 (20.0)	218 (19.5)
p	0.352		0.766	
Mortality, n (%)	668 (10.2)	396 (11.5)	215 (14.4)	201 (17.9)
p	0.052		**0.017**	

IQR = interquartile range.

[a]Calculated on an intensivist level, rather than a patient level, by first calculating the mean experience of each intensivist within each combination of ICU and visitor status.

[b]Mean Sequential Organ Failure Assessment for home versus visitor: 1.8 versus 1.9.

[c]Mean Sequential Organ Failure Assessment for home versus visitor: 4.8 versus 5.0.

Data reported as *n* (%), with *p* values from Fisher exact tests, or median (interquartile range), with *p* values from Mann-Whitney *U* tests, as applicable.

Boldface font indicates $p < 0.05$.

Home intensivists admitted 1,489 of 2,609 (57%) admissions in liver/specialty ICU, 1,386 of 1,806 (77%) in general/trauma/burns ICU, 1,164 of 1,785 (65%) in neuro-ICU, and 2,496 of 3,781 (66%) in cardiac ICU during the study period. Of the 34 intensivists, 15 worked across all ICUs, nine worked in three of the four, and four intensivists worked in one other ICU. Six intensivists (two from the general/trauma/burns ICU, one from neuro-ICU, and three from cardiac ICU) did not move from home. Of the 34 intensivists 28 (82%) spent time as visitors in other units. While working in their home units, those who became visitors had similar mortality outcomes to their colleagues who did not visit other units (**Table 2**).

Mortality Analysis

The overall ICU mortality rate was 10.7% ($n = 1{,}064$). Univariable analysis (Table 1) found a higher ICU mortality among patients admitted by visitors although this did not reach statistical significance (11.5% vs 10.2%; $p = 0.052$). The analysis was then categorized by ICU, which found that visiting consultants had significantly higher mortality rates than home consultants on liver/specialty ICU (17.9% vs 14.4%; $p = 0.017$) and general/trauma/burns (26.0% vs 19.6%; $p = 0.005$), with no evidence of significant differences in neuro-ICU ($p = 0.383$) or cardiac ICU ($p = 0.857$).

Multivariable analyses included the ICU ward and home/visitor status, as well potentially confounding factors relating to patient and admitting consultant (age decile, gender, SOFA,

Trauma/Burns ICU		Neuro-ICU		Cardiac ICU	
Major trauma, burns, general medicine, vascular surgery		Neurosurgery and neurology		Cardiothoracic surgery including heart, lung and heart-lung transplant; cardiology	
18		12		26	
Home	**Visitor**	**Home**	**Visitor**	**Home**	**Visitor**
1,386	420	1,164	621	2,496	1,285
59 (39–73)	61 (42–72)	52 (39–63)	53 (40–64)	65 (55–72)	65 (55–72)
0.515		0.474		0.844	
848 (61.2)	264 (62.9)	601 (51.6)	287 (46.2)	1,783 (71.4)	896 (69.7)
0.567		**0.033**		0.274	
242 (17.5)	66 (15.7)	425 (36.5)	230 (37.0)	1,755 (70.3)	911 (70.9)
1,109 (80.0)	343 (81.7)	355 (30.5)	198 (31.9)	327 (13.1)	184 (14.3)
35 (2.5)	11 (2.6)	384 (33.0)	193 (31.1)	414 (16.6)	190 (14.8)
0.723		0.687		0.260	
4 (3–7)	7 (4–13)	9 (2–12)	5 (3–6)	7 (5–12)	5 (3–8)
0.150		0.514		0.329	
3 (2–5)	4 (2–6)	1 (1–3)	1 (1–2)	5 (4–6)	5 (4–7)
< 0.001		0.290		**< 0.001**[c]	
554 (40.0)	157 (37.4)	254 (21.8)	129 (20.8)	182 (7.3)	82 (6.4)
0.362		0.629		0.313	
317 (22.9)	104 (24.8)	216 (18.6)	80 (12.9)	123 (4.9)	77 (6.0)
0.430		**0.002**		0.168	
271 (19.6)	109 (26.0)	87 (7.5)	39 (6.3)	95 (3.8)	47 (3.7)
0.006		0.383		0.857	

admission type, and experience). The first model was used to test the overall difference between home and visiting consultants. After accounting for potentially confounding variables and the clustering in the data, mortality was found to be significantly higher in visiting consultants (odds ratio [OR], 1.18; 95% CI, 1.02–1.37; $p = 0.024$).

A second model additionally included the interaction term between the visitor status and the ICU ward to test whether the visitor effect differed by ICU. This interaction term was significant ($p = 0.046$), implying that the magnitude of the visitor effect differed by ICU. As in the univariable analysis, no significant visitor effect was detected in either neuro-ICU (OR, 0.79; 95% CI, 0.46–1.36; $p = 0.400$) or in cardiac ICU (0.87; 0.62–1.21; $p = 0.402$). However, visitors were found to have significantly higher mortality in liver/specialty (OR, 1.36; 95% CI, 1.08–1.71; $p = 0.009$) and general/trauma/burns ICUs (1.35; 1.08–1.69; $p = 0.009$). The key results of both models are summarized graphically in **Figure 1**. The full models are reported in **Supplemental Table 1a** (Supplemental Digital Content 1, http://links.lww.com/CCM/C453) and **Supplemental Table 1b** (Supplemental Digital Content 2, http://links.lww.com/CCM/C454).

As a sensitivity analysis, we also used a propensity score adjusted model. This score was produced based on all of the factors in Table 1, as well as the time of day and year of admission. A GEE was then produced, which included this as a covariate alongside the ward and the visitor status. The analysis was

TABLE 2. Home ICU Mortality for Intensivists Who Worked as Visitors During the Study and for Those Who Only Worked on Their Home Ward

			ICU Mortality on Home Ward			
ICU/Visitor Status	Consultants	Admissions	*n* (Rate)[a] (%)	*p*	Adjusted OR (95% CI)[b]	*p*
General/trauma/burns ICU				0.605		0.513
Home only	2	415	85 (20.5)		Reference	
Worked as visitor	8	971	186 (19.2)		0.90 (0.66–1.23)	
Neuro-ICU				0.193		0.433
Home only	1	58	7 (12.1)		Reference	
Worked as visitor	7	1,106	80 (7.2)		0.70 (0.29–1.70)	
Cardiac ICU				0.371		0.411
Home only	3	793	26 (3.3)		Reference	
Worked as visitor	8	1,703	69 (4.1)		1.22 (0.76–1.98)	

[a]Univariable analysis of mortality rates was performed using Fisher exact test.
[b]From a multivariable model accounting for admission type, gender, age, and Sequential Organ Failure Assessment score.
Liver ICU was not included in the analysis, as all five intensivists based on this ward spent time as visitors in other wards.

repeated using a general linear mixed model, with the ward and the ward*consultant interaction as random factors. Finally, we created a GEE model incorporating variables for weekend/weekday admission, day/night admission, and year of study. All of these models yielded results similar to the model reported above.

DISCUSSION

We found that there was a higher mortality rate in patients admitted by an intensivist unused to working in that ICU. Subgroup analyses revealed that this visitor effect seemed to occur in both a specialty ICU (liver/specialty) and a general ICU (general/trauma/burns). The effect remained despite controlling for patient factors. Inexperience did not seem to account for our findings.

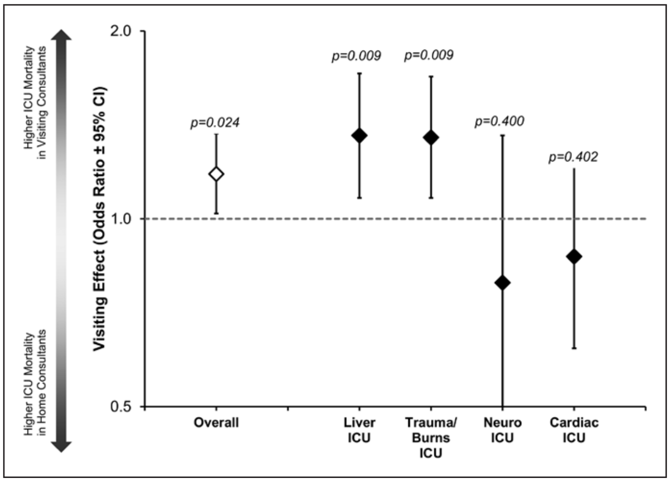

Figure 1. Visitor effect for the whole cohort and split by ward. The overall effect is from the generalized estimating equation model including all factors except the visitor*ICU interaction, and the results for the separate wards are from the model with this interaction included. The full models used in this analysis are reported as model 1 and model 2, respectively, in Supplemental Table 1a (Supplemental Digital Content 1, http://links.lww.com/CCM/C453) and Supplemental Table 1b (Supplemental Digital Content 2, http://links.lww.com/CCM/C454).

The "visiting patient" effect has been described: "outlier" patients cared for in a subspecialty ICU with a diagnosis outside the expertise of the unit had a higher mortality (17). We believe that our study is the first to explore the relationship between a visiting intensivist and patient outcome. Kahn et al (9) reported that patients receiving mechanical ventilation who were treated in ICUs with high-intensity intensivist staffing were more likely to receive evidence-based treatments such as daily sedation holds or spontaneous breathing trials. However, even the high-intensity intensivist group had best practice reliability rates of 42–47% for certain interventions. In our study, the two ICUs with the highest proportion of scheduled surgical cases, least case-mix variation and greatest opportunity for standardized practice, neuro- and cardiac ICU, did not demonstrate a visitor effect. Greater standardization and protocolized practice may have acted to harmonize the clinical practice of visitors with those of home intensivists. We also recognize that the study may have insufficient power to detect a visitor effect in these ICUs where mortality is much lower than the liver/specialty and general/trauma/burns ICUs.

We note that two of the ICUs admitted patients with higher severity of illness measured by SOFA during visitor periods. This occurred in one unit with a visitor mortality effect and one without. Given the structure of the study, there are two possible explanations for this: The first is that this is a chance observation from differences in several variables in multiple ICUs. The second is that this is part of the "overall visitor effect" on mortality. Visitors might admit sicker patients or delay admission until the patients are sicker because of their inexperience in that patient population. Regardless, the visitor effect on mortality remained after adjusting for these differences in severity of illness.

It is important to note that while we have called this the "visitor effect," we simply do not have the data to assign this effect to the visiting intensivist's clinical skill set. The observed association between visitor status and mortality, if causal, may be due to impaired team dynamics and communication. Gaps in communication between doctors and nurses impede shared goals of care (1); bridging those gaps can improve patient outcomes (2) but to do so requires functional teamworking. If nothing else, the ability of nursing staff to question decisions made by the intensivist may stop errors when communicating intended treatments. The "soft" skills of modifying clinician behavior (i.e., stopping them from performing an intervention that is suboptimal) by the multidisciplinary team may be more effective when team members are familiar to each other.

Our study raises important questions that we could not explore given the range of the exposure variables and statistical power. For example, it would be interesting to measure how long it takes for a visitor to become part of the home team. Unfortunately, the relatively short times that individual visitors spent at each ICU were insufficient to explore this.

Our study has a number of limitations. Although it is an observational study and subject to residual confounding, we believe a randomized trial of different types of intensivists in different ICUs would be challenging and expanding it to a multicenter exponentially so. Observational studies are always susceptible to missed confounders and indication bias that might account for these results. However, we believe this study and our analytic approach is uniquely resistant to this phenomenon as any potential confounder would have to be linked to the timing of the relatively random visitors' rotations rather than to the patients or the ICUs.

By comparing admissions within ICU, any limitations in the severity of illness adjustment would have been nondifferential with regard to visitor timing and applied equally to all patients. Similarly, differences in patient characteristics, diagnoses, and comorbidities are likely to be smaller within an ICU and unlikely to vary with the visitor rotation. Hospital effects are discounted by the fact that the four ICUs were located in a single institution. The movement of intensivists between ICUs could have been biased, as this was not strictly randomized, but this cannot detract that these intensivists went on to become visitors. Furthermore, visiting intensivists when working in their home units had similar outcomes to intensivists who did not visit elsewhere. Therefore, in this quasi-experimental study, any changes in patient demographics, case-mix, and procedures performed during visiting periods are likely to be a result of having a visiting intensivist rather than an explanation of the observed mortality.

The study period reflects care from several years ago as the computer systems at our institution were in their infancy and extracting the data only recently became possible. We do not believe that this detracts from our findings. Regardless of secular trends in ICU mortality or practice, the fundamental health services organization issues of unfamiliar intensivists in ICU have not changed. Finally, these are data from a single center and, as with all novel observations, require validation in other institutions.

It may be that our observed phenomenon can be applied to other hospital environments. Disruption of the "home team" advantage may well apply when a different anesthetist is in theatre, scrub nurse at the operating table, or junior doctor covering an unfamiliar ward. Our observations may be being replicated in other complex systems and deserve further study.

CONCLUSIONS

We found that in a large, single-center study of 9,981 patients admitted over 5 years to four ICUs in our hospital, there were two ICUs where mortality was higher when admitting intensivists were unfamiliar with the ICU. The length of service of an intensivist did not account for our findings. We have since restructured our ICUs and believe that the interaction between intensivists and ICUs merits further study.

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