

## Chapter 38. “Closed” Intensive Care Units and Other Models of Care for Critically Ill Patients

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### **Background**

Patients in the intensive care unit (ICU) require complex care relating to a broad range of acute illnesses and pre-existing conditions. The innate complexity of the ICU makes organizational structuring of care an attractive quality measure and a target for performance improvement strategies. In other words, organizational features relating to medical and nursing leadership, communication and collaboration among providers, and approaches to problem-solving<sup>1</sup> may capture the quality of ICU care more comprehensively than do practices related to specific processes of care.<sup>2</sup>

Most features of ICU organization do not exert a demonstrable impact on clinical outcomes such as morbidity and mortality.<sup>3</sup> While hard clinical outcomes may not represent the most appropriate measure of success for many organizational features, the role of “intensivists” (specialists in critical care medicine) in managing ICU patients has shown a beneficial impact on patient outcomes in a number of studies. For this reason, the Leapfrog Group, representing Fortune 500 corporations and other large health care purchasers, has identified staffing ICUs with intensivists as one of three recommended hospital safety initiatives for its 2000 purchasing principles (see also Chapter 55).<sup>4</sup>

In this chapter, we review the benefits of full-time intensivists and the impact of “closed ICUs” (defined below) on patient outcomes. Much of this literature makes no distinction between improved outcomes in general and decreased harm in particular. However, given the high mortality<sup>5</sup> and complication rates<sup>6-8</sup> observed in ICUs, it seems reasonable to consider global interventions such as organizational changes as patient safety practices.

### **Practice Description**

The following practice definitions are synthesized from studies reviewed for this chapter. For all of these models, the term “intensivist” refers to a physician with primary training in medicine, surgery, anesthesiology or pediatrics followed by 2-3 years of critical care medicine (CCM) training.

*Open ICU model*—An ICU in which patients are admitted under the care of an internist, family physician, surgeon or other primary attending of record, with intensivists available providing expertise via elective consultation. Intensivists may play a *de facto* primary role in the management of some patients, but only within the discretion of the attending-of-record.

*Intensivist Co-management*—An open ICU model in which all patients receive mandatory consultation from an intensivist. The internist, family physician, or surgeon remains a co-attending-of-record with intensivists collaborating in the management of all ICU patients.

*Closed ICU model*—An ICU in which patients admitted to the ICU are transferred to the care of an intensivist assigned to the ICU on a full-time basis. Generally, patients are accepted to the ICU only after approval/evaluation by the intensivist. For periods typically ranging from one week to one month at a time, the intensivist’s clinical duties predominantly consist of caring for patients in the ICU, with no concurrent outpatient responsibilities.

*Mixed ICU models*—In practice, the above models overlap to a considerable extent. Thus, some studies avoid attempting to characterize ICUs in terms of these models and focus instead on the level of involvement of intensivists in patient care regardless of the organizational model. This involvement may consist of daily ICU rounds by an intensivist (thus including “closed model ICUs” and “intensivist comanagement”), ICU directorship by an intensivist (possibly including examples of all 3 models above), or simply the presence of a full-time intensivist in the ICU (also including examples of all 3 models.)

*Intensivist models*—ICU management may include all of these models. These models are contrasted with the open ICU model, in which an intensivist generally does not participate in the direct care of a significant proportion of the ICU patients.

### **Prevalence and Severity of the Target Safety Problem**

ICUs comprise approximately 10% of acute care hospital beds.<sup>9</sup> The number of annual ICU admissions in the United State is estimated to be 4.4 million patients.<sup>10</sup> Due to an aging population and the increasing acuity of illness of hospitalized patients, both the total number of ICU patients and their proportional share of hospital admissions overall are expected to grow.<sup>11</sup>

ICU patients have, on average, mortality rates between 12 and 17%.<sup>25</sup> Overall, approximately 500,000 ICU patients die annually in the United States. A recent review estimated that this mortality could be reduced by 15 to 60% using an intensivist model of ICU management.<sup>12</sup>

Young and Birkmeyer have provided estimates of the relative reduction in annual ICU mortalities resulting from conversion of all urban ICUs to an intensivist model of management model.<sup>10</sup> Using conservative estimates for current ICU mortality rates of 12%, and estimating that 85% of urban ICUs are not currently intensivist-managed, the authors calculated that approximately 360,000 patients die annually in urban ICUs without intensivists. A conservative projection of a 15% relative reduction in mortality resulting from intensivist-managed ICUs yields a predicted annual saving of nearly 54,000 lives.

By only measuring ICU mortality rates, this analysis may underestimate the importance of intensivist-managed ICUs. In addition to mortality, other quality of care outcome measures that might be improved by intensivists include rates of ICU complications, inappropriate ICU utilization, patient suffering, appropriate end-of-life palliative care, and futile care.

### **Opportunities for Impact**

Currently, a minority of ICUs in the United States utilizes the intensivist model of ICU management.<sup>13</sup> Intensivists are even less frequently found in non-teaching and rural hospitals. The potential impact of the intensivist model is far-reaching.

### **Study Designs**

Among 14 studies abstracted for this chapter, 2 were systematic reviews and 12 were original studies. One systematic review is an abstract that has not yet appeared in journal form and does not provide cited references.<sup>12</sup> The other systematic review evaluated 8 references, all of which are included in this chapter.<sup>10</sup> An additional 4 studies absent from the systematic review are included here. These 4 studies include 2 abstracts that were published after the 1999 systematic review,<sup>14,15</sup> and 2 studies of pediatric ICUs with intensivists.<sup>16,17</sup>

Among the original studies, 6 incorporated historical controls and 5 used a cross-sectional approach. One study<sup>18</sup> had both historical and cross-sectional components. The original studies include 4 studies of adult medical ICUs, 6 studies of adult surgical ICUs and 2 studies of

pediatric multidisciplinary ICUs. Intensivist models used by the studies cited for this review include 4 closed ICUs, 4 mixed ICUs, 3 ICUs with intensivist comanagement and one open ICU.

Several studies were excluded, including abstracts with insufficient data,<sup>19-25</sup> unclear distinctions in patient management between control groups and intervention (intensivist managed) groups,<sup>26,27</sup> intensivist models that may have important roles in future practice (eg, telemedicine consultation with remote management) but are not yet widely available<sup>28,29</sup> and considerably older studies.<sup>30</sup>

## **Study Outcomes**

Required outcomes of interest in studies chosen for this chapter were ICU mortality, overall in-hospital mortality, or both. Some studies also included morbidity outcomes, adverse events and resource utilization (eg, length of ICU and hospital stay), levels of patient acuity or severity of illness (ICU utilization) and levels of high-intensity intervention usage. Studies addressing the impact of intensivist ICU management on resource utilization without mortality or outcome data were excluded. There are no data regarding the impact of intensivists.

## **Evidence for Effectiveness of the Practice**

As shown in Table 38.1, most of the studies report a decrease in unadjusted in-hospital mortality and/or ICU mortality, although this decrease did not reach statistical significance in 3 of the 14 studies.<sup>16,18,31</sup> One study found a statistically insignificant increase in the unadjusted mortality rates associated with the intensivist model ICU.<sup>32</sup> This study also found that the ratio of expected-to-actual mortality was reduced in the intensivist-model ICUs. This finding was associated with a higher severity of illness scores in the intensivist-model ICU population. A similar finding of significantly improved outcomes after adjusting for severity of illness and comparing expected-to-actual mortality rates was demonstrated in one pediatric study.<sup>16</sup> Overall, the relative risk reduction for ICU mortality ranges from 29% to 58%. The relative risk reduction for overall hospital mortality is 23% to 50%. These results are consistent with those of a previous systematic review that found a 15% to 65% reduction in mortality rates in intensivist-managed ICUs.<sup>10</sup>

Data concerning long-term survival (6 and 12 months) for patients cared for in ICUs with and without intensivist management is not available. Differences in outcomes between closed ICUs, mixed ICU models and co-managed ICUs are difficult to assess. Studies that have addressed conversion from an open to a closed model did not utilize full-time intensivists in the open model study phases.<sup>18,32-34</sup> Therefore it is not clear to what extent improved patient outcomes resulted only from changes in intensivists' direct patient care and supervision.

The observational studies evaluating these practices suffer from 2 major limitations. Half of the studies retrospectively compared post-implementation outcomes with those during an historical control period. Because none of these studies included a similar comparison for a control unit that remained open in both time periods, we lack information on secular trends in ICU outcomes during the time periods evaluated. The other major limitation associated with comparing mortality rates for ICU patients relates to differences in ICU admission and discharge criteria under different organizational models. Under the intensivist model, patients are generally accepted to the ICU only after approval/evaluation by the intensivist. Thus, conversion to an intensivist model ICU may bring about changes in the ICU patient population that are incompletely captured by risk-adjustment models and confound comparisons of mortality rates. Moreover, these changes in ICU admitting practice may exert contradictory effects. For example, an intensivist model ICU may result in fewer ICU admissions for patients with dismal

prognoses, and less futile care for patients already in the ICU. On the other hand, intensivist-managed ICUs with stricter admission and discharge criteria may result in a greater overall acuity of illness for the ICU patients and therefore higher mortality rates.

### **Potential for Harm**

The potential for harm resulting from intensivist management is unclear. Concerns raised in the literature about intensivist-managed ICUs include the loss of continuity of care by primary care physicians, insufficient patient-specific knowledge by the intensivist,<sup>35</sup> reduced use of necessary sub-specialist consultations, and inadequate CCM training of residents who formerly managed their own ICU patients.

Perhaps more worrisome is the impact that adoption of this practice would have on physician staffing and workforce requirements. Without a substantial increase in the numbers of physicians trained in CCM, projected increases in the ICU patient population over the next 30 years will result in a significant shortfall in the intensivist workforce.<sup>11</sup>

### **Costs and Implementation**

These studies did not address the incremental costs associated with implementation of full-time intensivists. Several studies have analyzed resource utilization and length of stay associated with intensivist-managed ICUs.<sup>13,16,18,19,29,31,32,36</sup> The results of these studies are variable with respect to costs. Some demonstrate a decrease in ICU expenses. Others found increased costs, likely due to the increased use of expensive technologies. Still others show little overall cost differential. The cost-effectiveness and cost-benefit of an intensivist-model ICU requires further study.

### **Comment**

Outcomes research in critical care is particularly challenging for several reasons. It typically relies on observational outcomes studies, and must account for the diversity and complexity of variables measured and controlled for, such as patient-based, disease-based, provider-based and therapy-based variables. Despite these challenges and limitations, the literature fairly clearly shows that intensivists favorably impact ICU patient outcomes. What remains unclear is which intensivist model to recommend—intensivist consultation versus intensivist co-management versus closed ICUs. Also, we do not know the degree to which the choice among these models depends on intensivist background – ie, medicine, anesthesiology or surgery. Finally, because the mechanism of the benefit of intensivist models is unknown, the degree to which this benefit can be captured by other changes in practice (eg, adoption of certain evidence-based processes of ICU care) remains unclear.

The major incentive for clarifying these issues concerns the implications for staffing ICUs in the future. While the evidence supports the beneficial role of full-time intensivists, the current number of trainees is insufficient to keep pace with the expected increase in the number of ICU patients.<sup>11</sup> Until we are able to sufficiently increase the size and number of CCM training programs for physician specialists, complementary solutions for meeting critical care management demands should be considered. These might include incorporating physician-extenders such as nurse practitioners and physician assistants with specialized critical care training, increased participation by hospitalists in care of ICU patients,<sup>37</sup> regionalization of critical care services,<sup>38</sup> or providing innovative methods to extend intensivists' expertise to remote sites through telemedicine consultations.<sup>28</sup> The latter practice seems particularly promising—a recent time series cohort study found an approximately 33% decrease in severity-

adjusted hospital mortality and a nearly 50% decrease in ICU complications when a technology-enabled remote ICU management program was instituted in a community-based ICU.<sup>28</sup>

**Table 38.1. Intensivist management in the care of critically ill patients\***

Study Setting	Study Year	ICU Type	Study Design, Outcomes	Intensivist Intervention	Mortality Relative Risk Reduction (%)	
					ICU	Hospital
<i>Closed ICU Model</i>						
Tertiary care, urban, teaching hospital; patients with septic shock; historical control <sup>33</sup>	1982-1984	MICU	Level 3, Level 1	Closed	NA	23
Teaching hospitals (n=2); two study designs using historical and concurrent controls <sup>18</sup>	1992-1993	MICU	Level 3, Level 1	Closed	NA	Retrospective: 19 (p=NS) Prospective: 26 (p=NS)
Tertiary care, urban, teaching hospital; historical control <sup>32</sup>	1993-1994	MICU	Level 3, Level 1	Closed	NA	-38 (p=NS)†
Tertiary care, urban, teaching hospital; historical control <sup>34</sup>	1995-1996	SICU	Level 3, Level 1	Closed	58	50§
<i>Mixed ICU models</i>						
ICUs (n=16) with different characteristics; cross-sectional <sup>16</sup>	1989-1992	Pediatric MICU SICU	Level 3, Level 1	Mixed	RRR 25¶ OR 1.5**	NA
ICUs (n=39) with different characteristics; cross-sectional. Patients with abdominal aortic surgery <sup>38</sup>	1994-1996	SICU	Level 3, Level 1	Mixed	NA	OR 3.0§§
ICUs (n=31) with different characteristics; cross-sectional. Patients with esophageal resection <sup>14</sup>	1994-1998	SICU	Level 3, Level 1	Mixed	NA	RRR 73¶ OR 3.5**
ICUs (n=39) with different characteristics; cross-sectional. Patients with hepatic resection <sup>15</sup>	1994-1998	SICU	Level 3, Level 1	Mixed	NA	RRR 81¶ OR 3.8**
Community teaching hospital; historical control <sup>40</sup>	1992-1994	MICU	Level 3, Level 1	Open	29	28
<i>Co-managed ICUs</i>						
Tertiary care ICU in a teaching children's hospital <sup>16</sup>	1983-1984	Pediatric MICU SICU	Level 3, Level 3	Co-manage	48 (p=NS)	NA
Tertiary care, Canadian teaching hospital; historical control <sup>39</sup>	1984-1986	SICU	Level 3, Level 1	Co-manage	52	31
Tertiary care, urban, teaching hospital; cross-sectional comparison (concurrent control) <sup>31</sup>	1994-1995	SICU	Level 3, Level 1	Co-manage	NA	32 (p=NS)

\* ICU indicates intensive care unit; MICU, medicalintensive care unit; Mixed, mixed intensivist model (including daily ICU rounds by an intensivist, the presence of a full-time intensivist, open units with comanagement and closed units with mandatory consultations or only intensivist management); NA, not available as outcome (was not evaluated); NS, not stastically significant; and SICU, surgical intensive care unit.

† Negative value indicates an increase in relative risk of mortality.

‡ O/E is observed to expected mortality ratio based risk adjustment

§ Hospital mortality measured 30-days after discharge

¶ RRR is the unadjusted mortality relative risk reduction

\*\* OR is the adjusted odds ratio of increased mortality associated without an intensivist model.

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