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*Eff Clin Pract. 2000;6:284-289.*

# Potential Reduction in Mortality Rates Using an Intensivist Model To Manage Intensive Care Units

**CONTEXT.** Because of evidence suggesting that outcomes are better in “intensivist-model” intensive care units (ICUs), the Leapfrog Group’s hospital safety standards propose that ICUs be managed by critical care physicians (intensivists) who work exclusively in the ICU.

**COUNT.** Number of lives saved annually in the United States.

**CALCULATION.** Lives saved = (number of ICU admissions × in-hospital mortality rate of ICU patients) × reduction in mortality rates associated with the intensivist model.

**DATA SOURCE.** Reduction in mortality rate associated with intensivist-model ICUs was determined by performing a structured literature review from 1986 to the present using MEDLINE. Other variables were estimated from various data sources.

**RESULTS.** In the nine studies that met our selection criteria, relative reductions in mortality rates associated with intensivist-model ICUs ranged from 15% to 60%. On the basis of the most conservative estimate of effectiveness (15% reduction), full implementation of intensivist-model ICUs would save approximately 53,850 lives each year in the United States.

**CAUTIONS.** Given the large number of ICU patients and their high baseline risks, even modest reductions in mortality rates would save many lives. Because of potential constraints related to the workforce and other resources, the feasibility of fully implementing intensivist-model ICUs nationwide is uncertain.

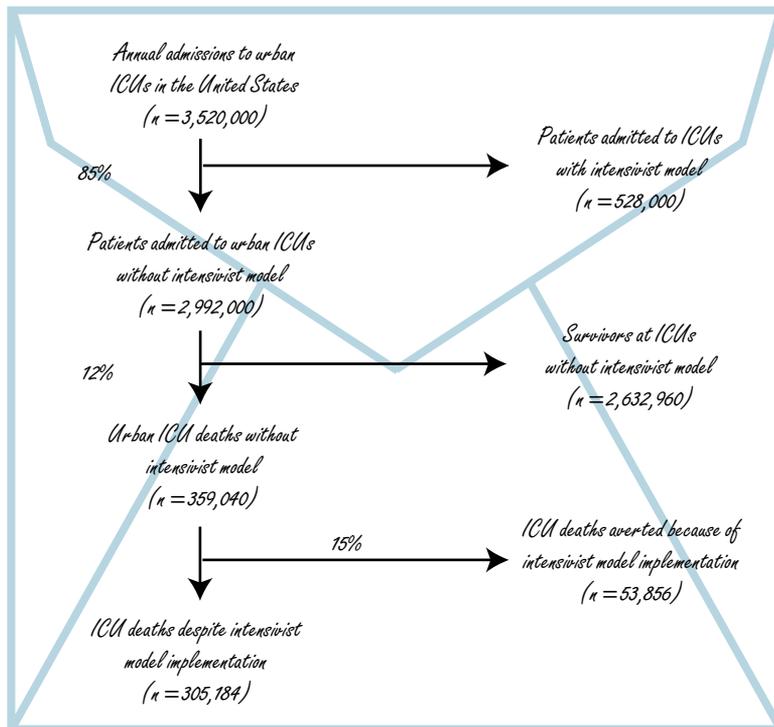
**B**ecause growing evidence suggests that outcomes are better in intensive care units (ICUs) managed predominantly by full-time intensivists, the Leapfrog Group’s hospital safety initiative<sup>1</sup> calls for hospitals to adopt “intensivist-model” ICUs. For hospitals to meet the Leapfrog standard, ICUs must be managed by physicians who are board-certified (or board-eligible) in critical care medicine. During daytime hours, such physicians must be present to provide clinical care exclusively in the ICU. At other times, they will be able to return pages within 5 minutes and rely on in-hospital “effectors” (physicians or physician extenders) who can reach ICU patients within 5 minutes. Using findings from previous studies, we estimated the number of lives that could be saved by full implementation of intensivist-model ICUs nationwide.

## Methods

As summarized in **Figure 1**, we calculated the number of lives that could potentially be saved by full implementation of intensivist-model ICUs. We started with the

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See related Policy Matters on pages 313-316.



**FIGURE 1. Back-of-the-envelope calculation of lives that would be saved each year by full nationwide implementation of intensivist-model staffing in the intensive care unit (ICU).**

population of ICU patients potentially affected by the policy and then estimated baseline in-hospital mortality risks and potential reductions in mortality rates associated with implementing intensivist-model ICUs.

### Current Number of Admissions to Intensive Care Units

To estimate the number of patients that could potentially benefit from the policy initiative, we determined the number of patients admitted each year to nonintensivist ICUs. We could not directly determine the overall number of patients admitted to ICUs in the United States. According to analysis of the 1999 Medical Provider Analysis and Review file, approximately 2.2 million Medicare patients were admitted to medical or surgical ICUs, excluding coronary care units (Pronovost P. Personal communication). Because Medicare patients represent approximately half of all adult ICU patients (Maryland State data, provided by P. Pronovost), we assumed in our baseline analysis that 4.4 million patients are admitted to ICUs in the United States each year.

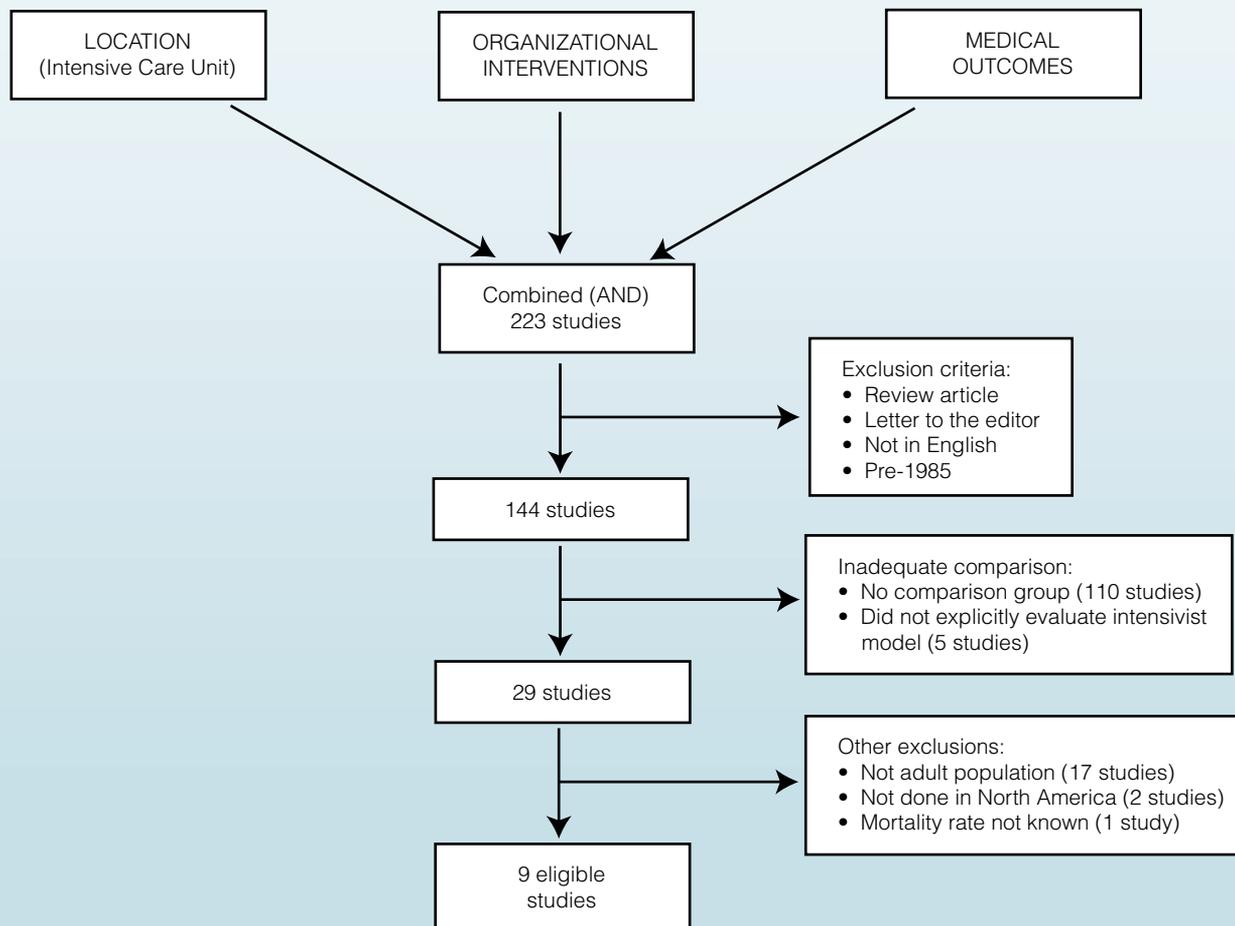
To avoid access issues in rural areas, the Leapfrog Group is restricting policy implementation to urban areas. According to analysis of the 1996 American Hospital Association file and census database, 80% of all U.S. hospital beds (and 53% of hospitals) are located in metropolitan statistical areas (MSAs). Assuming that 80% of ICU admissions similarly occur in MSAs, we

estimated that 3.52 million patients are admitted each year to ICUs in urban hospitals.

The current proportion of ICUs in the United States with intensivist models is unknown but probably low. In a 1991 national survey, only 22% of hospitals indicated that ICU order writing was restricted to unit staff (i.e., a “closed unit”).<sup>2</sup> In a follow-up survey,<sup>3</sup> the same group reported that 17% of ICUs had closed units with respect to order writing. Neither study described the proportion of closed units in which all ICU staff were board-certified (or board-eligible) in critical care medicine or met other Leapfrog criteria. In our baseline analysis, we assumed that 15% of all ICU patients are currently treated in ICUs that meet the Leapfrog standard.

### Current Mortality Rates in Intensive Care Units

We estimated average in-hospital mortality rates for ICU patients from two large multicenter studies. Zimmerman and colleagues<sup>4</sup> noted an overall in-hospital mortality rate of 12.4% in 38,000 patients admitted to 161 hospitals between 1993 and 1996. In another study by Shortell and coworkers,<sup>5</sup> in-hospital mortality for 17,000 patients at 42 randomly selected ICUs was 16.6% between 1988 and 1990. In our baseline analysis, we selected the lower (and thus more conservative) of these two estimates: 12%.



Search Terms Defined

1. LOCATION: intensive care units/or respiratory care units, intensive care
2. ORGANIZATIONAL INTERVENTIONS: organizational innovation, organization (floating subheading), intensivist, specialties/medical
3. MEDICAL OUTCOMES: cause of death, fatal outcome, hospital mortality (floating subheading), survival rate, length of stay, treatment outcome, outcome assessment (health care)

FIGURE 2. MEDLINE search strategy (OVID).

### Reductions in Mortality Rates with the Intensivist Model

Many studies have evaluated the effectiveness of similar (although not identical) staffing models in reducing ICU mortality rates. After performing a structured literature review (Figure 2), we identified nine studies on which to base our estimates of the effectiveness of implementing intensivist-model staffing.<sup>6-13</sup> Six of these studies were based on pre-post study designs at single sites, all generally large ICUs in teaching hospitals (Table 1). Three

studies had cross-sectional designs, comparing intensivist model hospitals (or the equivalent) with nonintensivist model hospitals during a single period (Table 2).

In all nine studies, intensivist-model staffing was associated with reduced ICU mortality rates. In five of the studies, the reductions in mortality rate were statistically significant. Relative reductions in mortality rates associated with intensivist-model staffing ranged from 15% to 60% (relative risk, 0.85 to 0.4). To be conservative in our calculations of lives saved, we selected the esti-

TABLE 1

## Pre-Post Studies of the Effectiveness of Intensivist-Model Staffing in the ICU\*

SETTING (YEARS)	MANAGEMENT MODEL FOR INTENSIVE CARE UNITS		HOSPITAL MORTALITY RATE†		UNADJUSTED RELATIVE RISK (95% CI)
	PREINTERVENTION (PATIENTS)	POSTINTERVENTION (PATIENTS)	PREINTERVENTION	POSTINTERVENTION	
Detroit Receiving Hospital (1982–1984) <sup>6</sup>	Internists with ICU housestaff (n = 100) <sup>‡</sup>	Full-time intensivists with ICU fellows and ICU housestaff (n = 112)	74%	57% <sup>§</sup>	0.77 (0.63–0.94)
Surgical ICU, Plains Health Care Medical Center, Saskatchewan (1984–1985) <sup>8</sup>	Attending physician or surgeon with ICU housestaff (n = 223)	Same, plus co-management by full-time intensivist (n = 216)	36%	25% <sup>§</sup>	0.61 (0.44–0.83)
Medical ICU, Long Island Jewish Medical Center (1992–1993) <sup>7</sup>	Admitting attending with ICU housestaff (n = 152)	Intensivists with ICU housestaff (n = 154)	45%	36%	0.80 (0.60–1.08)
Bridgeport Hospital, Connecticut (1992–1994) <sup>9</sup>	Private physicians with housestaff (n = 459)	Same, plus full-time medical director and co-management by intensivist (n = 471)	34%	25% <sup>§</sup>	0.72 (0.59–0.89)
University of Chicago Hospital (1993–1994) <sup>10</sup>	Admitting attending with ward housestaff (n = 124)	Intensivists with ICU housestaff (n = 121)	29%	25%	0.85 (0.56–1.29)
Rhode Island Hospital (1995–1996) <sup>11</sup>	Co-management by intensivist (n = 125)	Management by intensivist (n = 149)	14%	6% <sup>  </sup>	0.42 (0.20–0.90)

\*ICU = intensive care unit.

†Unadjusted except for the University of Chicago study.

‡Internists at Detroit Receiving Hospital were nonintensivists who maintained ambulatory care practices while rotating through as attending physicians in the ICU.

§P < 0.001.

||P < 0.05.

mate from the study that demonstrated the least effectiveness (15% reduction). However, in sensitivity analyses, we tested the effect of different assumptions about the effectiveness of intensivist-model ICUs.

## Results

In our baseline analysis, we estimated that full implementation of intensivist-model staffing would save approximately 53,850 lives each year in the United States. As expected, the number of lives saved varied according to assumptions about the effectiveness of intensivist-model staffing (Figure 3). For example, if we used a relative reduction in mortality rate of 35% (a midrange estimate from the nine studies) instead of 15%

(the most conservative estimate), 126,000 lives would be saved.

## Discussion

Because so many patients in the United States—approximately 500,000—die in ICUs each year, even small reductions in ICU mortality rates would save many lives. If the Leapfrog Group's initiative is successful in fully implementing intensivist-model ICU staffing in metropolitan areas nationwide, we estimate that approximately 53,850 lives could be saved each year.

Of course, our estimates depend heavily on assumptions about the effectiveness of implementing

TABLE 2

## Cross-Sectional Studies of the Effectiveness of Intensivist-Model Staffing\*

SETTING (YEARS)		INTERVENTION (PATIENTS)		MORTALITY RATE		UNADJUSTED RELATIVE RISK (95% CI)
CONTROL MODEL	INTENSIVIST MODEL	CONTROL MODEL	INTENSIVIST MODEL	CONTROL MODEL	INTENSIVIST MODEL	
Surgical ICU, University of Pennsylvania Medical Center (1994–1995) <sup>12</sup>	Same <sup>†</sup>	Attending surgeons with ward house-staff ( <i>n</i> = 100)	Full-time intensivists with ICU housestaff ( <i>n</i> = 100)	6%	4%	0.67 (0.19–2.20)
5 Maryland ICUs that manage post-operative AAA repairs (1994–1995) <sup>13</sup>	36 Maryland ICUs that manage post-operative AAA repairs (1994–1995)	No daily rounds by intensivists ( <i>n</i> = 472)	Daily rounds by intensivists ( <i>n</i> = 2515)	15%	6% <sup>‡</sup>	0.40 (0.31–0.52)
Winthrop-University Hospital, New York (1993) <sup>7</sup>	Long Island Jewish Medical Center, New York (1993)	Attending physician with ICU housestaff ( <i>n</i> = 95)	Full-time intensivists with ICU housestaff ( <i>n</i> = 195)	38%	28%	0.74 (0.52–1.05)

\*AAA = abdominal aortic aneurysm; ICU = intensive care unit.

<sup>†</sup>Patients in this study were selected for the control or intervention group (within the same ICU) according to the attending surgeon's preference.

<sup>‡</sup>*P* < 0.01.

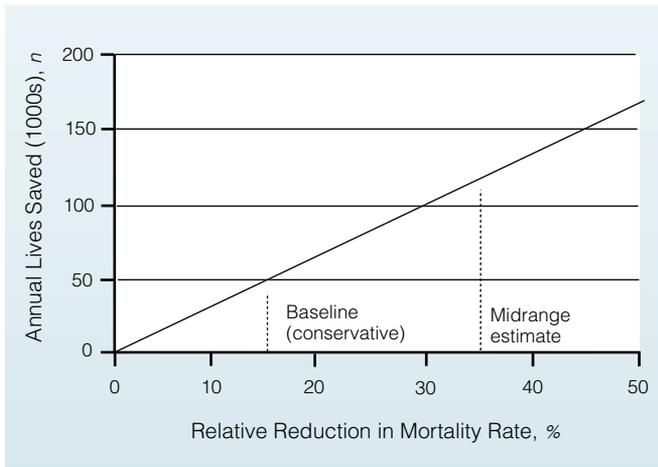
intensivist-model staffing. We chose to be conservative in estimating the potential effectiveness of the method because of several limitations in the original studies and questions about how generalizable their results would be to the nation as a whole. First, inferences from the six pre–post studies are limited by secular trend bias (i.e., mortality rates may have decreased at those hospitals for reasons other than implementation of intensivist-model staffing). The hospitals in these studies may have changed other aspects of care not directly related to physician staffing. Although no evidence shows that ICU mortality rates are decreasing, mortality rates for many clinical conditions are improving over time with advances in science and technology.<sup>14,15</sup> Second, estimates from the three cross-sectional studies probably suffered from imperfect risk adjustment. Thus, the results of these studies may be partially confounded by unmeasured differences in case-mix between control and intensivist-model groups. Third, caution is required when generalizing results of the nine studies, which were all based at large teaching hospitals, to other settings.

Finally, the “intervention” and the explicitness with which it was described varied substantially in the

studies we assessed. Some interventions involved simply adding co-management by a single intensivist to a system primarily run by non-ICU-based physicians; others described extensive changes in staff organization, including completely replacing ward-based teams with intensivists and ICU-based housestaff. It is important to note, however, that the Leapfrog Group's ICU standards fall on the latter, “stricter” side of the spectrum and therefore are likely to be more efficacious.

Although the potential benefits are large, it is uncertain whether full implementation of intensivist-model ICU staffing is feasible from a workforce and resource perspective. Workforce issues have not been studied carefully, but it is unlikely that there are currently enough board-certified intensivists to fully staff ICUs at all hospitals.<sup>15</sup> In hospitals with small units, it may not be economically realistic to restrict the activities of intensivists to the ICU. For these reasons, broad implementation of intensivist-model ICU staffing may require regionalizing intensive care and closing many small ICUs.

Many would argue that the lives saved by intensivist-model ICU staffing are not equivalent to those saved by other public health interventions (e.g., seat belt



**FIGURE 3.** Lives saved each year in the United States, according to the effectiveness of intensivist-model staffing in the intensive care unit.

laws). Patients in ICUs often have many comorbid conditions and thus shortened life expectancies compared with the general population. For this reason, future research should consider ways in which improvements in ICU care affect long-term survival and quality of life after hospital discharge.

### Take-Home Points

- Growing evidence suggests that outcomes are better in ICUs managed predominantly by full-time intensivists.
- We estimated the potential benefit of nationwide implementation of the Leapfrog Group standards for intensivist-model ICUs.
- In our baseline analysis, we estimated that full implementation of intensivist-model staffing would save approximately 53,850 lives each year in the United States.
- Because of potential constraints related to the workforce and other resources, the feasibility of fully implementing intensivist-model ICUs nationwide is uncertain.

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### Grant Support

Dr. Birkmeyer is supported by a Career Development Award from the VA Health Services Research & Development program. The views expressed in this paper do not necessarily represent the views of the Department of Veterans Affairs of the U.S. Government

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