

LETTER



# Impact of structured care systems on mortality in intensive care units

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Dear Editor,

The intensive care unit (ICU) is a data-rich environment requiring complex decisions made in the setting of high uncertainty. One approach to reduce complexity and support decision-making is to rationalize care delivery via Structured Care Systems (SCS), defined here as evidence-based guidelines, quality improvement programs, bundles, protocols, or decision algorithms consisting of at least two linked decision-points and/or interventions [2]. It is assumed that SCS have a favorable impact on clinical outcomes and care delivery by reducing variability of clinical practices, increasing efficiency and safety, and better aligning evidence and practice [1, 3, 5]. However, the impact of ICU-based SCS on clinical outcomes is not well established [4]. We aimed to determine the effect of SCS on mortality and length of stay (LOS) in the ICU, accounting for SCS type and target.

We conducted a systematic review and meta-analysis (PROSPERO: CRD42020193517) of prospective studies in adult ICU patients that implemented a SCS, had a control group without the SCS, and reported mortality. The primary outcome was hospital mortality (or another short-term mortality measure if unavailable). Secondary outcomes were LOS in ICU, SCS adherence, and number of Effective Practice and Organisation of Care (EPOC) implementation strategies used. Meta-analysis was completed with raw data and using a random-effects model. Study quality was assessed with the Cochrane Collaboration's risk of bias tool for randomized studies and the Newcastle–Ottawa Scale (NOS) for non-randomized studies. Sensitivity analysis was

conducted to identify differences in outcome associated with SCS type and target, and to assess the impact of implementation strategies, study quality, and reported post-implementation adherence. Additional information is in the online supplement.

Results are summarized in Table 1 and in the supplement. We identified 64 studies (1,358,054 patients) published between 1998 and 2020. SCS implementation was associated with a significant reduction in mortality [pooled mortality risk ratio (RR) 0.88 (95% CI 0.84–0.92,  $p < 0.001$ ;  $I^2 = 80.85\%$ )], although effect size was moderate (number needed to treat = 18) and was associated with lower study quality (Table 1). Sensitivity analysis revealed that SCS targeting sepsis or sedation had the largest impact on mortality [respectively, RR 0.73 (95% CI 0.65–0.81,  $p < 0.001$ ) and RR 0.86 (95% CI 0.76–0.99,  $p = 0.02$ )]. Among the individual SCS types, care bundles (RR 0.82, 95% CI 0.76–0.89,  $p \leq 0.001$ ) and guidelines (RR 0.86, 95% CI 0.77–0.97,  $p = 0.01$ ) were significantly associated with mortality reduction. No relation was noted between SCS and ICU-LOS. Level of SCS adherence was reported in 29 studies (45%) and the median post-implementation adherence rate was 83% (IQR 42–91%). Sensitivity analysis found that neither adherence rate nor the number of EPOC implementation strategies was significantly associated with mortality.

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Job van Steenkiste and Sarah Larson contributed equally to this work.

**Table 1 Meta-analysis and sensitivity analysis of the primary mortality outcome as effect measure for SCS type and target, adherence, implementation strategies, and quality assessment**

Comparison	Number of studies	Risk ratio	95% confidence interval	p value
<b>Overall meta-analysis for mortality</b>	64	0.88	0.84–0.92	<0.001
<b>SCS type (n = 64)</b>				
Bundles	24	0.82	0.76–0.89	<0.001
Protocols	19	0.94	0.81–1.09	0.400
Guidelines	9	0.86	0.77–0.97	0.011
Quality improvement programs	6	1.01	0.92–1.10	0.865
Algorithms	4	0.86	0.64–1.16	0.317
<b>SCS target (n = 37)</b>				
Sepsis	11	0.73	0.65–0.81	<0.001
Ventilator-associated pneumonia	7	0.95	0.83–1.09	0.441
Weaning from mechanical ventilation	7	1.27	0.95–1.69	0.103
Sedation	4	0.86	0.76–0.98	0.022
Pain Agitation Delirium	4	0.76	0.54–1.07	0.116
Nutrition	4	0.89	0.72–1.11	0.316
<b>Adherence (n = 29)</b>				
≥ 83.3% adherence <sup>a</sup>	15	0.90	0.80–1.02	0.096
< 83.3% adherence <sup>a</sup>	14	0.81	0.74–0.88	<0.001
<b>Implementation strategies (n = 64)</b>				
≥ 6 EPOC strategies used <sup>a</sup>	37	0.89	0.84–0.94	<0.001
< 6 EPOC strategies used	27	0.89	0.80–0.98	0.021
<b>Quality assessment (n = 64)</b>				
Randomized studies overall	14	0.95	0.81–1.11	0.514
Randomized studies 'low risk of bias'	9	1.08	0.90–1.31	0.416
Randomized studies 'some concerns of bias'	5	0.72	0.59–0.88	<0.001
Non-Randomized studies overall	50	0.87	0.83–0.92	<0.001
Non-Randomized studies ≥ 7 NOS stars	35	0.90	0.85–0.95	<0.001
Non-Randomized studies < 7 NOS stars	15	0.78	0.68–0.89	<0.001

NOS New Ottawa Scale, EPOC Effective Practice and Organization of Care

<sup>a</sup> Interpretation: studies comparing populations with and without exposure to the structured care systems (SCS) with either higher or lower than the median reported post-implementation adherence rate of 83.3% among 29 studies that reported adherence data. Similarly for EPOC strategies, maximum number of NOS stars is nine; seven stars indicates good or fair quality

Results support deployment of SCS in the ICU, specifically bundles and guidelines or those targeting sepsis or sedation. No association was found between mortality and SCS adherence or use of specific implementation strategies, suggesting that additional research is needed on potential modifiers of the relationship between SCS and mortality. Studies are also needed to identify components, implementation strategies, and target populations which maximize the impact of SCS on outcomes of critically ill patients.

#### Supplementary Information

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#### Declarations

#### Conflicts of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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