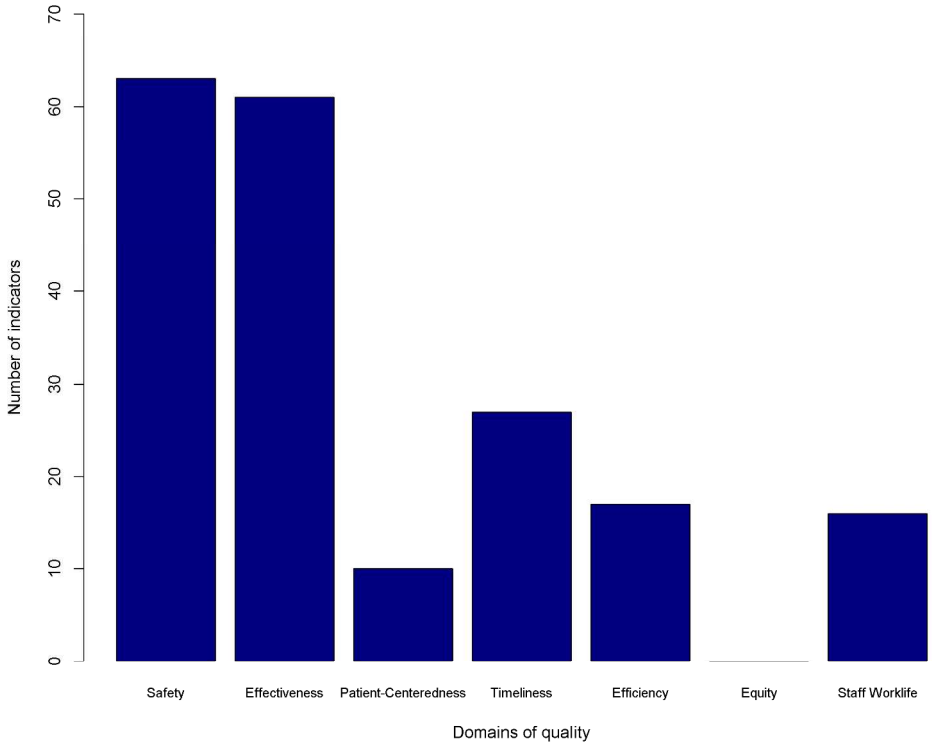
An environmental scan of quality indicators in critical care

Journal:	*CMAJ Open*
Manuscript ID	CMAJOpen-2015-0139
Manuscript Type:	Survey
Date Submitted by the Author:	16-Dec-2015
Complete List of Authors:	Valiani, Sabira; University of Ottawa Rigal, Romain; CHUM, Medicine Stelfox, Henry; University of Calgary, Department of Medicine John, Muscedere; Queen's University, Medicine and Critical Care Medicine Martin, Claudio; University of Western Ontario, Schulich School of Medicine & Dentistry, Critical Care Medicine Dodek, Peter Lamontagne, Francois; Universite de Sherbrooke Fowler, Robert; Sunnybrook Hospital, Medicine and Critical Care Medicine Gheshmy, Afshan; University of Ottawa Cook, Deborah; McMaster U, Medicine Clin Epid Biostats Forster, Alan; Ottawa Health Research Institue, Clinical Epidemiology Program Hebert, Paul; Ottawa Hospital Research Institute, Clinical Epidemiology Program
Keywords:	Critical care, intensive care
More Detailed Keywords:	quality indicators, performance, Donabedian, quality of care, quality improvement
Abstract:	Quality indicators are increasingly collected and reported in the critically ill, with the aim of improving the value of patient care. We undertook an environmental scan to identify and categorize indicators unique to critical care that are reported by key organizations. Design Data Sources: We convened a panel of 10 experts to identify key organizations that are focused on quality improvement or critical care. We then reviewed their on-line publications and searched their website content. Data Extraction: We summarized indicators specific to the care of critically ill patients and then categorized them according to the Donabedian and the Institute of Medicine frameworks. We also noted the organizations' rationale for selection of these indicators, and their substantiation by published evidence. Results Data Synthesis: From 28 targeted organizations, we identified 127 distinct quality indicators that are specific to critical care. Of these 32% were safety indicators and 31% were effectiveness indicators. The rationale for selecting these indicators was supported by published research evidence in 20% of indicators and by consensus in 26%. In most instances (54%), the rationale for selection was not reported or the reader was referred to other organizations' reports. Twenty-one percent of indicators were accompanied by a formal grading of evidence, whereas 41% percent provided no

	reference to publications. Conclusion Although there are many quality indicators related to critical care in the public domain, due to a paucity of rationale for selection, supporting evidence, and results of implementation, it is not clear which indicators should be adopted for use.



Number of Quality Indicators by Domain

254x211mm (300 x 300 DPI)

AN ENVIRONMENTAL SCAN OF QUALITY INDICATORS IN CRITICAL CARE

Paul C. Hebert MD MHSc FRCPC
Critical Care Physician & Physician-in-Chief, CHUM
CRCHUM Centre hospitalier de l'Université de Montréal
900 St-Denis, Suite R04-476
Montreal, QC, H2X 0A9
Phone: (514) 890-8000, poste 27282
Internet: paul.hebert.chum@ssss.gouv.qc.ca

Sabira Valiani, MD[1]; Romain Rigal, PharmD, MSc[2]; Henry T Stelfox, MD, PhD[3]; John Muscedere, MD[4]; Claudio M Martin, MD[5]; Peter Dodek, MD, MHSc[6]; François Lamontagne, MD, MSc[7]; Robert Fowler, MD, MSc[8]; Afshan Gheshmy, MD[1]; Deborah J Cook, MD, MSc[9]; Alan J Forster, MD, MSc[10] and Paul C Hébert, MD, MSc[11].

[1] University of Ottawa, Ottawa, ON, Canada.

[2] Centre de Recherche du Centre Hospitalier de l'Université de Montréal (CRCHUM), Montréal, QC, Canada.

[3] Department of Critical Care Medicine and Community Health Sciences, University of Calgary, Calgary, AB, Canada.

[4] Department of Medicine, Queen's University, Kingston, ON, Canada.

[5] London Health Sciences Centre, Lawson Health Research Institute, London, ON, Canada.

[6] Division of Critical Care Medicine and Center for Health Evaluation and Outcome Sciences, St. Paul's Hospital and University of British Columbia, Vancouver, BC, Canada.

[7] Centre de Recherche Clinique Étienne-Le Bel, Université de Sherbrooke, Sherbrooke, QC, Canada.

[8] Departments of Medicine and Critical Care Medicine, Sunnybrook Hospital, Toronto, ON, Canada.

[9] Departments of Medicine Clinical Epidemiology and Biostatistics, McMaster University, Hamilton, ON, Canada.

[10] Department of Medicine, University of Ottawa, Clinical Epidemiology Program, Ottawa Hospital Research Institute, Ottawa, ON, Canada.

[11] Département de Médecine, Centre Hospitalier de l'Université de Montréal (CHUM), Hôpital Notre-Dame, Montréal, QC, Canada.

Key words: critical care, quality indicators, quality of care, quality improvement, intensive care unit.

Abstract

Objective

Quality indicators are increasingly collected and reported in the critically ill, with the aim of improving the value of patient care. We undertook a directed environmental scan to identify and categorize indicators unique to critical care that are reported by key organizations.

Design

Data Sources: We convened a panel of experts (n=10) to identify key organizations that are focused on quality improvement or critical care. We then reviewed their online publications and searched their website content.

Data Extraction: We summarized indicators specific to the care of critically ill patients and then categorized them according to the Donabedian and the Institute of Medicine frameworks. We also noted the organizations' rationale for selection of these indicators, and their substantiation by published evidence.

Results

Data Synthesis: From 28 targeted organizations, we identified 127 distinct quality indicators that are specific to critical care. Of these 32% were safety indicators and 31% were effectiveness indicators. The rationale for selecting these indicators was supported by published research evidence in 20% of indicators and by consensus in 26%. In most instances (54%), the rationale for selection was not reported or the reader was referred to other organizations' reports. Twenty-one percent of indicators were accompanied by a formal grading of evidence, whereas 41% percent provided no reference to publications.

Conclusion

Although there are many quality indicators related to critical care in the public domain, due to a paucity of rationale for selection, supporting evidence, and results of implementation, it is not clear which indicators should be adopted for use.

INTRODUCTION

In the healthcare sector, quality indicators have been developed to compare actual patient care to best practice. They provide a quantitative tool for healthcare providers and decision-makers who aim to improve processes and outcomes of patient care (1). Conceptual frameworks may be used to categorize these indicators (2). Two of the most commonly used frameworks are those of Donabedian (3) and the Institute of Medicine (IOM) (4). In the Donabedian framework, health care quality indicators are categorized as related to structure (conditions under which care is provided), process (methods by which health care is provided), or outcome (changes in health status attributable to health care). From the perspective of patient care, the IOM has identified six dimensions: 1) safety, 2) effectiveness, 3) patient-centeredness, 4) timeliness, 5) efficiency and 6) equity.

As clinicians and ICU decision-makers, we are constantly being asked to produce evidence of performance or improvement in care. However, it is not clear which measures should be used. There is tremendous heterogeneity in their scope, scale, and scientific basis. The scientific literature abounds with a bewildering array of candidate quality indicators (5-7) and intensive care societies, quality improvement organizations, patient advocacy and safety groups have begun to report on quality using some of these indicators. To help inform the rational selection of quality indicators, we undertook a directed environmental scan of quality indicators that are reported by key organizations.

METHODS

Search Strategy

We convened a panel of experts to identify organizations that have interests in quality of care or intensive care. The panel consisted of 10 intensivists who have expertise in quality measurement, epidemiology, and systematic reviews from across Canada. Selection of panel members was based on two

criteria: 1) scientific productivity in critical care; and 2) clinical and methodological expertise in literature review. In addition, geographic representativeness of the panel members was sought.

We contacted Canadian and provincial organizations (n=15) (i.e. provincial health care quality councils and critical care societies) that had, at a minimum, published one quality indicator in critical care. To add to the Canadian data, we also selected a convenience sample of major international organizations (n=13). We specifically sought information from international intensive care societies and state-wide integrated health systems that contributed to the science of quality indicator development and implementation. This international sample was not meant to be comprehensive. It was selected to benchmark Canadian findings to data from international organizations that operate in similar health care systems. From August 2012 to January 2013, we reviewed publications and websites from these organizations to identify quality indicators related to the care of the critically ill. Website content was searched using the key words "intensive care unit", "critical care", and "quality indicator" where necessary. If no quality indicators relevant to this environmental scan were identified using this search strategy, the organizations were contacted via electronic mail. We requested information pertaining to their quality of care initiatives as well as information about how indicators were selected.

For the purpose of this environmental scan, we defined a quality indicator as any measurement proposed by the organization that could be used as a measure for monitoring or improving the quality of patient care (1). We considered that an indicator had a full operational definition if it included a description in quantifiable terms of what to measure and the specific steps needed to measure it consistently (8). Collections of indicators ("bundles") aimed at improving the care of patients with respect to a single disease process (e.g. sepsis treatment or ventilator-associated pneumonia prevention bundles), were counted as single composite measures. They were evaluated as a whole and as individual components. We included all quality indicators that focused on the care of the critically ill and excluded indicators used solely in neonatal populations.

One reviewer (SV) narratively summarized all identified quality indicators, including their descriptive definition, measurement criteria, rationale for selection, and evidentiary basis. We also identified indicators for which information on early implementation results and potential unintended outcomes was available from targeted organizations.

Two of the authors (SV and AG) assessed the redundancy of quality indicators based on reported operational definitions. We also agreed on the categorization of each quality indicator according to the Donabedian and the IOM classifications. We extended the latter by adding the "staff work-life" domain, as used in the Critical Care Vital Signs Monitor project (9).

RESULTS

Twenty-eight organizations were targeted for inquiry by our expert panel (Table 1). A total of 222 quality indicators were identified from their publications and website content. Out of these 222 indicators, 127 (57% of all indicators) had a full operational definition, 88 (39%) had a partial definition, and 7 (4%) indicators had no definition at all (i.e. identification by title only). After review of definitions and titles of the 222 indicators, 127 were considered unique, of which 9 were composite measures (Supplemental file 1).

Donabedian Classification

From our review, 11 (8%) of the 127 unique indicators were related to structure, 68 (54%) were related to processes of care, and 48 (38%) were related to outcome. The most commonly reported structure indicators were use of private rooms for patients who have antibiotic-resistant infections, nurse to patient ratios, ICU occupancy, intensivist to patient ratios, and 'closed' ICU structure.

Process indicators that were endorsed by four or more organizations included compliance with hand hygiene, formal medication reconciliation process at ICU admission, prescription of venous thromboembolism prophylaxis, glycemic control protocols, and the implementation of rapid response

team. Additionally, nine bundles of indicators were identified as process indicators; these were in the following categories: 1) Prevention of ventilator-associated pneumonia, 2) Central line insertion and maintenance, and 3) Sepsis resuscitation and management. These bundles were developed by the Institute for Health Improvement (IHI), Agency for Healthcare Research and Quality (AHRQ), and the Canadian Patient Safety Institute (CPSI) through the Safer Healthcare Now! initiative.

Similarly, outcomes indicators reported by four or more organizations included catheter related blood-stream infection rate, ventilator-associated pneumonia rate, ICU-acquired Clostridium difficile or methicillin resistant Staphylococcus aureus infections, ICU length of stay, and standardized mortality ratios.

IOM Classification

We also categorized the 127 unique quality indicators according to the IOM dimensions of safety, effectiveness, patient-centeredness, timeliness, efficiency, equity, plus an additional category of staff work-life. Sixty seven (53%) of the indicators were related to multiple aims. The largest numbers of quality indicators were in the domains of safety (63 (32%)) and effectiveness (61 (31%)). Twenty-seven (14%) were related to timeliness, 17 (9%) were related to efficiency, and 16 (9%) were related to staff work-life. Only ten (5%) indicators were related to patient-centeredness and none were related to equity.

The most commonly reported safety indicators were compliance with hand hygiene, formal medication reconciliation process at ICU admission, prescription of venous thromboembolism prophylaxis, glycemic control protocols, implementation of a rapid response team, catheter related blood-stream infection rate, ventilator-associated pneumonia rate, and ICU-acquired Clostridium difficile or methicillin resistant Staphylococcus aureus infections. These safety indicators were all endorsed by four or more organizations. Most often reported effectiveness indicators were: 1) prescription of venous thromboembolism prophylaxis, 2) glycemic control protocols, 3) catheter related blood-stream infection rate, 4) ICU length of stay, and 5) standardized mortality ratio.

IOM-Donabedian Matrix

Table 2 displays the distribution of quality indicators across a two-dimensional matrix that merges the Donabedian classification with the IOM classification. This typology facilitates the evaluation of domains of quality that require further assessment while underscoring the type of information that should be collected. As in other fields of medicine, the greatest number of available indicators are process indicators related to safety and effectiveness. From our review, structure and outcome indicators related to patient-centeredness, efficiency, and equity are lacking among all endorsed indicators in the critically ill.

Quality Indicator Selection Rationale and Supporting Evidence

Among the 222 identified indicators, organizations' rationale for reporting was a reference to published research (45 indicators, 20%), internal consensus methodology (58 indicators, 26%), or a reference to another organization's established quality indicators (40 indicators, 18%). However, 79 (36%) indicators had no rationale for their selection reported.

Only five of the 28 organizations formally evaluated the level of evidence to support their quality indicators (i.e. GRADE (10), CDC , or AHRQ framework; (11) for 28 (13%) of 222 identified indicators. One organisation assessed 7 quality indicators (3%) through a less rigorous process (i.e. "peer reviewed synthesis of the evidence"). Indicators that were not graded formally or informally were supported by references to literature (77, 35%) or were not supported at all (110, 49%).

Of the 127 unique quality indicators, then, 27 (21%) included a formal evaluation of evidence, 6 (5%) included an informal evaluation, 42 (33%) included a reference to published literature, and 52 (41%) had no reference to evidence provided by the organization. Interestingly, the number of organizations reporting an indicator does not correlate with its evidence grading. Specifically, of the 127 indicators identified, 25 were endorsed by three or more organisations, but only eight of these (32%) were supported by evaluation evidence.

Early Results of Implementation

Data about the implementation of quality indicators was reported by four of the 28 stakeholder organizations: the Institute for Healthcare Improvement (IHI), the Canadian Patient Safety Institute (CPSI), the Australasian and New Zealand Intensive Care Society (ANZICS), and Health Quality Ontario (HQO).

Unintended Outcomes

Three organizations (AHRQ, IHI, and CPSI) reported potential or observed unintended consequences of implementing recommended quality indicators. Each quality indicator endorsed by the AHRQ included an evaluation of its potential for unintended harm, based on a literature review of published evidence. As with the ranking of evidence for the AHRQ quality indicators, the potential for harm was also ranked as low, moderate or high, allowing a direct comparison between the strength of evidence for the use of the quality indicator, and the potential for harm. The IHI and the CPSI reported risks of hypoglycemia associated with use of insulin protocols, pulmonary edema associated with fluid resuscitation, self extubation associated with daily interruptions of sedation, bleeding associated with venous thromboembolism prophylaxis, and C. difficile and hospital acquired pneumonia associated with implementation of ventilator-associated pneumonia bundles. Unfortunately, the incidence of unintended consequences was not reported by any of these three organizations.

DISCUSSION

In this directed environmental scan, we identified a total of 127 unique quality indicators related to critical care. Little agreement exists among the 28 targeted organizations as to which measures should be used to monitor, and will eventually help improve, the quality of care of the critically ill. However, there are common indicators reported in the domains of safety and effectiveness, including measures

related to prophylaxis of venous thromboembolism, central line blood stream infection, and glycemic control.

In order to measure care provided to the critically ill, healthcare providers and managers need quality indicators that cover structure, process, and outcomes and that address all the dimensions of quality (12). Although there are a variety of safety and effectiveness measures that address processes of care, there are very few measures of patient-centeredness, efficiency and equity that address structure and outcome.

Based on available online information, it is clear that targeted stakeholder organizations consider implementation of quality indicators to be a priority. However, rigorous reporting of the rationale for selection, evidentiary basis, and evaluation after implementation of these quality indicators was scarce. Furthermore, authoritative organisations do not report on quality indicators in a systematic manner.

We can nonetheless recommend the adoption of quality indicators with the highest grade of supporting evidence from Table 3. These encompass ventilator-associated pneumonia bundles, measures to prevent central line associated bloodstream infection, venous thromboembolism prophylaxis, limited components of sepsis resuscitation and management bundles, glycemic control policies, the presence of pharmacist on rounds, and use of simulation exercises for trainees.

In this environmental scan, only 127 (57%) of all identified quality indicators had a full operational definition. While we acknowledge that the development of implementation guidelines for quality indicators may be beyond the scope of endorsing organizations, a standardized operational definition may facilitate implementation and evaluation. The CPSI through the Safer Healthcare Now! initiative, as well as IHI and the AHRQ provide implementation packages. Also, cost estimates (low, moderate, or high) and resources required for implementation were available in the CPSI and AHRQ implementation packages. Only four organizations reported early results of implementation and only AHRQ systematically reported unintended consequences.

Increasingly, stakeholder organizations and hospitals are moving toward the use of an amalgamated selection of quality indicators spanning all domains of quality of care to make up a "scorecard" or "dashboard". The Critical Care Vital Signs Monitor project is one such example of a quality indicator scorecard (9). Critical Care Services Ontario has also developed a scorecard to monitor quality of care (13). Future research will be required to evaluate combinations of indicators and the potential benefits and risks to patient care with their implementation.

This report has several limitations. First, the environmental scan was limited to publications and websites of the targeted organizations. This was primarily a Canadian scan plus a convenience sample of international organizations—it was not a comprehensive search through all pertinent organizations. As a result, it is possible that we have missed important information related to the development of indicators or indicator sets in the biomedical literature. It is also possible that we missed the evidence base, syntheses or evidence assessment methods because such process reports were disseminated through scientific publications. A scoping review of these publications may help discern quality indicators based on their evidence grading. However, as websites and published bulletins are the main public voice of most societies, we believe that this space should include all major important scientific information. An inherent limitation of web searches is also their obsolescence of the reported results.

Secondly, an evaluation of the quality indicators themselves was beyond the scope of the review. We did record whether the quality indicator had an operational definition; however, the definition itself was not evaluated. The key components of a good quality indicator, namely, importance, scientific soundness, useability and feasibility (including cost burden), were also not evaluated in this study.

CONCLUSION

Many authoritative organizations across the globe have begun to endorse quality indicators, bundles and dashboards with the aim of improving the care of the critically ill. Although the domains of safety and effectiveness are well covered, there is paucity of measures that address patient-centeredness, efficiency, and staff worklife. The notable absence of equity indicators is concerning. The lack of convergence among organisations' selection of candidate quality indicators, as well as their uneven

approaches to report on rationale for selection, evidentiary support, and results of implementation may not facilitate the adoption of indicators into ICU practice.

FOOTNOTES

Authorship contribution

All authors participated in various capacities within the study as well as with this manuscript. SV was involved with the design, implementation and analysis of all aspects of the study including data gathering, analysis, and manuscript generation. RR, HTS, JM, CMM, PD, FL, DJC, AJF and PCH were involved in the study design, data analysis and manuscript edition. AG was involved in the data gathering and evaluation of quality indicator redundancy across all sources. All were in agreement to the final version of this manuscript being submitted.

Competing interests

No competing interest to declare.

Ethics approval:

This study only used data already in the public domain and therefore ethical approval was not required.

Data sharing statement

Data may be obtained by writing to the corresponding author.

References

1. Mainz J. Defining and classifying clinical indicators for quality improvement. International journal for quality in health care : journal of the International Society for Quality in Health Care / ISQua. 2003;15(6):523-30.
2. Stelfox HT, Straus SE. Measuring quality of care: considering measurement frameworks and needs assessment to guide quality indicator development. Journal of clinical epidemiology. 2013.
3. Donabedian A. Evaluating the quality of medical care. . Milbank Q. 2005;83(4):691-729.
4. Institute of Medicine CoQoHCiA. Crossing the quality chasm : a new health system for the 21st century. Washington, D.C.: National Academy Press; 2001. xx, 337 p.
5. de Vos M, Graafmans W, Keesman E, Westert G, van der Voort PH. Quality measurement at intensive care units: which indicators should we use? Journal of critical care. 2007;22(4):267-74.
6. Berenholtz SM, Dorman T, Ngo K, Pronovost PJ. Qualitative review of intensive care unit quality indicators. Journal of Critical Care. 2002;17(1):1-12.
7. Rhodes A, Moreno RP, Azoulay E, Capuzzo M, Chiche JD, Eddleston J, et al. Prospectively defined indicators to improve the safety and quality of care for critically ill patients: a report from the Task Force on Safety and Quality of the European Society of Intensive Care Medicine (ESICM). Intensive care medicine. 2012;38(4):598-605.
8. Loyd R. Quality Health Care: A guide to developing and using indicators. Barlett Ja, editor2004.
9. Martin C. Critical Care Vital Signs Monitor: A scorecard for safe and efficient patient care in the ICU 2009. Available from: http://www.patientsafetyinstitute.ca/English/research/cpsiResearchCompetitions/2006/Documents/Martin/Report/Martin%20Full%20Report.pdf.
10. Atkins D, Best D, Briss PA, Eccles M, Falck-Ytter Y, Flottorp S, et al. Grading quality of evidence and strength of recommendations. BMJ (Clinical research ed). 2004;328(7454):1490.
11. Owens DK, Lohr KN, Atkins D, Treadwell JR, Reston JT, Bass EB, et al. AHRQ series paper 5: grading the strength of a body of evidence when comparing medical interventions--agency for healthcare research and quality and the effective health-care program. Journal of clinical epidemiology. 2010;63(5):513-23.
12. Quality AfHRa. Quality Measure Tools and Resource Use Measures. Part IV. Selecting Quality and Resource Use Measures [May 1 2014]. Available from: http://www.ahrq.gov/professionals/quality-patient-safety/quality-resources/tools/perfmeasguide/perfmeaspt4.html.
13. Secretariat CC. Critical Care Unit, Balanced Scorecard Toolkit. Ontario: 2012.

National Critical Care Societies
Canadian Critical Care Society (CCCS)
American Society of Critical Care Medicine (SCCM)
European Society of Intensive Care Medicine (ESICM)
Australasian and New Zealand Intensive Care Society (ANZICS)
Intensive Care Society (ICS)
Provincial Critical Care Societies
Alberta Critical Care Clinical Network (ACCCN)
British Columbia Society for Critical Care Medicine (BCSCCM)
Ontario Critical Care Secretariat (OCCS)
Provincial Health Quality Councils
British Columbia Patient Safety and Quality Council (BCPSQC)
Health Quality Council of Alberta (HQCA)
Saskatchewan Health Quality Council (SHQC)
Manitoba Institute of Patient Safety (MIPS)
Health Quality Ontario (HQO)
New Brunswick Health Quality Council (NBHQC)
National Health Providers
Health Canada
National Health Service (NHS)
Quality Improvement & Patient Safety
Canadian Patient Safety Institute (CPSI) Safer Healthcare Now! Initiative (SHN) Critical Care Vital Signs Monitor Project (CCVSM)
Canadian Healthcare Association (CHA
National Quality Forum (NQF)
Institute of Healthcare Improvement (IHI)
Agency for Healthcare and Research Policy (AHRQ) Health Cost and Utilization Project (HCUP)
National Quality Measures Clearinghouse (NQMC)
Institute of Medicine (IOM)
Canadian Institute for Health Information (CIHI)
Intensive Care National Audit Research Centre (ICNARC)
Accreditation
Accreditation Canada
Other
Health Talk Online
US Department of Veteran Affairs (VA)

	Structure	*Process*	*Outcome*	Total
Safety	1 (1%)	33 (17%)	29 (15%)	63 (32%)
Effectiveness	8 (4%)	33 (17%)	20 (10%)	61 (31%)
Patient-centeredness	0 (0%)	8 (4%)	2 (1%)	10 (5%)
Timeliness	3 (2%)	19 (10%)	5 (3%)	27 (14%)
Efficiency	2 (1%)	13 (7%)	2 (1%)	17 (9%)
Equity	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Staff Worklife	8 (4%)	4 (2%)	4 (2%)	16 (9%)
Total	22 (11%)	110 (57%)	62 (32%)	194 (100%)

Note that indicators may overlap multiple domains of quality.

Quality Indicator	Evidence Grade	Implementation results reported
Mechanical ventilation		
VAP Bundle	Moderate to High [1]	Yes [2]
• Elevation of the head of the bed	Level 1 [2]	Yes [2]
• Daily sedation vacation & assessment of readiness to extubate	Level 1 [2]	Yes [2]
• Prevention of VTE	Level 1 [2]	Yes [2]
• PUD prophylaxis	Level 1 [2]	Yes [2]
• Daily oral care with chlorhexidine	Level 1 [2]	Yes [2]
Pneumonia: blood cultures performed within 24h or prior to arrival	ES [3]	No
Pneumonia: antibiotics consistent with guidelines	ES [3]	No
Invasive procedures		
Ultrasound guidance for CVC insertion	High [1]	No
Central Line Insertion Bundle	Moderate to High [1]	Yes [2;5]
• Maximal barrier precautions	1B [5] ES [3]	Yes [2;5]
• Chlorhexidine skin antisepsis	1A [5]	Yes [2;5]
• Hand hygiene	1B [5]	Yes [2;5]
• Optimal catheter type and site selection	1A-1B [5]	Yes [2;5]
Central Line Care Bundle		Yes [2;5]
• Daily review of line necessity	1A [5]	Yes [2;5]
• Aseptic lumen access	1A [5]	Yes [2;5]
• Catheter site and tubing care	1B [5]	Yes [2;5]
Patient-centered care		
Goals of care documentation	Moderate [1]	No
Sepsis management		
Sepsis Management Bundle		
• Administer low dose steroids by standard policy	2C [2;4]	No
• Maintain adequate glycemic control	1B [2]	No
• Prevent excessive inspiratory plateau pressures	1C [2;4]	Yes [4]
Sepsis Resuscitation Bundle		
• Serum lactate measured	1B [2]	No
• Timing of blood cultures	1C [2;4]	No

• Treat hypotension and/or elevated lactate with fluids	1B [2]	No
• Maintain adequate central venous oxygen saturation	1C-2C [2]	No
• Antibiotics given by time goal	1B [2;4]	No
• Apply vasopressors for ongoing hypotension	1C [2]	No
• Maintain adequate CVP	1C [2;4]	Yes [4]
Sepsis patients with second litre of crystalloid before time goal	1C [4]	No
Blood cultures drawn before antibiotics	1C [4]	No
Glycemic control policies	Moderate to high [1]	No
• After initial stabilization for patients with severe sepsis	1B [4]	No
• Validated protocol for insulin dose adjustments	2C [4]	No
Prevention of adverse events		
Appropriate transfusion practices	Not graded	Yes [2]
Pharmacist on rounds	Moderate to high [1]	No
Medication reconciliation by a pharmacist	Moderate [1]	Yes [2]
VTE prophylaxis	ES [3]	Yes [5;7]
Preventing pressure ulcers	Moderate [1]; ES [3]	Yes [2]
Simulation training	Moderate to high [1]	No
Training on infusion pumps	Low [1]	No
Infection control		
Isolation of patients with resistant infections	Moderate [1]	No
Hand hygiene improvement	Low [1]	Yes [6]
Staffing		
Rapid response team establishment	Moderate [1]	Yes [2,5]
Staffing ratios: increasing nurse to patient ratio to prevent death	Moderate [1]	No

CDC: center for disease control; CPG: clinical practice guidelines; CVC: central venous catheter; CVP: central venous pressure; DVT: deep vein thrombosis; ES: evidence synthesis; VTE: venous thromboembolism; PUD: pressure ulcer disease.

Reporting organisations (respective evidence grading tool): (1) Agency for Health Research and Quality (AHRQ); (2) Institute for Health Improvement (GRADE); (3) National Quality Measures Clearinghouse (Evidence Synthesis); (4) Society of Critical Care Medicine, European Society of Intensive Care Medicine (GRADE); (5) Canadian Patient Safety Institute (CDC); (6) Health Quality Ontario (Not applicable); (7) Australian and New Zealand Intensive Care Society (Not applicable).

Supplemental File Content – Listing of all unique quality indicators.

Unique Quality Indicator	Endorsing organizations
Mechanical Ventilation	
VAP bundle (IHI)	IHI
VAP bundle (SHN)	CPSI (SHN)
VAP bundle (AHRQ)	AHRQ
VAP bundle (Pediatrics)	CPSI (SHN)
VAP Rate	CPSI (SHN), CPSI (CCVSM), OCCS, IHI, ACCCN, HQO
Patients ventilated <24 after admission	ACCCN
Ventilator utilization	ACCCN
Invasive ventilator utilization	ACCCN, CSPSI (CCVSM), OCCS
Ventilator volume	ACCCN
Inspiratory plateau pressure	SCCM, ESICM
Mechanical ventilation with delivery of appropriate tidal volumes	ACCCN
Pneumonia: Blood cultures performed within 24h or prior to arrival	NQF, NQMC
Pneumonia: antibiotics consistent with guidelines	NQMC
Unplanned extubation rate	ACCCN, CPSI (CCVSM), OCCS
Ventilated patient flow	CPSI (CCVSM)
Invasive Procedures	
Central line insertion bundle (SHN)	CPSI (SHN), Accreditation Canada, ACCCN
Central line care bundle (SHN)	CPSI (SHN)
Central line bundle (IHI)	IHI
Central line insertion protocol with maximal sterile barrier technique	NQMC
Measures to prevent central line associated bloodstream infection at time of central venous catheter insertion	NQF
Ultrasound guidance for CVC insertion	NQF, AHRQ
Catheter related blood stream infection rate	ACCCN, OCCS, ICH, IHI, ANZCS, HQO, NQF
Occurrence of pneumothorax as a result of CVC placement	ACCCN
Occurrence of inadvertent arterial cannulation as a result of CVC placement	ACCCN
Iatrogenic pneumothorax in non neonates	NQMC, AHRQ
Patient Centered and End of Life Care	
Family conference	ACCCN
Psychosocial support	ACCCN
Spiritual support	ACCCN
Bereavement package	ACCCN
End of life pathway in place	ICS
Comfortable dying	NQF
Goals of care documentation	ACCCN, NQF, AHRQ
Family and patient satisfaction	CPSI (CCVSM), OCCS, ACCCN
Health related quality of life	ACCCN
Sedation and restraint	ACCCN, OCCS
Deaths in ICU with provision of cardiopulmonary resuscitation	ACCCN
In-hospital deaths occurring in an ICU environment	ACCCN
Code blues	ACCCN
Organ donation	OCCS
Two patient identifiers before service or procedure	Accreditation Canada
Sepsis Management	
IHI Sepsis Management bundle	IHI

IHI Sepsis Resuscitation bundle	IHI
Severe sepsis treatment	NQF, OCCS
Low dose steroid administration	SCCM, ESICM
Lactate measure by time goal	BCPSQC
Antibiotic by time goal	SCCM, ESICM, BCPSQC
Blood cultures before antibiotics	SCCM, ESICM, BCPSQC
Sepsis patients with second litre crystalloid before time goal	SCCM, ESICM, BCPSQC
Maintain adequate CVP	SCCM, ESICM
Sepsis management bundle reliability	IHI, SCCM, ESICM
Sepsis resuscitation bundle reliability	IHI, SCCM, ESICM
Mortality due to sepsis and septic shock	IHI, SCCM, ESICM, BCPSC
Glucose control or glycemic control policies	SCCM, ESICM, BCPSQC, AHRQ, IHI
Evaluation of glycemic control	IHI, BCPSQC
Prophylaxis and Preventable Adverse Events	
Deep venous thrombosis/venous thromboembolism prophylaxis	OCCS, ACCCN, CPSI (SHN), ANZICS, BCPSQC, NQF, Accreditation Canada, NQMC, AHRQ
Diagnosis of new venous thromboembolism after ICU admission	ACCCN
Peptic ulcer disease prophylaxis	AHRQ, ACCCN
Appropriate transfusion practices	IHI, ACCCN, OCCS
Medication errors	ACCCN
Medication reconciliation	ACCCN, Accreditation Canada, CPSI (SHN), IHI
Medication reconciliation by pharmacist	AHRQ
Rate of new GI bleeding	ACCCN
Patient falls	NQF
Falls with injury	NQF
Decubitus ulcer rate	ACCCN
Preventing pressure ulcers	IHI, AHRQ
Pediatric pressure ulcer rate per 1000 admissions	NQMC, AHRQ
Early nutrition	ICS, OCCS
Infection Control	
Isolation of patients with resistant infections	ICS, AHRQ
Hand hygiene	ICS, HQO, BCPSQC, AHRQ
Reduce antibiotic resistant organisms	CSPI (SHN), CPSI (CCVSM)
Unit acquired bacteremias	ICS
Methicillin sensitive S. aureus bacteremia	NHS
Unit acquired methicillin resistant S. aureus bacteremia	ICS, NHQ, HQO
Vancomycin resistant enterococcus bacteremia	HQO
Unit acquired C. difficile or methicillin resistant S. aureus infection	ICS, HQO, Accreditation Canada, ACCCN
Catheter-associated UTI	NQF
Staffing	
Nurse to patient ratios	ICS, ACCCN
Staffing ratios	AHRQ
Respiratory therapist to patient ratios	ACCCN
Intensivist to patient ratios	ACCCN, ICS
Core staffing by level of acuity	OCCS
Closed unit (intensivist model)	IHI, OCCS
Intensivist led management model by level of acuity	OCCS
In-house physician resources	ACCCN
Workload	ACCCN

Rapid response team establishment	IHI, CPSI (SHN), ANZICS, AHRQ
Utilization of rapid response team	IHI
Multidisciplinary rounds take place	ICS, IHI
Pharmacist on rounds	AHRQ
Training on infusion pumps	Accreditation Canada, AHRQ
Daily goals	ACCCN, ICS, IHI
Staff turnover	ACCCN
Nurse turnover	CPSI (CCVSM), OCCS
RN absenteeism	ACCCN, CPSI (CCVSM), OCCS
Nurse overtime work hours	ACCCN, CPSI (CCVSM), OCCS
CritiCall availability	OCCS
Critical care networks	OCCS
Patient Flow and Volume	
Number of non-clinical transfers	ICS
Repatriation	OCCS
Delays in patient admission to the ICU	ACCCN, OCCS
Cancelled OR Cases	ACCCN, OCCS
Interfacility ICU transfers	ACCCN, OCCS, CPSI (CCVSM)
Access and exit block	ANZICS
Avoidable days	ACCCN, CPSI (CCVSM), OCCS
Case volume	ACCCN
Occupancy	ACCCN, CPSI (CCVSM), OCCS, ICS
Time from ICU to inpatient bed	IHI
Number of unplanned transfers	NHS
Handover (intra and inter ICU)	ACCCN, Accreditation Canada
ICU length of stay	ACCCN, OCCS, IHI, CPSI (CCVSM), NHS, NQF, VA
PICU severity adjusted length of stay	NQF
Deaths within 6 hours of admission	ACCCN
ICU Discharges	
Number of crash calls per 1000 inpatient discharges	IHI
Clinical deterioration of ICU discharges within 72 hours	ANZICS
Night time discharges	ACCCN, ICS, CPSI (CCVSM), OCCS, VA
Patient transport out of the ICU using two identifiers	ACCCN
ICU readmissions within 72 hours	ACCCN, CPSI (CCVSM), OCCS
ICU readmissions within 48 hours	ICS, VA
PICU unplanned readmission rate	NQF
Quality Improvement	
Quality improvement program in place	ICS
Utilization of patient assessment systems	ANZICS
Regular review of morbidity and mortality	ICS
Mortality and Severity of Illness	
Acuity of illness or burden of disease for patients treated in ICU (SOFA score)	ACCCN
Standardized mortality ratio	ICS, CPSI (CCVSM), NHQ, BCPSQC, ACCCN, OCCS, NQF, VA
PICU standardized mortality ratio	NQF

ICU: Intensive Care unit; OR: Operating Room; CVP: Central Venous Pressure; CVC: Central Venous Catheter; VAP: Ventilator-Associated Pneumonia; PICU: Pediatric Intensive Care; GI: Gastro-Intestinal; SOFA: Sequential Organ Failure Assessment; RN: Registered Nurse; UTI: Urinary tract Infection.

Meaning of organizations' acronyms can be found in Table 1.