# Intensive care unit quality improvement: A "how-to" guide for the interdisciplinary team*

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***Objective:*** **Quality improvement is an important activity for all members of the interdisciplinary critical care team. Although an increasing number of resources are available to guide clinicians, quality improvement activities can be overwhelming. Therefore, the Society of Critical Care Medicine charged this Outcomes Task Force with creating a "how-to" guide that focuses on critical care, summarizes key concepts, and outlines a practical approach to the development, implementation, evaluation, and maintenance of an interdisciplinary quality improvement program in the intensive care unit.**

***Data Sources and Methods:*** **The task force met in person twice and by conference call twice to write this document. We also conducted a literature search on "quality improvement" and "critical care or intensive care" and searched online for additional resources.**

***Data Synthesis and Overview:*** **We present an overview of quality improvement in the intensive care unit setting and then describe the following steps for initiating or improving an interdisciplinary critical care quality improvement program: a) identify local motivation, support teamwork, and develop strong leadership; b) prioritize potential projects and choose the first target; c) operationalize the measures, build support for the project, and develop a business plan; d) perform an environmental scan to better understand the problem, potential barriers, opportunities, and resources for the project; e) create a data collection system that accurately measures baseline performance and future improvements; f) create a data reporting system that allows clinicians and others to understand the problem; g) introduce effective strategies to change clinician behavior. In addition, we identify four steps for evaluating and maintaining this program: a) determine whether the target is changing with periodic data collection; b) modify behavior change strategies to improve or sustain improvements; c) focus on interdisciplinary collaboration; and d) develop and sustain support from the hospital leadership. We also identify a number of online resources to complement this overview.**

***Conclusions:*** **This Society of Critical Care Medicine Task Force report provides an overview for clinicians interested in developing or improving a quality improvement program using a step-wise approach. Success depends not only on committed interdisciplinary work that is incremental and continuous but also on strong leadership. Further research is needed to refine the methods and identify the most cost-effective means of improving the quality of health care received by critically ill patients and their families. (Crit Care Med 2006; 34:211–218)**

**Key Words: intensive care; critical care; quality improvement; interdisciplinary; quality of health care**

Many publications exist on the issue of quality improvement and outcome assessment (1, 2), and a growing number are specific to critical care (3–11). Although we recognize the value of these prior contributions, the volume of this literature can be overwhelming to critical care clinicians. The objectives of this report are to summarize key concepts and outline a practical approach to develop, implement, evaluate, and sustain a quality improvement program in the intensive care unit (ICU). We also include patient safety as a component of quality (12). In addition, complementary resources are available on the Society of Critical Care Medicine (SCCM) Web site (13). To accomplish these objectives, the authors, as part of the SCCM Outcomes Task Force, met in person twice and by conference call twice to develop and write this document. We conducted a literature search on "quality improvement" and "critical care or intensive care" and searched online for additional resources to inform the process. The document was circulated electronically for multiple revisions from all authors.

## UNDERSTANDING QUALITY IN HEALTH CARE

Quality of health care has been defined by the Institute of Medicine as care that is

*See also p. 261.

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Dr. Pronovost consulted for VHA and received grants from AHRQ. The remaining authors have no financial interests to disclose.



**DOI: 10.1097/01.CCM.0000190617.76104.AC**

Table 1. Advantages and disadvantages of process and outcome measures

| | Process Measure | Outcome Measure |
|---|---|---|
| Do patients care about this? | Less understandable to patients | Yes; very important to patients |
| Do providers care about this? | Yes; it relates directly to what providers are doing | Yes; however, providers are wary of confounding and may request risk-adjustment models |
| Obtain from routinely collected data? | Usually | Sometimes; additional data that are not routinely collected may be needed |
| Interpretable for feedback and quality improvement? | Provides clear feedback about what providers are actually doing | Difficult for providers to definitively know where to target efforts because outcomes are usually affected by several different processes |
| Directly measures prevention? | Yes | No |
| Need for risk adjustment? | No; however, need to clearly define eligible patients | Yes; need different models for each outcome |
| Time needed for measurement? | Less | More (for risk-adjustment) |
| Sample size requirements? | Smaller | Larger |

safe, timely, effective, efficient, equitable, and patient-centered (14). Those leading quality improvement programs should understand the model developed by Donabedian (15, 16) including three classic quality-of-care components: structure, process, and outcome. Although these components are not necessarily mutually exclusive, the concepts provide a useful framework for understanding and improving the quality of healthcare.

**Structure** represents the first component of the quality of care model and can be defined as the way we organize care. Structurally, ICUs are heterogeneous, even within regions or countries. Sources of structural variation include how the ICU is integrated into the hospital or health care system, the size of the ICU, whether the unit is open or closed, the type and amount of technology available, and the number, roles, and responsibilities of ICU staff. Variation in these structural features can affect the quality of care and therefore the potential for recovery from critical illness. For example, studies have suggested that patients managed in a closed ICU by physicians with critical care training have better outcomes than patients managed in open ICUs by generalists without critical care training (17). In addition, technology that is inadequate for an ICU's case-mix can adversely affect outcome (18). Despite these and other studies, our knowledge of how structure affects ICU quality is immature but evolving.

**Process** represents the second component of the quality of care model. Processes generally refer to what we do, or fail to do, for patients and their families. Delivering high-quality care in the ICU requires the synchronous efforts of large numbers of clinical and nonclinical processes. Just because data exist that show improved outcomes with specific interventions, this does not guarantee that these findings are translated effectively into clinical practice (19). In fact, nonclinical processes of the ICU, such as the process of organizational management, can have an important effect on quality (20, 21). Another important process-of-care focus for quality initiatives is transfer of patients between the ICU and other parts of the hospital or between different clinicians within the ICU (22).

**Outcomes** represent the third component of the quality of care model and refer to the results we achieve. Critical care clinicians and researchers have traditionally dedicated the most time to measuring and improving patient outcomes. In fact, critical care has led the way in developing risk-adjustment mortality models and standardized mortality ratios. Nonetheless, risk-adjusted measures have important limitations and cannot fully assess the quality of care in an individual institution or ICU (23). Other outcomes also determine ICU quality, including morbid events (e.g., nosocomial infections, venous thromboembolism, or serious adverse drug events) (24), organ dysfunction, health-related quality of life, and patient and family satisfaction with care. For these reasons, it may be suitable to think of the many "qualities" of care rather than a singular quality of care (8).

Critical care clinicians interested in quality improvement should understand the structure-process-outcome model and select aspects they are both interested in and able to improve. Acknowledging that structure is the most challenging to change, clinicians may wish to target processes or outcomes instead. Table 1 describes the advantages and disadvantages of using processes vs. outcomes when trying to improve quality of care. Outcome measures are intuitively important targets for clinicians, but they are often less responsive to improvement efforts and more prone to bias than process measures (8, 25, 26). This is partly because adverse outcomes occur less frequently than deficiencies in their associated processes of care. In addition, processes are usually easier to measure and modify (27). Although many factors within health care systems affect outcomes, not all of these factors can be modified by clinicians. Nonetheless, a comprehensive ICU quality improvement program will usually address measures in each of these three categories and may also consider the structures, processes, and outcomes outside the ICU that affect the quality of care for critically ill patients and their families (4).

## MEASURING QUALITY IN INTENSIVE CARE

A number of features define a good quality measure (28–30). The measure must be important, valid, reliable, responsive, interpretable, and feasible. (The appendix contains a description of each of these features.) Although the critical care team members generally need not test the validity, reliability, and responsiveness of every quality measure they choose, they should ascertain that these attributes of the measure have been determined. However, the team must assess the overall importance of the candidate measure because importance may vary between different ICUs. The team should also consider the interpretability and feasibility of a measure before starting a project because these attributes may differ across ICUs based on factors such as the team's experience with quality im-

Table 2. Key steps for initiating, improving, evaluating, and sustaining a quality improvement program

Initiating or improving a quality improvement program
1. Do background work: Identify motivation, support team work and develop strong leadership.
2. Prioritize potential projects and choose the projects to begin.
3. Prepare for the project by operationalizing the measures, building support for the project, and developing a business plan.
4. Do an environmental scan to understand the current situation (structure, process, or outcome), the potential barriers, opportunities, and resources for the project.
5. Create a data collection system to provide accurate baseline data and document improvement.
6. Create a data reporting system that will allow clinicians and other stakeholders to see and understand the problem and the improvement.
7. Introduce strategies to change clinician behavior and create the change that will produce improvement.

Evaluating and sustaining a quality improvement program
1. Determine whether the target is changing with ongoing observation, periodic data collection, and interpretation.
2. Modify behavior change strategies to improve, regain, or sustain improvements.
3. Focus on sustaining interdisciplinary leadership and collaboration for the quality improvement program.
4. Develop and sustain support from the hospital leadership.

provement (for interpretability) or the availability of computerized clinical information systems (for feasibility).

## DEVELOPING OR IMPROVING AN ICU QUALITY IMPROVEMENT PROGRAM

Initiating a new quality improvement program or improving an existing program requires a series of steps to ensure that the program is successful. Table 2 outlines one approach to these steps, and each step is described next.

*Motivation, Teamwork, and Leadership.* Quality improvement is an attitude and culture that should resonate through the entire ICU. As such, the foundation for a successful quality improvement program is strong motivation, teamwork, and leadership. Potential motivators for quality improvement programs are numerous. Motivators often derive from local expertise and interest of individuals on the ICU team. Family feedback or a patient-specific safety issue may also be the stimulus. An institution-wide quality of care initiative may incorporate all departments, thus involving the ICU. Hospital accreditation organizations often strategically target the ICU because of the severity of illness and complexity of care. Recently, professional societies such as the SCCM and regulatory agencies such as the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) have promoted awareness of the importance of improving quality of care in the ICU. Whatever the initial impetus, successful quality improvement programs often require a change in organizational culture. A clear commitment is needed from all professionals involved.

Quality improvement is not a one-person or one-discipline task; it requires the shared commitment of the entire interdisciplinary ICU team. All voices need to be heard and respected since everyone has something to contribute. Those responsible should be properly trained; fortunately, numerous educational curricula and resources are available to develop appropriate skills (13). The successful quality improvement program often consists of a number of individual projects under common interdisciplinary leadership. Quality improvement is also a continuous journey rather than a discrete, time-limited project.

Even though individual ICU clinicians may champion specific quality improvement projects, change is rarely achieved without strong leadership. Leadership is needed throughout the process, from the initial identification of a target to the evaluative phase. A successful leader needs to dedicate time and commitment for the program to succeed.

*Prioritize and Choose a Project.* The first step for initiating or improving a quality improvement program is to identify the opportunities and resources that might influence the choice of where to start. The first project should be feasible and likely to be successful so that the team can build on its successes. Initially, the team should avoid ambitious projects that consume resources and discourage team members.

A number of potential quality measures can form the basis of a specific quality improvement project. In Table 3, we classify potential quality measures according to structure, process, and outcome. Process measures linked to improved outcomes in randomized trials are indicated. Process measures that compose the "ventilator bundle" proposed by the Institute for Healthcare Improvement (IHI), JCAHO, and the Volunteer Hospitals of America are also indicated. Other organizations have also developed their own lists of potential ICU quality measures including JCAHO, (31) IHI, (32) and individual investigators (33). Links to these measures are available at the SCCM Web site (13).

Suitable quality measures for the ICU may evolve as new research emerges. This is especially true for process measures. For example, medical emergency teams, specific nurse-to-patient ratios, or evening in-house intensivist coverage may eventually become structural quality measures if future studies support their effectiveness.

*Prepare for the Project.* The first step is careful preparation. For example, preparing for a project concerning improving venous thromboprophylaxis might include the following: Identify methods by which thromboprophylaxis is currently being measured, identify key stakeholders and their level of interest in the project, determine whether evidence-based guidelines are already available, and collect preliminary data about current thromboprophylaxis (and perhaps venous thromboembolism) rates.

The initiation of a quality improvement project requires a project plan or business plan that includes a task list, budget considerations, and a timeline. The concept of a business plan is often intimidating to clinicians; however, it does not need to be extensive and can be helpful regardless of whether the quality improvement team is seeking additional funding for the project. The plan should outline the project for team members and hospital administrators. For example, a project plan for thromboprophylaxis might review the current burden of venous thromboembolism (the outcome), use of anticoagulant and mechanical thromboprophylaxis (the process), and institutional costs (personnel and non-personnel costs, complications that may increase length of stay, and resource utilization). The plan should also specify whether resources are required and, if so, whether they have been allocated (34). A well-written plan may be useful if re-

Table 3. Possible intensive care unit quality of care measures

| |
|---|
| Structure measures |
| Intensivist-lead rounding team |
| Process measures |
| DVT prophylaxis[a,b] |
| Stress ulcer prophylaxis[a,b] |
| Ventilator associated pneumonia prevention strategies |
| HOB elevation[a,b] |
| Heat and moisture exchangers & filters[a] |
| Central venous catheter bloodstream infection prevention strategies |
| Hand hygiene |
| Maximal barriers |
| Chlorhexidine[a] |
| Avoidance of femoral site[a] |
| Avoid routine replacement[a] |
| Protocol-driven ventilator weaning[a] |
| Targeted sedation protocols |
| Daily sedation vacation[b] |
| Daily assessment of extubation readiness[b] |
| Severe sepsis[a] |
| Early fluid resuscitation |
| Early antibiotics |
| Corticosteroids for shock |
| Activated protein C for shock |
| Low tidal volume ventilation in ALI/ARDS[a] |
| Noninvasive ventilation for hypercarbic respiratory failure |
| Early enteral feeding[a] |
| Appropriate transfusion threshold[a] |
| Delayed transfer out of ICU |
| Palliative care |
| Symptom measurement & management at end of life |
| Family conferences |
| Directives regarding CPR, basic & advanced life support |
| Outcome measures |
| Unplanned extubation rate |
| Ventilator-associated pneumonia rate |
| CVC bloodstream infection rate |
| Multiply resistant organism infection rate |
| Serious adverse drug event rate |
| Family satisfaction |
| Unscheduled readmissions within 24–48 hrs of ICU discharge |
| Mortality (absolute and severity-adjusted) |

DVT, deep vein thrombosis; HOB, head of bed; ALI, acute lung injury; ARDS, acute respiratory distress syndrome; CPR, cardiopulmonary resuscitation; CVC, central venous catheter.

[a]Process measures strongly linked to outcomes in randomized trials; [b]part of the "ventilator bundle" proposed by the Institute for Healthcare Improvement (www.ihi.org). In this table, we outline possible quality of care measures, classified according to structure, process, and outcome variables.

questing additional resources for the project and can provide the basis for projecting expenditures and/or savings to the institution. Such documentation may also help obtain support from the hospital leadership.

*Do an Environmental Scan.* Without preliminary information on current quality of care and the barriers to a quality improvement project, it is difficult to design and launch a successful project. Therefore, performing an "environmental scan" is an important step (6). An initial scan may involve available clinical or administrative databases. For example, pharmacy databases may be a useful starting place for assessing anticoagulant thromboprophylaxis. Surveys of reported practice patterns can be used to garner impressions of interventions for which compliance is difficult to measure, such as antiembolic stockings (35). More direct methods of establishing baseline data are observational studies such as chart reviews. Finally, qualitative studies can be used to characterize behaviors that bear on quality improvement efforts and identify potential barriers to improvement.

The environmental scan may also include a measure of organizational culture. Several tools are now available for assessing an ICU's quality culture (e.g., the *SCCM ICU Index*) or culture of safety, such as the Patient Safety Climate Survey (36) and the Safety Climate Scale (37). These instruments can highlight important issues that may need to be addressed before, during, or after the project to maximize quality improvement.

*Create a Data Collection System.* Once the environmental scan is complete, the quality improvement team will have information that will allow them to design an effective data collection system for baseline assessment. Without accurate baseline data, the team cannot document any improvements. Deciding what will be measured goes beyond generalities such as "effective thromboprophylaxis." The target measure must be carefully defined using discrete, measurable components, and a specific improvement goal should be explicitly stated. The team should consider the following features. First, a *unit of analysis*, or denominator, of the measure needs to be chosen. Common denominators are defined in relation to a patient sample (e.g., per 100 patients) or standardized for patient exposure (e.g., per patient-day). For example, the latter might be chosen to express the median percent of ICU days of effective thromboprophylaxis. Second, *the event or outcome of interest* becomes the numerator of the measure and must also be defined. For example, effective thromboprophylaxis needs to be defined. Because anticoagulant thromboprophylaxis is more effective than mechanical prophylaxis, the primary quality measure might be the proportion of patient-days that patients received anticoagulant thromboprophylaxis, with mechanical approaches only counting in the numerator when patients are bleeding or at serious risk of bleeding. Another option is to record missed opportunities for thromboprophylaxis (i.e., proportion of patient-days that patients received neither anticoagulant nor mechanical approaches), which could be easier to measure and provide sufficiently useful information. Organizations such as JCAHO and IHI are defining, operationalizing, and evaluating quality measures that can be used by the quality improvement team (31, 32). Third, are *data collection methods* already collected? If not, how easily can they be obtained? Will physician order sheets, pharmacy databases, the nursing databases, or nurse self-reports be used? Whenever possible, build measurement into daily workflow and capitalize on existing data sources (38, 39). Regardless of the data source, perform a small-scale pilot before embarking on wide-scale measurement. Quality measures should be developed and implemented with the

same rigor as conducting good clinical research, keeping feasibility in mind.

Choosing when to collect data requires a balance between feasibility and precision. Frequent measurements may increase the precision of estimates but require more time and effort. Although reducing the frequency of measurements makes measurement more feasible, it may hide important variation in quality.

Who will perform the measurement will vary across ICUs and depends on what is being measured and how. Busy clinicians may find it difficult to engage in this aspect of quality improvement. Explicitly incorporating quality initiatives into the mission of an ICU and explicitly embedding responsibility for quality improvement into specific job descriptions will help. A potential predictor of success is the integration of project activities into clinicians' usual workload. However, this alone is insufficient. Provision of educational materials, data collection methods training, reliability testing of key measures, and ongoing audit of data accuracy are also necessary for whoever is performing the measurement.

*Create a Data Reporting System.* A successful quality project requires transparent and informative data reporting. The reason why data reporting is important is that most critical care clinicians are too busy to analyze and interpret data themselves. In the absence of timely and useful data reporting, interest wanes and projects lose momentum. On the other hand, interpretable and actionable data empower the ICU team, affirm that quality improvement efforts are making a difference, and increase the chances for sustainability.

When deciding how data should be reported, consider the specific aims outlined during the planning phase, the background of the target audience, and local familiarity with existing data reports. Before releasing quality improvement results, it is useful to pilot presentation formats and solicit suggestions about design and interpretability from target audiences. Possible formats include text, tables, and figures; each has advantages and disadvantages. Text is a familiar vehicle for communication but may take more space and be less inviting to read. Tables display both descriptive and numerical variables, are easily assembled, and hold large amounts of information in a small space. However, tables are less useful for showing data over time. Graphs and figures (e.g., control charts, run charts, instrument panels, report cards) can visually display data over time but may require more expertise to create. Regardless of the chosen formats, data should be clearly labeled and simply displayed. The most meaningful formats show not only past but present performance (40).

Determining when to report data depends partly on how often the target is actually measured. For process measures, monthly or even weekly reports may be more relevant, particularly if clinicians work in 1-wk blocks and feedback is being given about their week.

As with data collection, deciding who will analyze and report the data depends on what is being measured and the available resources. The data analyst should be familiar with computational databases and have the relevant statistical expertise and clinical understanding to create valid summaries presented in a format that faithfully represents the results. Avoid mixed messages from different individuals reporting the data. It is also important that feedback be discussed face-to-face with clinicians. This means that a quality improvement leader or champion may need to have multiple meetings each month to ensure that the majority of ICU clinicians are aware of the progress of the project and have an opportunity to provide feedback.

*Introduce Strategies to Change Behavior.* The foregoing steps are necessary, but not sufficient, to make a quality improvement project come to life; the next step is to implement behavior change strategies that are likely to produce the desired change (6). The Cochrane Effective Practice and Organization of Care Review Group has published a summary of 41 systematic reviews of hundreds of original studies testing the effects of different behavior change strategies on clinician behavior and patient outcomes (41). Behavior change strategies can be simple or complex and vary in effectiveness (42). For example, dissemination of mailed educational materials and conferences are least likely to change behavior. Audit and feedback of recent performance are the backbone of successful quality improvement initiatives but are insufficient by themselves (43). Informal discussions and formal presentations by local opinion leaders on the quality improvement team are crucial adjuncts to help change behavior, but reminders and prompts (such as preprinted orders) along with periodic interactive educational interventions are most useful for inducing and sustaining change. The most powerful behavior change strategies (and often the only strategies that are successful) are multifaceted rather than single approaches, are adapted to the local setting, and address documented barriers in the environment (6, 44).

Selecting the behavior change strategies for each project depends not only on the effectiveness of the strategy but also on its feasibility, acceptability, and cost. For example, the proven effectiveness of computer decisions support systems in changing behavior (45) cannot be realized in an ICU without computerized clinical information systems or computerized order entry. It can be helpful to choose behavior change strategies by capitalizing on those that have worked previously; behavior change strategies useful for one project can often be used across several projects in a quality improvement program (46).

*Evaluating and Sustaining an ICU Quality Improvement Program.* A key step in closing the loop on quality improvement initiatives is taking a scientific approach to evaluating whether the target measure is changing. In other words, the quality improvement program itself should be subjected to a quality improvement process. Without formal evaluation of a quality improvement program, it is impossible to judge whether it is successful and sustainable.

After generating initial results, challenges may arise when trying to sustain the improvements. A study of factors associated with clinicians staying involved in quality improvement projects found the following predictors: continuous use of the same quality improvement model, taking courses in the science of quality improvement, and remaining employed in the same unit (47). This study provides important lessons on enhancing the sustainability of a quality improvement program and encourages a focus on consistency of efforts, staff training, and staff retention. Other issues that may be important include simple methods for data collection, transparent presentation of results, augmentation of strategies to change behavior, sustaining the energy of the quality improvement team and bedside clinicians, and continued interdisciplinary leadership and collaboration.

*Sustain Data Collection.* Sustaining a quality improvement program requires ongoing reassessment of the methods being used to collect data. When a project

starts, the champions may have to manually collect data. Later, automated data collection methods may become available to obtain data from the electronic medical record or other electronic sources such as billing data. If such automation is possible, maintenance of the project will be greatly facilitated. If not, the team needs to ensure that sufficient resources are allocated to sustain the data collection. In the future, computerized clinical information, clinical decision support, and computer order entry systems will generate quality reports, thereby automating this aspect of data collection and reporting for selected process and outcome measures and making this step easier for ICU clinicians.

*Modify Behavior Change Strategies.* Program evaluation may illustrate a need to modify the chosen behavior change strategy (46). For example, if clinicians initially receive weekly thromboprophylaxis reports, and satisfactory results are obtained, reporting frequency may decrease to monthly or quarterly. On the other hand, if thromboprophylaxis rates never reach target values, additional in-services or ongoing educational sessions may be necessary. If thromboprophylaxis rates decrease after initial improvement, new efforts such as preprinted orders may be necessary.

*Sustain Interdisciplinary Leadership and Collaboration in the ICU.* A key aspect for sustaining a quality improvement program is to ensure ongoing interdisciplinary leadership. This leadership needs to maintain investment in all aspects of the process, ranging from ensuring the quality of data collection and its effective use to addressing problems. Since quality improvement programs are designed to improve quality, not to place blame on individuals, an environment of disclosure should be fostered by leadership so staff feel free to report events that affect quality. Staff must believe that they can report any problems or errors without fear of reprisal from leadership.

A major barrier to any quality improvement initiative is the individuals or groups who believe they do not need to improve. They may not believe in the process, may feel threatened by it, or may have constructive ideas for how to improve the process that can be uncovered by engaging them. One strategy is to invite them to participate in the quality improvement process. Another way to convince these individuals is by using local baseline data to establish that a problem exists and, ideally, show that the project is correcting a problem (48).

Networks can help sustain quality improvement programs and work well when ICUs within them have similar structures, processes, and targets for improvement. Drawing on the collective resources of a network can be particularly useful for small ICUs with limited resources to build and sustain a successful quality improvement program. An example is the Vermont-Oxford network for research and quality improvement in neonatal intensive care. This network builds on the IHI collaborative model and consists of hospitals that share data and resources to assist multidisciplinary teams in quality improvement (49). This network also illustrated the value of rapid-cycle improvement methodology to integrate evidence-based practices into neonatal ICUs (50). Dlugacz and colleagues (48) described the creation of a similar network among the ICUs of a multiple-hospital system that established data collection, provided feedback, and created a culture change. These efforts improved quality through defining levels of care in ICU, decreasing rates of unplanned extubation, and improving end-of-life care.

*Sustain Support From Hospital Administration.* Although quality improvement initiatives can accomplish much within the ICU, it is helpful if hospital administration supports the program (48). A key task for quality improvement leaders is to portray their program in terms that are meaningful to diverse stakeholders within and outside of the ICU (51). For clinicians, the most meaningful motivation is improving patient care, and tangible benefits will help ensure they stay engaged. For program managers and division chiefs, the key aim may be improving program outcomes. For hospital administrators, it may be improving reputation in the region, based on improving outcomes and increasing market penetration for ICU care.

Informal demonstrations of the change in culture can also be powerful. If executive rounds are a part of the institution's safety culture, these rounds can be linked to the quality improvement initiatives in the ICU (52). If the hospital has a quality improvement committee, relevant personnel from this committee or department can be integrated into each of the rapid-cycle improvement projects. Celebrate the successes of each improvement project with the ICU staff, but also include the program and hospital leadership in these celebrations. Encourage hospital administrators to use these inspiring stories with the hospital board and the public.

*Successful quality improvement programs require interdisciplinary teamwork that is incremental and continuous.*

## CONCLUSIONS

Successful quality improvement programs require interdisciplinary teamwork that is incremental and continuous. Each step is a discrete part of a project and each project can be considered as part of a program. Although quality improvement may seem overwhelming at first, approaching a project in a step-wise manner as outlined here and beginning with a single, concrete project can help to ensure that quality improvement becomes routine and integral to the ICU. Quality improvement efforts require scientifically sound performance measures. Just as in clinical research, sufficient resources must be allocated to ensure a robust data collection, analysis, and reporting system. Leadership is crucial to the success of both the overall program and each project within it. Individual quality improvement projects and the entire quality improvement program should learn from its successes as well as failures. Further research is needed to refine the methods and identify the most cost-effective means of improving the quality of health care received by critically ill patients and their families.

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## APPENDIX: FEATURES DEFINING A ICU GOOD QUALITY MEASURE

A good ICU quality measure should be important, valid, reliable, responsive, interpretable, and feasible. Each of these characteristics is briefly described next with a focus on their relevance for the ICU quality improvement team.

An **important** measure for quality improvement programs should generally be high prevalence outcomes or outcomes associated with considerable morbidity and mortality. For a structure or process measures to be important, it must be strongly linked to clinically important outcomes. In addition, various parties may consider the measure more or less important, depending on their perspective. Measures that are important for the individual patient and family may differ from the measures important to the ICU manager, hospital executive, or community. Each perspective should be viewed as complementary instead of competitive, and the quality improvement team should take each into consideration.

A **valid** measure refers to the extent to which a measure reflects what it is supposed to measure. Validation may include comparing the measure to other measures such as a gold standard (criterion validity) or to other measures or constructs that should give similar results (construct validity). Generally, the ICU quality improvement team will use measures that have already been shown to be valid.

A **reliable** measure refers to the extent to which a measure yields the same result when assessed by a different rater (interrater reliability) or the extent to which repeated measurement provides the same result when the factor being measured hasn't changed (intrarater reliability). Generally, the ICU quality improvement team will use measures that have already been shown to be reliable.

A **responsive** measure refers to the extent to which the measure is sensitive to change introduced by the quality improvement process. An important component of a responsive measure is that there is room for improvement in the measure and that the measure is capable of detecting that improvement. There should be a gap between current performance and desired performance that the measure can identify. The ICU quality improvement team should determine that others have found the measure to be responsive and also there is room for improvement within their individual ICU.

An **interpretable** measure is easily understood by the target audience including critical care clinicians, ICU management, and hospital leadership.

A **feasible** measure is useful because it is relatively easy to obtain and can be collected with available resources. Feasibility will vary depending on the resources that are available and should be assessed for every measure before implementing a quality improvement project.