Implementation of a mandatory checklist of protocols and objectives improves compliance with a wide range of evidence-based intensive care unit practices

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Objective: **To determine a) if a checklist covering a diverse group of intensive care unit protocols and objectives would improve clinician consideration of these domains and b) if improved consideration would change practice patterns.**

Design: **Pre- and postobservational study.**

Setting: **A 24-bed surgical/burn/trauma intensive care unit in a teaching hospital.**

Patients: **A total of 1399 patients admitted between June 2006 and May 2007.**

Interventions: **The first component of the study evaluated whether mandating verbal review of a checklist covering 14 intensive care unit best practices altered verbal consideration of these domains. Evaluation was performed using real-time bedside audits on morning rounds. The second component evaluated whether the checklist altered implementation of these domains by changing practice patterns. Evaluation was performed by analyzing data from the Project IMPACT database after patients left the intensive care unit.**

Measurements and Main Results: **Verbal consideration of evaluable domains improved from 90.9% (530/583) to 99.7% (669/671, $p < .0001$) after verbal review of the checklist was mandated. Bedside consideration improved on the use of deep venous thrombosis prophylaxis ($p < .05$), stress ulcer prophylaxis ($p < .01$), oral care for ventilated patients ($p < 0.01$), electrolyte repletion ($p < .01$), initiation of physical therapy ($p < .05$), and documentation of restraint orders ($p < .0001$). Mandatory verbal review of the checklist resulted in a greater than two-fold increase in transferring patients out of the intensive care unit on telemetry (16% vs. 35%, $p < .0001$) and initiation of physical therapy (28% vs. 42%, $p < .0001$) compared with baseline practice.**

Conclusions: **A mandatory verbal review of a checklist covering a wide range of objectives and goals at each patient's bedside is an effective method to improve both consideration and implementation of intensive care unit best practices. A bedside checklist is a simple, cost-effective method to prevent errors of omission in basic domains of intensive care unit management that might otherwise be forgotten in the setting of more urgent care requirements. (Crit Care Med 2009; 37:2775–2781)**

Key Words: error; safety; best practice; checklist; protocols; guidelines

In 1999, the Institute of Medicine published "To Err Is Human: Building a Safer Health System" highlighting medical errors in the United States (1). According to this report, medical errors cost $17 billion to $29 billion annually and result in 44,000 to 98,000 preventable deaths per year. Although there is more intensive monitoring and more frequent clinician evaluation in the intensive care unit (ICU) than in most other parts of a hospital, the complexity of patients and the sheer number of decisions and interventions made on a daily basis make the ICU especially vulnerable to medical errors (2). A recent report demonstrated an average of 149.7 serious errors/1000 patient days and 36.2 preventable adverse events/1000 patient days in an ICU at a university hospital (3). The types of errors that occur have been demonstrated to be similar in both surgical and medical ICUs (4). The transition of level of care from an ICU to a less intensive level of care in a hospital may also be associated with errors resulting in ICU readmission or even death (5).

Medical errors can be categorized as errors of commission or errors of omission. A large amount of attention has appropriately been given to errors of commission, such as those associated with ordering, transcription, and administration of medications (6). Although many errors of commission are obvious, errors of omission may be less visible. Errors of omission are associated frequently with a failure to consider "routine" ICU interventions that may be forgotten in the face of more acute issues (7). Because the underlying causes may be different, errors of omission may therefore require different prevention strategies than errors of commission (8).

Multiple protocols and guidelines have been published on "best practice" in the ICU. However, protocols and guidelines are optimally useful only when they are

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considered for every patient and implemented for those meeting the appropriate criteria. Unfortunately, there is often a discrepancy between published guidelines and practice patterns in the ICU. For example, a recent review reported that "best practice" therapeutics were implemented in just 56% of ICU patients who were eligible for the implementation of these practices (7) whereas a different report showed that pharmacologic deep venous thrombosis (DVT) prophylaxis was withheld in 20% of ICU patients who met the criteria for prescribing DVT prophylaxis (9). A methodology that could ensure consideration of "best practices" for all appropriate ICU patients has the potential to minimize errors of omission. We hypothesized that the presence of a checklist to ensure consideration and subsequent implementation (when appropriate) of a wide range of protocols and objectives could decrease errors of omission that occur in the routine day-to-day care of an ICU patient. To study this, we instituted a checklist on morning rounds in the ICU. Although we did not record baseline consideration of domains covered on the checklist before its availability, our study design examined whether a) mandatory verbal review altered verbal consideration of these domains compared with when the checklist was available but optional and b) mandatory verbal review of the checklist altered practice patterns compared with a baseline time before the checklist was available.

METHODS

Location

The study was conducted in the 24-bed surgical/burn/trauma intensive care unit (SICU) in Barnes-Jewish Hospital, a 1228-bed tertiary care hospital affiliated with Washington University School of Medicine. Each week, the SICU is staffed by two board-certified attendings (one during the day, one at night, one each from the departments of surgery and anesthesiology); two to three critical care fellows from the departments of surgery, anesthesiology, and internal medicine; and six to seven residents from the departments of surgery, anesthesiology, emergency medicine, and obstetrics and gynecology. The attending on service changes weekly. Fellows and residents typically rotate in 4-wk blocks with different start/stop dates depending on departmental origin, resulting in new trainees starting, on average, every 2 wks. The typical nurse/patient ratio is 1:2, and the SICU has a dedicated pharmacist, dietitian, and two clinical nurse specialists. The average experience level of the bedside nursing staff was 9.7 yrs with a yearly turnover rate of 18%, and this did not vary throughout the study. Morning rounds are multiprofessional and include all team members (attending, fellows, residents, nurses, pharmacist, dietitian) listed above.

Patient Population and Study Design

A multiprofessional committee developed a checklist of protocols, guidelines, and objectives used commonly in the SICU (Fig. 1). The checklist was initially designed based on a perception that many of the SICU-specific protocols or guidelines, which had been developed internally, were not being universally implemented. This led to an initial version of the checklist that was targeted specifically toward daily review of each SICU protocol on every patient. However, before checklist implementation, discussion at our monthly quality improvement meeting highlighted the fact that this initial version would have left a number of elements of ICU care without a formal method to ensure they were considered on a daily basis. Examples of domains that would have been missed on a checklist that solely covered SICU-specific protocols were common prophylaxis measures (DVT prophylaxis, stress ulcer prophylaxis), and other elements of ICU care that were not as easily characterizable (ordering physical therapy, placing appropriate patients on telemetry on discharge from the ICU). Ultimately, the decision was made to include domains which we subjectively believed were at higher risk of becoming errors of omission, especially in sicker patients with more immediately life-threatening concerns. As such, the checklist was designed to be a hybrid of: a) SICU-specific protocols and guidelines, such as those used for phosphorus repletion and blood glucose control (10, 11); b) evidence-based "best practices" that were not the target of specific SICU-specific protocols (DVT prophylaxis); c) ICU "best practices" not as clearly amenable to protocol formation, such as removing central venous catheters

Insulin		☐Y	☐N	
New Suspected Infection		☐Y	☐N:	☐ abdominal source ☐ other known infection ☐ resistant infection ☐ no suspected infection
Sedation		☐Y	☐N:	☐ CHI ☐ Short term vent ☐ other ☐ non-vented
Electrolyte repletion				
	Phosphorus	☐Y	☐N	level_____
	Magnesium	☐Y	☐N	level_____
	Potassium	☐Y	☐N	level_____
CAARES		☐Y		☐Opt out
		☐BEST		☐No vent
		☐STAR		☐Difficult Airway
		☐SWAT		☐Other
		☐Oral care		
Trach Protocol: Meets criteria		☐Y		☐N
Telemetry: Meets Telemetry Indications Upon Transfer				
		☐Y		☐N
		☐New cardiac event in past 24 hours]		
		☐Sign over HOB/Outside room		
Stress Ulcer Prophylaxis:		☐Y		☐N
		☐Y Completed 7 day therapy		
Nutrition		☐TPN		
Deep Venous Thrombosis Prophylaxis:		☐Y		☐N Reason_____
☐Heparin	☐Lovenox	☐SCD's	☐IVC filter	
End of Life Issues:		☐Y		☐N ☐Family conference planned
Level of care orders		☐Y		Renewal Date: _____
Central Venous Line needed		☐Y		☐N
Physical Therapy		☐Y		☐N
Restrain orders		☐Y		☐N

Figure 1. Checklist of intensive care unit protocols and objectives. *CAARES*, Continuous Assessment of Airway, Respiration and Extubation in the surgical/burn/trauma intensive care unit; *BEST*, Breathing Spontaneous Trial; *STAR*, Short-term Trach Asssessment of Respiration; *SWAT*, Slow Wean After Trach; CHI, closed head injury; HOB, head of bed; IVC, inferior vena cava.

when they were no longer needed, and ensuring end-of-life issues were discussed, if applicable (12–14); and d) patient safety and regulatory issues both in the SICU (such as restraint orders and physical therapy) and on transfer to a lower level of care (such as posted reminders that a patient would need telemetry upon transfer from the ICU). Although no element on the checklist was deemed to be more important *a priori*, a decision was made that the first six items on the checklist would be SICU-specific protocols or guidelines. This was based on familiarity with these protocols and guidelines as well as their ready availability at every patient's bedside. Ultimately, however, the common denominator behind the disparate items on the checklist was the belief that each element listed had the potential to be inadvertently overlooked in daily ICU care. We refer to each element on the checklist as a "domain" for the remainder of the manuscript. To facilitate ease of usage, the checklist was referred to as the DOUG (Daily Operationalization of Unit Guidelines). After the checklist's development, all SICU attendings and fellows were educated and encouraged to use it on each patient on morning rounds.

The study was divided into two portions, with different methods of measuring outcome in each. The first component of the study (referred to hereafter as the consideration phase) evaluated whether mandating that the entire checklist be verbally reviewed on morning rounds outside each patient's room altered verbal consideration of the domains it covered. Evaluation was performed using real-time bedside audits on morning rounds. The second component of the study (referred to hereafter as the implementation phase) evaluated whether mandating verbal review of the checklist altered implementation of these domains by changing practice patterns. Evaluation was performed by analyzing data from the Project IMPACT database (Cerner, Kansas City, MO) after patients left the ICU.

During the preintervention component of the consideration phase, the checklist was available, but the method in which it was utilized (verbal readback, silent readback, a combination, not used) was left to each individual attending's discretion. During this preintervention component, an audit was conducted without the medical team's knowledge by the SICU's two clinical nurse specialists (M.E.S., C.S.S.) and pharmacist (W.M.) who rounded with the team each morning. The audit evaluated whether each domain was individually considered during rounds on each patient in the SICU. The end point of the audit was discussion of a domain, not implementation of a protocol or objective. For instance, if it was discussed that a patient was not a candidate for pharmacologic anticoagulation because of a specific reason and therefore did not receive DVT prophylaxis, this would count as consideration of DVT prophylaxis (even though the patient did not actually receive pharmacologic prophylaxis). If a patient was on DVT prophylaxis and this was verbally mentioned, this also would count as consideration. Alternatively, if no mention was made of DVT prophylaxis, this was recorded as a failure to consider the issue regardless of whether the patient was receiving DVT prophylaxis. The audit results were then communicated to the SICU co-directors (C.M.C. and W.A.B.), who mandated that all elements on the checklist be verbally reviewed on every patient every morning outside the patient's room on morning rounds (the intervention component of the consideration phase). A follow-up audit performed 2 mos post intervention, using the identical methodology and without the knowledge of the medical team, assessed the impact of mandatory verbal review of the entire checklist. The initial and follow-up audits are the preintervention and postintervention groups, respectively, shown in Table 1. Of note, we did not perform any audits on domain consideration before the availability of the checklist. Therefore, the consideration phase compares a time period when the checklist was available but optional with a time period when verbal review of the checklist was mandated. However, we cannot determine the effect of the simple availability of the checklist on domain consideration because we do not have any data before its availability on an optional basis.

During the implementation phase, domains that were evaluable were compared between a 4-mo baseline period immediately before the development/availability of the checklist (June to September 2006) and a 4-mo period after completion of the consideration phase, when verbal review of all elements on the checklist on every patient was mandated (February to May 2007). It should be noted that the entire consideration phase of the study occurred in the interval between the pre- and postintervention portions of the implementation phase. This is because the consideration phase tested whether mandating verbal review of the checklist changed consideration of domains (with the checklist available in both groups but mandated only in the latter) whereas the implementation phase determined whether mandating verbal review of all elements on the checklist (as a result of the consideration phase) changed implementation of evaluable domains compared with a baseline period before the checklist was available. At no time were patients in either the pre- or postintervention portions of the consideration phase compared with patients in either the pre- or postintervention portions of the implementation phase (or vise versa). Figure 2 shows a timeline of the study design, demonstrating the relationship between each component of the study and the outcome variable measured in each. The study was approved by the Washington University Human Research Protections Office, and informed consent was waived.

Table 1. Verbal consideration of intensive care unit protocols and objectives before and after the checklist was mandated

	Pre Intervention, %	Post Intervention, %	*p*
Insulin protocol	96	100	.12
Suspected infection protocol	96	100	.12
Sedation protocol	100	100	1
Electrolyte protocol	89	100	.007
Oral care protocol	85	98	.008
Need for telemetry on transfer	96	100	.13
Stress ulcer prophylaxis	89	100	.007
DVT prophylaxis	92	100	.03
Need for physical therapy	81	98	.02
Daily restraint orders	77	100	<.0001
Evaluation of end-of-life issues	98	100	.28

DVT, deep venous thrombosis.
All domains listed as a protocol required a physician order.

Statistical Analysis

Categorical variables were analyzed with chi-square tests using Analyze-it Standard Edition (Analyze-it Software, Leeds, UK). Continuous variables were analyzed with Wilcoxon two-sample test using the statistical program SAS version 9.1 (SAS, Cary, NC). A $p < .05$ was considered to be statistically significant.

RESULTS

Efficacy of Checklist in Changing Bedside Consideration of Protocols and Objectives

A total of 114 patients were evaluated in the consideration phase (53 when the checklist was optional, 61 when it was mandatory). A total of 11 domains were evaluable in the consideration phase, re-

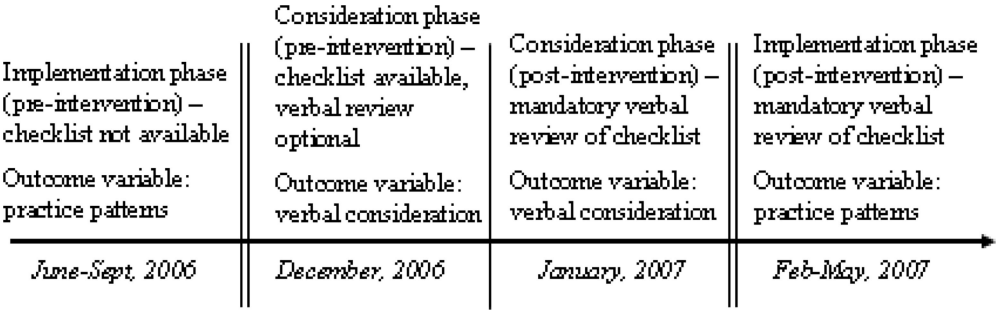

Figure 2. Experimental design and timeline. The study took place in two phases: the consideration phase and the implementation phase, each of which had a pre- and postintervention group. The entire consideration phase (pre and post) took place between the two phases of the implementation phase. The consideration phase evaluated whether mandating verbal review of the checklist altered verbal consideration of the domains it covered. The implementation phase evaluated whether mandating verbal review of the checklist altered implementation of these domains by changing practice patterns.

Table 2. Patient characteristics before and after implementation of the checklist

	Pre Intervention	Post Intervention	*p*
Age, yr	56.6	56.3	.48
Gender, male, %	57	58	.72
APACHE II	16.1	16.4	.71
Mortality, %	5.0	6.5	.20
Arrhythmia as admitting diagnosis, %	4.7	5.8	.45
GI bleed as admitting diagnosis, %	3.6	6.0	.07
Intraoperative hemorrhage as admitting diagnosis, %	6.5	2.5	.0006

APACHE, Acute Physiology and Chronic Health Evaluation; GI, gastrointestinal.

Table 3. Practice patterns before and after implementation of the checklist

	Pre Intervention	Post Intervention	*p*
Time from admission until prescription of medical DVT prophylaxis, days	1.8	1.4	.08
Utilization of physical therapy, %	27	42	<.0001
Transferred to telemetry, %	16	35	<.0001
Central catheter duration, days	6.1	5.4	.11

DVT, deep venous thrombosis.

sulting in 583 assessments of whether a domain was considered when the checklist was optional and 671 assessments of whether a domain was considered after verbal review of all elements on the checklist was mandated. Consideration of the domains on the checklist improved from 90.9% in the preintervention group (530/583) to 99.7% in the postintervention group (669/671, $p < .0001$). The 53 care domains that were not considered on morning rounds in the preintervention group varied widely (Table 1) whereas the only domains not considered after mandatory verbal review of all elements on the checklist were oral care protocol and need for physical therapy (once each). After mandatory verbal review of the checklist, verbal consideration improved in the following domains: DVT prophylaxis, stress ulcer prophylaxis, oral care for ventilated patients, electrolyte repletion, utilization of physical therapy, and documentation of restraint orders. Domains that were already verbally considered at or near 100% of the time before mandatory verbal review of all elements on the checklist (i.e., sedation protocol, insulin protocol, suspected infection protocol) continued to be verbally considered in all patients after its use was mandated.

Efficacy of Checklist in Changing Practice Patterns

To determine whether practice patterns were changed, a comparison was performed on the four domains that were evaluable from the Project IMPACT database before and after implementation of the checklist. In the 4 mos before the availability of the checklist, there were 632 SICU admissions which were well matched to the 653 ICU admissions after its availability in terms of age, gender, and Acute Physiology and Chronic Health Evaluation (APACHE) II score (Table 2). After implementation of the checklist, the number of patients transferred from the SICU to a lower level of care on telemetry more than doubled and the use of physical therapy in the SICU increased >50% ($p < .0001$ for each) (Table 3). There were also trends toward more rapid initiation of pharmacologic DVT prophylaxis and decreased length of central venous catheter duration post implementation of the checklist ($p = .08$ and .11, respectively) (Table 3).

DISCUSSION

Errors of commission and errors of omission are both common in the ICU. The former tend to be visible (e.g., giving someone an inappropriately high dose of a medicine) and generate frequently a large amount of attention. Errors of omission, however, tend to be insidious. A review estimated that 167,819 lives could be saved in ICU patients by eliminating errors of omission (15). Although many of the domains involved in that study have subsequently been called into question (16–18), there is little argument that errors of omission represent a major problem in the ICU setting. Frequently, however, these errors are unrecognized. For instance, if a patient with postoperative ectopy is discharged from the ICU without orders for telemetry and dies of assumed dysrhythmia 1 day after discharge, this may not trigger an investi-

gation. Similarly, a patient who develops a catheter-related bloodstream infection may not trigger a *post hoc* analysis as to whether the central catheter could have been removed earlier. Additionally, the records of a patient who develops a ventilator-associated pneumonia may not be examined to determine whether all possible preventive measures (for example, head of bed up, oral care protocol) were taken. Unfortunately, the multiplicity of life threats and interventions commonly encountered in the ICU often distract from seemingly mundane—but ultimately no less important—aspects of care. Consistent with this, it has been demonstrated that the sickest patients are actually the least likely to receive "best practice" therapeutics, with each 1% increase in APACHE II score resulting in a 1% decreased chance of "best practices" being prescribed (7). Although prompt responses to immediate life threats are essential, neglect of the more mundane aspects of critical care may lead to disability and even death.

Whereas defining "best practice" in the ICU is difficult, ensuring implementation of these practices may be even more difficult. This is because translating "best practices" to the bedside can only be successful if these practices are clearly enumerated, considered on a routine basis, easily executable, and verifiable. Cabana et al identified seven barriers of knowledge and attitudes that prevent guidelines from being translated into behavior change (examples include lack of awareness, lack of motivation) (19). The McDonnell Norms group recently added an additional barrier of failing to make guideline-based advice available at the point of care (20). The Joint Commission responded to the challenges of implementation by proposing a detailed conceptual framework for the variables and strategies relevant to translating protocols and guidelines into bedside behavior that emphasizes the importance of both monitoring impact and obtaining feedback (21).

To decrease errors of omission and bridge the gap between protocol and bedside care, we created a simple checklist with no financial cost to the ICU or the patient. Our results demonstrate that mandatory verbal review of all elements on the checklist during morning rounds is an effective method to obligate clinicians to first a) consider domains that might otherwise have been ignored due to workflow issues; and then b) implement protocols and guidelines available to the provider at the point of care. The checklist allows for immediate feedback to the bedside provider which increases both consideration and usage of ICU "best practices." This may be especially important in a teaching hospital due to the relative lack of continuity in patient care. For example, over the course of time it took to perform this study, 14 attendings, nine fellows, and >60 residents rotated through the SICU. Regardless of the frequency of physician turnover or the quality of sign-out, the checklist assured that basic core elements of ICU care were considered on a daily basis.

This study was performed in two phases because different information was available from bedside audits and database analysis. In the consideration phase, we determined whether the ICU team verbally considered domains on the checklist but did not evaluate whether this changed clinical practice. Although these should be theoretically linked, there may not be a simple 1:1 correlation between considering a domain and bedside behavior. An example of this is the data on sending patients out of the SICU on telemetry. In the consideration phase, this was discussed 96% of the time so no statistically significant difference was noted after the checklist was mandated and this was discussed 100% of the time ($p = .13$). However, after the checklist was mandated, the number of patients transferred out of the ICU on telemetry more than doubled from 16% to 35% ($p < .0001$). There are a number of possible explanations for this. The first is that consideration and bedside behavior are relatively independent of each other, because a modest 4% increase in verbal consideration of telemetry is significantly smaller than the 19% increase in actually sending patients out on telemetry. Another possibility is that they are closely linked. There were >10 times more patients assessed in the implementation phase than the consideration phase so any effect seen in the former could be magnified (and become statistically significant) if translated into the latter. A middle ground between these two extremes is that there is some linkage, but it is not a 1:1 correlation. In this interpretation, improved consideration could change bedside behavior somewhat, but additional factors (Hawthorne effect, for example) would also need to be taken into account to explain the disproportionate improvement seen in the implementation phase. Finally, the discrepancy may have been due to study design. The checklist was available in both portions of the consideration phase (Fig. 2)—the difference being that it was optional in the first and mandatory in the second. In contrast, the checklist was not available at all in the first portion of the implementation phase. Although we know that mandating verbal review of the checklist improved overall consideration of the domains analyzed, we do not know the impact of its mere presence because we did not study consideration before the existence of the checklist. As such, verbal consideration of telemetry could have ranged from 0% to 96% before the existence of the checklist, and its presence, even in an optional form, might have had a profound impact. Anecdotally, we believe that telemetry was rarely discussed on rounds before the initiation of this study, so it may be that the simple presence of the checklist (even when not mandatory) dramatically improved consideration, although making it mandatory improved this even further up to 100%. The changes in behavior seen in the implementation phase could therefore result from a combination of both of these.

Several mechanisms currently exist to reduce errors of omission. Computerized reminder systems are increasingly common. Although adherence to guidelines can be improved with automated systems, these systems have generally been tailored to single issues, such as DVT prophylaxis or antibiotic redosing (22, 23). Because there are numerous protocols and objectives in the ICU setting, a single issue reminder can have obvious utility in a targeted fashion but multiple reminders are needed to address a range of errors of omission. Computerized documentation of multiple ICU core measures has been implemented successfully at a major academic medical center with marked improvements in compliance levels (24). The advantage to doing this in a computer-based system is that it theoretically eliminates human error. However, it is dependent on a) appropriate computer software being present in an ICU; and b) human interpretation of data and decision making. Standardized order sets have also been demonstrated to improve compliance with ICU protocols and objectives (25). However, many order sets are used predominantly on admission and cannot incorporate the judgment of a bedside clinician as to whether an intervention will be necessary in the future. For instance, pharmacologic DVT prophylaxis may not be appropriate the

morning after a surgery with a 3-L blood loss in a patient with an elevated INR but may be lifesaving if instituted 1 or 2 days later. Additionally, the concept of a checklist of ICU protocols has been successfully utilized in a trauma ICU (26). Although many of the domains examined were different between their checklist and ours, the concept that routine reminders can improve awareness and practitioner practice patterns is consistent between the two studies. It is important to emphasize that any system of reminders requires an open-ended commitment. For example, although the use of pharmacologic DVT prophylaxis has been demonstrated to increase markedly after initiation of automated reminders, one study demonstrated that when the reminders were removed from the system, use of prophylaxis returned to preintervention levels (27).

This study has a number of limitations. Because the checklist was available to both groups in the consideration phase (optional in the first, mandatory in the second), we do not have a true baseline about domain consideration before institution of the checklist. It is reasonable to assume that access to the checklist, even on an optional basis, improved consideration of its contents. However, we cannot make firm conclusions about the benefit of introducing it in an optional fashion. Further, we cannot conclusively prove that mandatory verbal review of the elements contained on the checklist actually changed consideration of the domains evaluated. It is possible that, in the preintervention phase, the same domains were considered before or after rounds, in "off-line" discussions, or simply without verbal acknowledgment. However, in all domains that could be evaluated in both the consideration phase and implementation phase (telemetry, physical therapy, DVT prophylaxis), an improvement in the former correlated with an improvement in the latter. We also cannot rule out the possibility of observer bias in the bedside audits because members of the research team hypothesized that mandatory verbal review of the elements on the checklist would improve consideration of covered domains. The information covered on the checklist was also very wide ranging, including safety issues in the ICU, safety issues upon transfer, communication issues with patients and/or their families, and issues that related to both safety and regulatory concerns. The diffuse nature of the checklist could therefore be criticized for not focusing on any particular area(s) of weakness but simply focusing on anything pertaining to day-to-day ICU management instead. Additionally, it is not clear that each element of the checklist needed to be there. For example, because our sedation protocol was already considered 100% of the time in the preintervention phase, its presence on the checklist may have been of limited utility. It is highly likely that some elements on the checklist are more robust than others, and the checklist's overall utility may have been improved by either shortening it (by eliminating less robust items) or replacing less robust items with other, more appropriate, domains. Since the conclusion of this study, we have periodically revised the checklist based on feedback discussed at our monthly quality improvement meeting to a) add additional domains; b) change the wording on certain domains to clarify process outcomes; and c) delete domains that are not felt to give useful information. Although the vast majority of the checklist has remained unchanged over the last 2½ yrs, the fact that we revise it intermittently indicates that we believe constant attention needs to be paid to not only performing this on a daily basis but also ensuring the appropriate domains are evaluated long term. Because of differences in ICU structures, patient populations, staffing patterns, and protocols, it is unclear how easily the checklist could be adopted in other ICUs. However, we would suggest that many elements evaluated on the checklist are universal (DVT prophylaxis, stress ulcer prophylaxis, central catheter needed) and other domains could be modified to fit the needs of an individual ICU.

Not all domains on the checklist resulted in evaluable data in either the consideration phase or the implementation phase. In the consideration phase, data are unavailable on three domains—tracheostomy protocol, need for central venous catheter, and nutrition. The first two are evidence-based domains (12, 13, 28) but data were unfortunately not obtained in a quantifiable way on the audits (i.e., "seldom mentioned"). The nutrition domain was included on the checklist to ensure that total parenteral nutrition orders were written on weekends when full-time nutrition support is not present in the SICU and also to assess whether a patient could be started on enteral feedings. We did not have an easy way to quantify these related but disparate end points and have subsequently changed the wording on a revised and extended version of the checklist that now includes 17 domains (available on request from the corresponding author).

In the implementation phase, we were able to obtain evaluable data on only four of 14 domains. This is due to the limitations of database analysis to determine implementation. For instance, the first domain on the checklist was our insulin protocol (11). A discussion of whether or not the patient should be on the insulin protocol was easily evaluable in the consideration phase via audits performed on morning rounds. However, the Project IMPACT database cannot distinguish whether a patient received insulin in the SICU under our protocol or whether a patient was followed by an endocrinologist and had his/her glucose managed on an individual basis. Similar issues existed with our "new suspected infection" guideline. This guideline is based on published recommendations for the treatment of intra-abdominal infection and ventilator-associated pneumonia (29, 30). However, although database mining can determine whether or not a patient received antibiotics and for how long, it cannot determine whether or not we followed our own protocol in prescribing and discontinuing antibiotics. This highlights the need for new tools to measure outcomes because currently our ability to initiate interventions outpaces metrics to measure their results. The development of new methods to measure such metrics (i.e., studying how cognitive tools, such as checklists, change clinical care) would clearly be beneficial. Another potential concern is whether there are unrecognized cognitive (rather than financial) costs to the checklist. The checklist extends morning rounds by a relatively modest length because it takes 35 to 45 secs on average to recite the checklist per patient. However, it is possible that the time could be better spent on other relevant clinical issues or that the checklist could distract the caregivers involved due to the volume of information contained on the checklist. To minimize this side effect, the resident physician who recites the checklist is never the one who will take care of the patient that day. Rather, a resident listening to the presentation on morning rounds makes notes on the checklist in real time. Once the presentation is finished, the resident who filled out the checklist reads it out loud and any items that were not mentioned in the presentation are immediately addressed.

The goal is to prevent "clutter" that would distract the presenting physician from key clinical issues but simultaneously to assure the checklist is performed as a safety net. Whether this prevents cognitive "clutter" or whether this is feasible outside of an academic ICU without a rounding team is unclear. We also did not systematically measure individual practitioners' attitudes toward the checklist. Anecdotally, the majority of the attending staff viewed the checklist positively, believing that it functions as a safety net to improve patient safety. A small minority, however, viewed it as a nuisance and did not believe the extra 35 to 45 secs to perform the checklist were value added. Because fellows and residents changed frequently during the study and were not the same between pre- and postintervention phases, their attitudes are more difficult to quantify. One final limitation is the possibility of extinction over time. Although the checklist is read out loud at each patient's bedside and is now an accepted part of the culture in our SICU, this does not necessarily correlate to continued appropriate practice patterns. As such, intermittent audits of the evaluable practice patterns (physical therapy, transferred to telemetry, etc) need to be performed.

Despite these limitations, our results demonstrate that a simple checklist of ICU protocols and objectives increases both consideration and implementation of multiple domains prone to errors of omission. This can be done without any financial cost except a slight increase in the time it takes to round in an ICU each day. How generalizable this is to other ICUs is not clear.

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