Introduction

The complexity of medicine in the modern era is increasing on an almost daily basis. Nowhere is this more obvious than in the intensive care unit (ICU), where a vast array of cutting-edge practices, potent medications, and advanced technologies are brought to bear in support of failing organs and critical illness. The care of ICU patients is also time-sensitive. The typical ICU patient requires an average of 178 activities per day [1]. The care of one patient can easily require dozens of healthcare providers to carry out thousands of activities properly, at the right time, and in the correct order. This choreography can be challenging under normal circumstances, given the natural limitations of human memory and attention. In the stressful, high-stakes environment of the ICU, it can be nearly impossible.

The high levels of stress and fatigue that caregivers experience can compromise their cognitive function [2] and lead to decreased compliance with proper protocols, increased error rates, and reduced efficiency [3, 4]. Using checklists to standardize processes ensures that all steps and activities are addressed, thereby reducing the risk of costly oversights or mistakes and improving overall outcomes. Checklists are typically an organized list of essential elements or steps that need to be considered or performed for a given task. They differ from other tools in that they lie somewhere between an informal cognitive aid and a protocol. They provide guidance to users and serve as verification after task completion, without leading to a predetermined conclusion [5]. Checklists can function in several ways, including as memory aids, evaluation frameworks, diagnostic tools, and tools to standardize and regulate processes or methodologies. Ultimately, checklists need to highlight the critical issues: facilitating care delivery, decreasing variability, and improving performance.

Most literature regarding checklist use in the workplace comes from outside medicine. Industries that require precise execution for quality and safety, such as aviation and product manufacturing, depend on checklists as simple aids to achieve consistent quality and minimize errors. In aviation, checklists are now a mandatory part of routine operations and are highly regulated. They are used both in the course of normal practice and during emergency situations, providing a systematic approach to situation recovery. Today, many aircraft manufacturers have transitioned from paper to electronic checklist systems. In product manufacturing, the smallest error during development can affect the quality of the final product, increase costs, and potentially harm the consumer. Checklists play a central role in ensuring
that proper operating procedures are followed and quality standards are maintained. Quality assurance personnel use them routinely at multiple stages of the production process to evaluate whether required regulatory standards are being met. Checklists are frequently the most important component of standard operating procedures for manufacturing and distribution processes because they help to maintain product quality standards.

Healthcare has begun to follow the example of other industries in adopting the use of checklists in select high-intensity fields like trauma, anesthesiology, and critical care [6–8]. However, they have not yet fully permeated the healthcare industry. The reasons for their lack of use are both operational and sociocultural. Operationally, it can be challenging to standardize processes for the wide variability that exists between and even within patients. Physiologic differences, the nuances of patient comorbidities, the occurrence of unforeseen events, and other unpredictable dynamics all influence the approach to diagnosis, treatment, and even recovery, making the design and implementation of a standardized approach very difficult. Socioculturally, healthcare providers, especially physicians, are often resistant to standardization tools, viewing them as a limitation on their autonomy and even infantilizing. As memory aids, checklists can be perceived to undermine a physician’s claim to expertise, and their use tantamount to an admission of weakness.

Types of checklists
Checklists can be divided into four basic types: static parallel, static sequential with verification, static sequential with verification and confirmation, and dynamic [9]. The main differences between these types are the number of people involved and the degree to which required elements or actions are substantiated.

Static parallel checklists require only one person and consist of a series of read-and-do tasks. An example is the machine checklist used by anesthesiologists on a daily basis.

The static sequential with verification checklist requires two people, usually performing a challenge and response. The first person reads off a series of items (challenge) that the second person confirms as having been addressed (response). An example is the central line insertion checklist, in which the nurse challenges the completion of each task or behavior while the proceduralist confirms whether it has been addressed.

The static sequential with verification and confirmation checklist is usually used in group settings, and the tasks or action items are completed by a variety of team members. A person is selected to state each item (challenge), after which the responsible team member(s) confirms the completion of that particular task (response). An example of this type is the surgical safety checklist performed in the operating room for patients undergoing surgery [10]. Before making an incision, the surgeon calls a “time out” and states the patient’s identifying information, specific procedure type, side, and site. He/she then asks about the presence of necessary equipment, which is confirmed by the circulating nurse, and about the patient’s medical condition and availability of blood products, which is confirmed by the anesthesiologist.

Dynamic checklists utilize tools like flowcharts to facilitate complex decision-making. They usually have an algorithmic progression with multiple possible options; healthcare providers must choose options sequentially to determine the optimal pathway. An example is the difficult airway algorithm developed by the American Society of Anesthesiologists [11]. In difficult airway scenarios, the team leader uses it to provide guidance on securing the airway and to communicate the plan and required roles to other team members based on progression along the predetermined algorithm.

Checklists can also be further categorized according to the context of their use: normal or non-normal. Normal checklists are used in the course of routine day-to-day operations,
such as preflight checks in aviation or instructions on preoperative preparation for patients in healthcare. Non-normal, or emergency, checklists are used to troubleshoot errors or mitigate harm when individual or system failures occur. Completion of the checklist provides a systematic approach to situational recovery that facilitates reliable communication, enables consistent operations, and prevents further errors.

Development and implementation of checklists

Recent reviews have started addressing the current gap in robust strategies and standardized methodologies for the development of medical checklists [9,12]. When checklists are well thought through, they can standardize the how, why, where, what, and by whom regarding performance of tasks. This standardization can improve quality by reducing variability and error in both routine and emergent situations. Checklists democratize knowledge, allowing healthcare providers to support each other by verifying work performance. Appropriate development of novel and effective checklists is complex. Necessary steps include assembling a multidisciplinary team to guide development, reviewing the existing literature for evidence-based best practices, understanding the local context and environment, and using an iterative approach to test and validate the tool [9].

It is essential to have a definitive objective in mind before creating a checklist. One way to set an appropriate goal is to use the S.M.A.R.T. criteria [13]. A multidisciplinary team should be assembled to provide diverse perspectives in a collaborative development process. The team should review and incorporate empiric and implicit evidence from the evidence-based literature and their own experience before deciding on the content of the checklist. The Translating Evidence into Practice (TRiP) model is a framework that helps frontline healthcare providers summarize the evidence-based recommendations and determine how to effectively evaluate the focus of their improvement effort, e.g., the checklist [14] (Figure 1.1). The first step is to summarize the evidence. Recommendations should be made on the basis of established evidence-based interventions as found in the literature (explicit knowledge). Some elements will be known to improve patient outcomes (e.g., using aseptic technique for central-line insertion). However, when elements lack empiric evidence, teams can tap into the “wisdom of crowds” to obtain diverse input on potential checklist items [15]. Once an exhaustive list of prospective interventions is compiled, the multidisciplinary team should decide which components can be expected to have the strongest impact in practice.

The next step is to identify local barriers to implementation. Frontline staff often have implicit knowledge of existing barriers and how they might hamper delivery of the proposed checklist components. Engaging these providers in a non-judgmental manner can uncover these barriers. One potential barrier to implementation occurs when providers are unaware of or disagree with recommendations or the evidence behind them. Alternatively, providers may not be properly supported in efforts to deliver the prescribed practices. Most commonly, failure to use evidence-based practices results when caregivers forget to perform a process or the process is at odds with the care delivery environment, making it difficult to do the right thing each time for every patient.

A checklist of tasks and action items must remain manageable in size and scope. Attention must be paid to the number of items, their arrangement, and operator workflow. Formative work in cognitive psychology recognizes that most people can remember only 7–9 items with relative accuracy [16]. As the complexity of the task, provider stress, or fatigue levels increase, the memory becomes increasingly unreliable [17]. If a process necessitates that the checklist contains more items, it is better to separate out the components into sections or subsets organized as their own individual checklists. Such organization needs to be cognitively and operatively
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1. Summarize the evidence
   - Identify interventions associated with improved outcomes
   - Select interventions with the largest benefit and lowest barriers to use
   - Convert interventions to behaviors

2. Identify local barriers to implementation
   - Observe staff performing the interventions
   - "Walk the process" to identify defects in each step of implementation
   - Enlist all stakeholders to share concerns and identify potential gains and losses associated with implementation

3. Measure performance
   - Select measures (process or outcome)
   - Develop and pilot test measures
   - Measure baseline performance

4. Ensure all patients receive the interventions
   - Implement the "four Es" targeting key stakeholders from front line staff to executives
   - Engage
     - Explain why the interventions are important
   - Educate
     - Share the evidence supporting the interventions
   - Evaluate
     - Regularly assess for performance measures and unintended consequences
   - Execute
     - Design an intervention "toolkit" targeted at barriers, standardization, independent checks, reminders, and learning from mistakes

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**Overall concepts**
- Envision the problem within the larger healthcare system
- Engage collaborative multidisciplinary teams centrally (stages 1–3) and locally (stage 4)

**Figure 1.1** Strategy for translating evidence into practice.


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functional. For example, our Daily Goals checklist is organized by organ/disease system into 7–9 sections with no more than 7–9 items under each system [18]. Expanding beyond these limits can result in the creation of an unmanageable tool that is neither useful nor used.

Once consensus has been achieved on the checklist components, appropriate measures need to be developed to monitor the practical performance. Such measures are used to evaluate how consistently individual components are performed (process measures) or how outcomes of interest are affected (outcome measures). The accuracy and validity of the selected measures must be tested and verified. Feedback on results must be given to frontline providers in a manner that ensures transparency and accountability.

The last step of the TRiP model provides a framework for implementation of the developed checklist. The model engages and educates frontline staff about the necessity of the checklist, executes the checklist, evaluates its effect on performance, and monitors for any unintended consequences. The checklist is developed in collaboration with frontline operators, who are
also encouraged to be educated to support its use. This education includes evidence specific to the checklist being developed as well as general principles related to the science of safety and safe design, and the utility of cognitive tools in improving quality and safety. Engagement with frontline healthcare providers should focus on identifying barriers to implementation and defining solutions to overcome them. The opinions of all providers who will potentially use the checklist are valuable, as even “dissenters” provide valuable insights that may lead to a more successful implementation. Evaluation and data collection are also important components of engagement. The data should be shared with healthcare providers, operators, and other stakeholders as they are collected so that users can gauge whether the intervention is working and track progress over time. The ultimate goal is to make the process an iterative one that incorporates new evidence, provides continuous education, and ensures engagement and automatic evaluation.

Changing the story

The reductions in mortality and costs associated with central line-associated bloodstream infections (CLABSI) seen in the Michigan Keystone project [8,19] led to other health systems and nations attempting to replicate the results [20–22]. Media accounts of the program have provided a one-dimensional narrative about the miraculous results achieved through the implementation of a technologically simple tool – a checklist. This narrative is an oversimplification. While checklists were an important tool in generating long-term sustainable outcomes, the narrative ignores the complex social interactions that were necessary to create a cultural change to eliminate CLABSI [23].

For an outsider, the checklist is often seen as the entire intervention, instead of one facet of a larger and more holistic quality improvement effort, which can involve changing an entire system of care and/or its delivery. Failure to address this system as a whole leaves the bedside healthcare provider as the singular “hero” who must prevent harm despite the odds. When engaging or emulating other successful systems, healthcare providers must recognize all aspects that were required for the successful implementation of a quality improvement initiative, and not just focus on the use of a checklist.

The narrative surrounding preventable harm in healthcare is often more important than the use of any individual tool aimed at eliminating harm. In the past, CLABSI was considered inevitable – central lines are necessary for the care of critically ill patients, and infection is an unfortunate but inevitable consequence of their use. With the persistence of such a narrative, it can be difficult to engage bedside providers in quality improvement efforts to prevent harm, as they may view these efforts as a waste of time and resources. Likewise, a checklist should be considered only one component of a broader quality improvement perspective. These initiatives must start with the belief that the efforts put forth will result in real gains. Without these overarching themes, the checklist is doomed to fail and may even have a negative impact on future quality improvement efforts involving them.

Beyond checklists: engineering toward zero harm

Although checklist use has improved patient safety, it is not a panacea for eliminating all preventable harm that patients may experience. Checklists are being used increasingly in safety efforts in part because of their success as a component of efforts to eliminate CLABSI. The resulting expansion of checklist use has led to the checklist itself sometimes being perceived as a burden and detraction from patient care. The risk of “checklist fatigue” threatens to undo the initial benefits gained from their development and implementation.
In the field of patient safety and quality improvement, we must look beyond the checklist itself and instead understand its ultimate goal – ensuring adequate delivery of evidence-based therapies to eliminate a specific harm. Though an individual checklist may serve this function at the time of its use, it is a static tool that may become irrelevant over the dynamic course of a patient's care. Likewise, a checklist targeting one harm may sometimes overlap or even contradict with another checklist targeting a different harm. Our siloed approach of targeting harms individually belies a lack of understanding regarding when and where these synergies and discordances may be occurring, leading to unintended, and sometimes harmful, consequences.

If we are to continue to build upon our past successes in eliminating preventable harm, we must learn from other high-reliability industries such as aviation, nuclear power, and product manufacturing. In these industries, harm is not perceived as inevitable, but rather as a problem that can be overcome through a systems engineering approach. Such an approach is not merely theoretical. An active prototype (Project Emerge) is being developed at the Johns Hopkins Medical System and the University of California San Francisco.

Project Emerge simultaneously addresses seven common harms in ICU patients: venous thromboembolic events, CLABSI, delirium, ICU-acquired weakness, ventilator-associated events, care inconsistent with patient goals, and loss of respect and dignity. The first step in creating this prototype was to catalog all the stakeholders, resources, and workflows associated with the evidence-based practices that contribute to prevention of each harm (Figure 1.2). This detailed assessment was used to gain an understanding of the interdependencies within the existing system. The knowledge was coalesced into a generalizable, scalable framework that explicitly details the steps necessary for harm reduction. These steps broadly consist of proactively identifying each of the harms for which a patient is at risk, which of the predetermined strategies is needed to eliminate the specific harm, who is responsible for performing the tasks aimed at harm elimination, when these tasks should be performed, and how to ensure that all tasks have been performed as prescribed.

The adoption of methodologies used by other industries, specifically checklists, has revolutionized modern healthcare by targeting adequate delivery of practices proven to improve care quality and reduce patient harm. However, the current permutation of checklists tends to focus on some harms at the expense of others. Likewise, the ubiquitous use of checklists is becoming increasingly time- and labor-intensive at the cost of efficiency. Future improvements in healthcare quality and patient safety will need to depend on a more integrated approach that uses technology to improve delivery of healthcare processes through automated process monitoring, thus removing this unsustainable burden from the individual healthcare provider.
Conclusion

Harm has long been understood to be either an inevitable part of healthcare, or worse, a failure of provider vigilance. This view is antiquated and ignores the nature of systems as applied to harm. That is, every system is perfectly designed to achieve the results it achieves [24]. True harm elimination requires not just the adoption of checklists, but also the understanding that harm is a preventable part of a system, and that we must design systems with the end goal of harm elimination in mind.

New technologies, such as device integration and sensor technologies, provide us with the opportunity to remove the bedside clinician from the burdens of process assurance. Leveraging these new technologies will also give us the ability to scale our harm elimination efforts and to address multiple potential harms simultaneously. Only through this broad systems approach can we realistically hope to eliminate the burden of preventable harm in our healthcare system.

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Introduction

Caring for the critically ill patient is the main mission of an ICU. To ensure optimal patient care, a complex interaction between a wide range of medical specialties and between professionals of diverse occupational groups is essential. In addition, delivery of care is complex, dynamic, and often highly fragmented, with many shared or overlapping tasks. Thus, integration of the caring teams’ individual actions into one single network of patient-centered activities is a challenge.

Effective communication is a key element in teamwork and one of the main prerequisites of well-functioning patient care [1]. Failures in communication account for the majority of critical incidents and adverse events in an ICU. Furthermore, poor communication is considered an important cause of nurse–physician conflicts in the ICU [2]. To change workflow and to enhance patient safety, improving communication and changing the culture of teamwork is therefore critical. Besides staff communication and collaboration, several other issues need to be taken into account when addressing problems related to patient care. In the setting of hospital care, they include staffing levels and team composition, standardization of the process of care, early recognition and treatment of the deteriorating patient, and, finally, the local safety climate [1].

Transfer of information relevant to patient care is practiced almost continuously. In addition, medical responsibility is transferred several times per day from one caregiver to another. These processes of handover are complex, and up to now they have been only poorly analyzed and understood. To ensure quality of care, a well-designed handover with clearly defined aims and tasks of the various participants is needed. As outlined in the following paragraphs, using systematic, standardized daily goal discussions has the potential to improve the process of care in respect of several of the problems outlined above.

Daily goal discussions as a key element in care of the critically ill patient

The daily goals concept as a tool to improve communication in the ICU was presented for the first time in 2003 by Peter Pronovost and his team [3]. The concept aims at improving communication within the caring team during patient rounds while encouraging the use of
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Table 2.1 General aspects of a daily care plan in critically ill patients

- List of the patient's clinical problems.
- Interpretation of lab results, cultures, imaging procedures, and other investigations.
- Defining physiological targets and aims.
- Management plan.
- Effective and efficient handover.
- Issues for discharge planning.

(Modified from [9])

all possible information resources to prevent errors and increase efficiency [4]. It does so by facilitating a systematic, standardized, and well-structured approach, while simultaneously allowing for multidisciplinary input. This concept is founded on theories of crew resource management [5]. A key element is a shared understanding of goals and, based on this, a well-coordinated and organized process of patient care. This can be further supported by clearly assigning clinical and educational responsibilities [6].

Ultimately, the daily care plan (a brief outline is presented in Table 2.1) should be based on a shared understanding of patients’ problems, underlying diseases, and measures to ensure optimal outcome. In the ICU, the ultimate result will either be an improved or restored quality of life, or compassionate and supportive palliative or end-of-life care. Using the daily goals concept aims at enhancing the understanding and implementation of all these activities.

In general, patient care rounds are used as a key mechanism to ensure and coordinate communication within the team responsible for patient care, to serve as a platform for effective exchange of information relevant to patient care, to ensure shared perception of a patient's situation, to support decision-making, and to agree on patient management and on each participant’s role and tasks [7,8]. Virtually the same aims are also relevant for the process of handover. A well-designed daily goals tool (e.g., a checklist or specifically designed form) will not only support patient care rounds, but may also be used as the basis for handover. It will contribute to a safe, effective, efficient, timely, and patient-centered process of care. Eventually, it will be one of the key elements ensuring optimal patient outcome.

Daily goal discussions: beneficial effects and challenges

As shown by Pronovost et al. [3], a daily goals checklist for morning rounds in the ICU improves interprofessional communication and increases nurses’ and residents' understanding of the goals of care for the day in the ICU. In addition, these authors observed that patients’ length of stay in their ICU was reduced after the introduction of this concept.

A number of beneficial effects of the daily goals concept were confirmed in subsequent research, but due to limited space only a few examples can be mentioned here. These studies vary in design and setting, and they were all performed as single-center studies. Karalapillai et al. [9] found distinct improvements of ICU nurses’ self-reported understanding of the medical plan, including, among other elements, the patient's clinical problems, the management plan, and issues for discharge. Similar findings were reported for a pediatric ICU by Agarwal et al. [10]. As described by Rehder et al. [11], using a bedside whiteboard for documentation can support shared agreement of patients’ daily goals. Siegeli [12] proposed that a daily goals tool may also have a positive effect on the communication between the caring team and the patients’ families. Based on their mixed-methods study, Centofanti et al. [13] note that a daily goals checklist may have a direct impact on patient care by fostering a systematic approach, by encouraging participation from all team members, and by minimizing errors of omission and