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SPECIAL ARTICLE

Implementing Emergency Manuals: Can Cognitive Aids Help Translate Best Practices for Patient Care During Acute Events?

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In this article, we address whether emergency manuals are an effective means of helping anesthesiologists and perioperative teams apply known best practices for critical events. We review the relevant history of such cognitive aids in health care, as well as examples from other high stakes industries, and describe why emergency manuals have a role in improving patient care during certain events. We propose 4 vital elements: create, familiarize, use, and integrate, necessary for the widespread, successful development, and implementation of medical emergency manuals, using the specific example of the perioperative setting. The details of each element are presented, drawing from the medical literature as well as from our combined experience of more than 30 years of observing teams of anesthesiologists managing simulated and real critical events. We emphasize the importance of training clinicians in the use of emergency manuals for education on content, format, and location. Finally, we discuss cultural readiness for change, present a system example of successful integration, and highlight the importance of further research on the implementation of emergency manuals. (Anesth Analg 2013;117:1149–61)

When a patient has an acute event in the perioperative setting, health care practitioners aim to manage the situation according to best practices and to minimize morbidity as well as mortality. Yet during the stress of a critical event, the vast majority of clinicians do not implement all known best practices optimally.[1] Sometimes, vital steps are never performed. How can this fact be changed so that clinicians perform better and patients benefit? Emergency manual implementation and use are 2 important elements within the larger context of team training, such as crisis resource management (CRM)[2] (Fig. 1), the Veterans Affairs (VA) Medical Team Training,[3] or TeamSTEPPS™.[4]

When and Why to Use Emergency Manuals

There is a common misconception that emergency manuals are not relevant in the management of time-sensitive acute events. Certainly, it can be harmful to consult a book or computerized device at the wrong time (e.g., when a pulseless patient needs chest compressions, or other acute physical actions, with insufficient clinicians present). However, with appropriate use, emergency manuals can be a helpful resource for important management priorities during many critical events, in addition to providing an accessible resource for more common needs of "Pre" crisis education and "Post" event debriefing. (Fig. 2 and further explanation in the "Four Elements of Implementation: Use" subsection) In other high-stakes industries, such as aviation and nuclear power, emergency manuals have proved to be helpful tools, are integrated into training, and are expected to be used.

A recent aviation example of the effective use of an emergency manual during a time-sensitive critical event occurred on January 15, 2009. After a bird strike caused the failure of both engines on U.S. Airways Flight 1549 shortly after take-off, the pilot, Captain Chesley "Sully" Sullenberger III, first officer Jeff Skiles, and crew, were able to perform a safe emergency landing in New York's Hudson River. The pilot took control of flying the plane and communicated with air traffic control, while the first officer read from the "dual engine failure" section of the emergency manual to ensure that they completed the recommended "management" actions.[a] This event unfolded quickly, with many lives at stake including their own, the crew had <4 minutes between the bird strikes and their safe water landing.

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[a]Loss of thrust in both engines after encountering a flock of birds and subsequent ditching on the Hudson River, U.S. Airways Flight 1549 Airbus A320-214, N106US Weehawken, New Jersey, January 15, 2009, Aircraft Accident Report NTSB/AAR-10 /03. Washington DC: National Transportation Safety Board, 2009. Available at: http://www.ntsb.gov/doclib/reports/2010/AAR1003.pdf. Accessed March 15, 2013.

[b]Burian BK. Emergency and abnormal checklist design factors influencing flight crew response: a case study. Air Line Pilots Association Air Safety Week Forum. Washington, DC, 2004.

[c]Burian BK. Design guidance for emergency and abnormal checklists in aviation. In: Proceedings of the Human Factors and Ergonomics Society 50th Annual Meeting. San Francisco, CA: SAGE Publications, 2006:106–10.

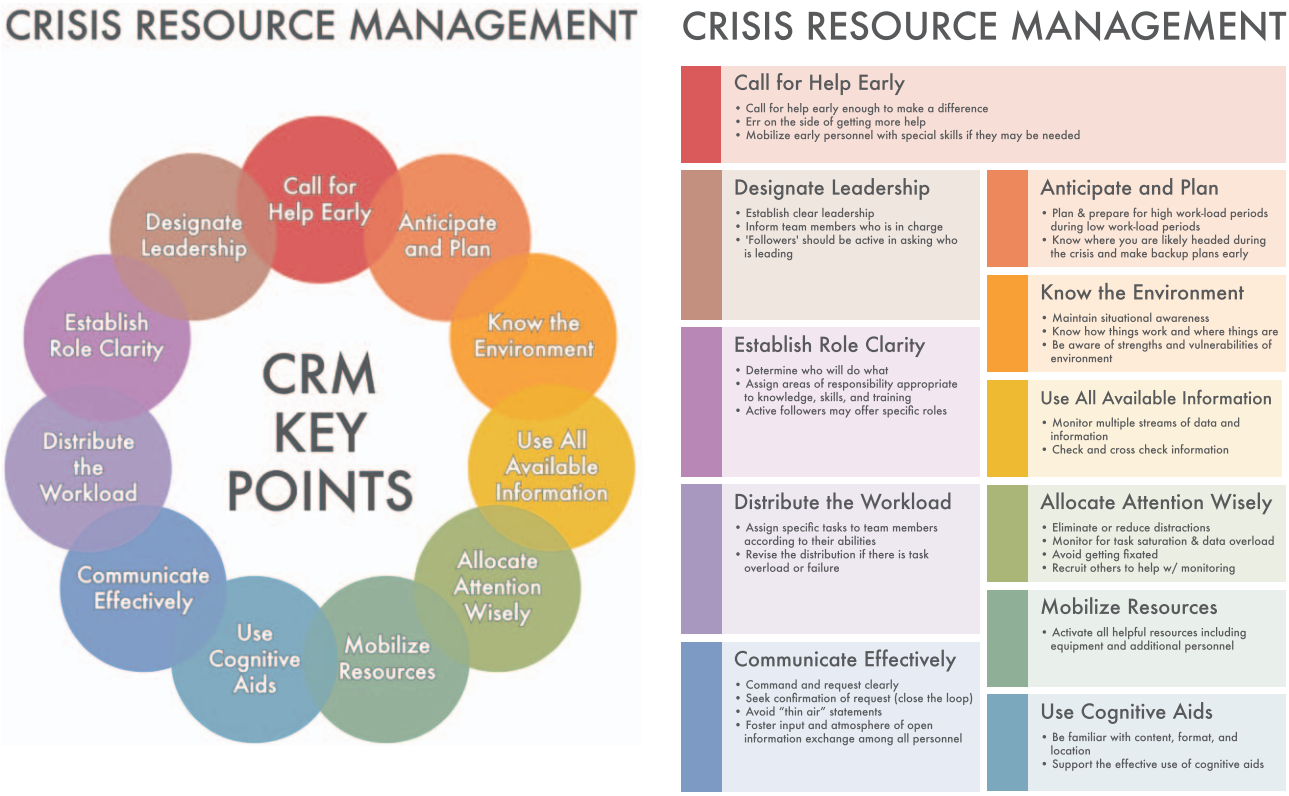


Figure 1. Key points of crisis resource management (CRM). At left, back cover of emergency manuals. At right, inside back cover. Integration of these concepts, which are frequently discussed in simulation courses, into clinical arenas is expected to raise awareness of nontechnical contributions to critical events. © 2008 Diagrams: S. Goldhaber-Fiebert, K. McCowan, K. Harrison, R. Fanning, S. Howard, D. Gaba.

Aviation studies of similar incidents underscore that well-designed and accessible emergency manuals, combined with recurrent training, can be used effectively even in the midst of time-sensitive crises.[b,c]

Although patients and their diseases differ from airplanes, there is growing simulation-based evidence that clinicians under stress, and therefore the patients in their care, can be well served by the similar use of emergency manuals once they are integrated into practice settings, training, and culture. There is a challenge to appropriately implement emergency manuals in a way that positively affects patient care, while avoiding distraction from concurrent necessary actions.

There is a finite set of critical events for each clinical domain. Each event has significant data on best practices for management, although these are ultimately modified by the particular patient's comorbidities and individual case details. For each critical perioperative event, common management errors have been repeatedly observed during simulated and real clinical care. In health care, there is a responsibility to improve this situation by recognizing the challenges that clinicians face, and then creating and appropriately implementing tools that can help. Although our examples come from the perioperative setting, emergency manuals are equally pertinent for acute events in emergency departments, labor and delivery wards, medical or pediatric wards, and intensive care units.

Terminology

For consistency, we use the term emergency manual throughout this article, referring to a bundle of cognitive aids relevant for a particular context such as perioperative care or aviation. In aviation, these are often referred to as emergency sections of flight manuals or as quick-reference handbooks. In health care, emergency manuals, or their components, have been referred to by various names, each with their pros and cons.

Cognitive aid is a term used in many high-stakes industries as well as in much of the medical literature, emphasizing that the information is provided to cue practitioners at the time it is needed. Cognitive aids are tools to help people remember to act on important information that they often already know but may either be inert or nondeployable. The term recognizes that humans are not optimized to retrieve rarely used information. However, individual practitioners unfamiliar with the term may feel it insults their capabilities, implying that they have a cognitive impairment. For this reason, we adopted the more neutral "emergency manual" as the main title for such a bundle, in parallel with similar terms in aviation.

The term "crisis checklists" is an extension from the successful work of Gawande et al. in implementing the World Health Organization surgical safety checklist, emerging from their more recent work in medical crises.[5,6] In the lay public and the medical community, there is positive momentum for the role of checklists in health care. By its component words, "check list" implies a linear flow to check off items, without subsequent reconsideration that may be needed in some medical situations, e.g., difficult airway management. A checklist also does not automatically include other considerations, such as signs or differential diagnoses that are not explicit actions. This inherent issue is often dealt with by

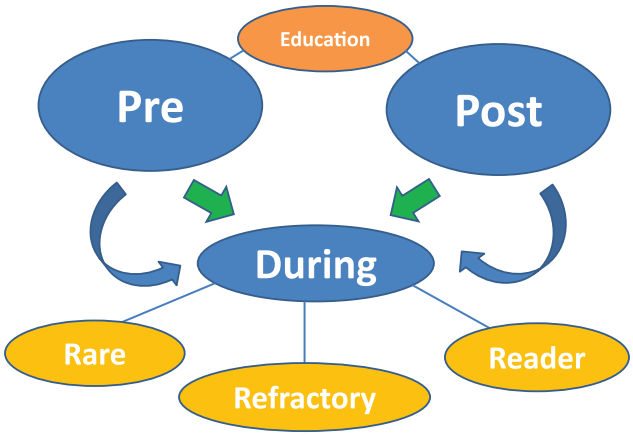


Figure 2. Clinical uses of emergency manuals. The double arrows from "Pre" and "Post" to "During" emphasize that both content and format familiarity are increased when emergency manuals are utilized for educational review. During a crisis, specific categories of events may be appropriate for emergency manual consultation in particular ways. © 2012 Diagram: S. Goldhaber-Fiebert.

including separate boxes for the additional considerations that do not fit within the linear flow of the main checklist. Finally, asking for the checklist during a crisis may create confusion with other routine checklists such as the surgical safety checklist described above.

While the implications of terminology are relevant and naming the emergency manuals is important for their integration in the clinical arena, the 4-element implementation process described in the main part of this article is ultimately the most important aspect in ensuring their optimal use.

Cognitive Psychology and Human Factors

In health care, we can learn significantly from the extensive relevant literatures in the fields of cognitive psychology and human factors. Klein's recognition-primed decision making model emphasizes the positive role of intuition in the form of pattern matching.[7] Experts rapidly recognize a familiar pattern that matches the current situation "well enough," which is often followed by analyzing the fit using mental simulation, then making adjustments as necessary. This intuitive process allows professionals in diverse fields, ranging from fire chiefs to acute care clinicians, to usually correctly make difficult decisions in less than ideal circumstances, including time pressure, high stakes, and incomplete information.[8,9]

In concert with the recognition-primed decision making model, anesthesiologists often must act efficiently and intuitively. These responses involve rapidly recognizing diagnostic patterns and managing the first minutes of a crisis. When patients require immediate actions, it is sometimes distracting for a clinician to consult a cognitive aid.

In contrast, Tversky and Kahneman[10] wrote extensively about the systematic, albeit rare, biases that follow naturally from the heuristic mental shortcuts that allow us to perform efficiently. Heuristics are simple and necessary techniques that help people to efficiently decide adequate responses to difficult questions. Clinicians, like all dynamic decision makers, use many heuristics as approximation strategies during ambiguous, time-sensitive situations.[11] Through cognizance of the common resulting biases, also known as cognitive errors, practitioners can help to protect patients from poor outcomes.

Cognitive errors that are specifically applicable to anesthesiologists and the perioperative setting have been recently reviewed.[12] Emergency manuals may help avert preventable patient harm, as part of a toolbox to combat cognitive errors.[13] For example, tunneling of attention causes clinicians to fixate on what the individual or team perceives (rightly or wrongly) as the greatest risk, potentially resulting in a loss of situational awareness.[14,15]

Klein[16] and Kahneman,[17] while emerging from competing psychological schools of thought, both have applicable models for decision making in clinical care, and each has written an informative book for nonpsychologist lay audiences. Their recent collaboration confirmed that the works of Kahneman and Klein[18] are not contradictory, but rather mostly emphasize different aspects of the same phenomena. Applied to health care, our intuitive expertise, while necessary and often helpful, as in efficiently responding to acute status changes, can be misleading and if unchecked can lead to a worsening patient status. Management gaps, caused by well-described cognitive biases and errors, are a fundamental reason why emergency manuals can be useful to anesthesiologists and other clinicians during refractory or rare critical events.

Experts provide extensive pattern recognition and applicable mental models that they have developed from prior experiences, so they are often appropriately consulted for management advice.[19] However, no physician is expert at managing all aspects of all critical events. For example, during a pulseless electrical activity (PEA) cardiac arrest, important diagnostic causes can be missed even when multiple clinicians trained in Advanced Cardiovascular Life Support (ACLS) are present. It is not good enough to treat and exclude 90% of the "H's and T's" (Hypovolemia, Hypoxia, Hydrogen ion–acidosis, Hyperkalemia/Hypokalemia, Hypothermia, Hypoglycemia and other metabolic disorders AND Tablets [drug overdose, accidents], Tamponade [cardiac], Tension pneumothorax, Thrombosis-coronary, Thrombosis-pulmonary [embolism], Trauma) a common mnemonic for diagnostic causes in PEA, because of reliance on memory alone.[20] Even when all H's and T's are verbalized at a PEA cardiac arrest, often some are neither excluded nor actively pursued. Usually, when teams miss crucial steps in the management of simulated or real critical events, it is not because they have never heard of the appropriate intervention. Ideally, the H's and T's of PEA should be organized in order of priority for the particular medical context, e.g., operating room (OR) versus medical ward, and should be read aloud with explicit follow-up actions to either exclude or treat. By providing information that is not easily retrievable from memory, emergency manuals can be helpful in allowing us to focus our limited available attention on higher level cognitive tasks.

During crises, avoidable performance gaps occur, which is often pointed out by participants themselves during debriefing.[2,21] The common culprits in performance gaps, besides knowledge, are a combination of crisis management

team challenges (communication, leadership, etc.) and a failure to implement knowledge under stress.[22–24]

This latter failure to appropriately execute actions may be because of nondeployable knowledge, systematic cognitive errors, or several common memory issues.[10,d,e,]

Stressful situations have been shown to negatively impact multiple aspects of human memory, including retrieval of inert knowledge, working memory for calculations, and prospective memory for future tasks.[d] Here, we define each briefly, with application to anesthesiology and clinical medicine. Inert knowledge is familiar but sometimes not accessible or active, like the imperfect ability to retrieve the full details of all H's and T's for PEA cardiac arrest. Working memory is used to make calculations, such as for drug dosages. These calculations require active attention, which is a limited resource during periods of stress and distraction, when mental tasks may also take longer and be more prone to error. Prospective memory error is a formal term for getting distracted despite knowing what to do, sometimes described as "forgetting to remember," such as listening to breath sounds on manual mode, getting interrupted by a question, and then forgetting to switch on the ventilator again.

Practitioners are starting to recognize the danger to patients of relying entirely on their own memories and the potential advantages of accessible cognitive aids or checklists.[25,26] In both observational and controlled trials, perioperative teams that consult an emergency manual for simulated critical events perform vital actions more often, more efficiently, and more accurately than those who do not.[5,27,28]

These simulation-based medical studies can be understood in the context of the described psychology research, further emphasizing a role for emergency manuals. However, the mere presence of cognitive aids does not ensure that they will be used[29,30] or used appropriately,[31] which all underscores the importance of systematic implementation and appropriate training.[32]

Implementation Science

Traditionally, translational science describes the progression from bench studies to clinical trials. McGaghie et al. discuss a parallel concept to describe translational research for medical education and simulation.[33,34] This type of research can be divided into 3 categories: T1 is change in clinician actions achieved in an educational laboratory or simulated setting; T2 is transfer of these results to improved patient care practices by providers in a clinical setting; and T3 is improved patient or public health outcomes, such as lower morbidity or mortality. Implementation science integrates methods from many fields, including human factors, behavioral and cognitive psychology, business, education, and aviation. Within health care, implementation science can help patients receive the full benefits of known data in preventive, diagnostic, or treatment realms. In the case of emergency manuals, the goal is to provide easily accessible information, combined with training, to help clinicians effectively prevent, diagnose, and treat critical events. To date, research has been mainly within the T1 category, although there are now more opportunities to move to T2.

Why Now?

The time is ripe for implementation of emergency manuals containing best practices for perioperative critical events. There is increased interest in the use of related resources among both physicians and the public. Gawande's 2010 book, *The Checklist Manifesto*[35] addresses tools for preventing errors, with examples including preoperative checklists for safer surgery. In October 2011, Dr. Gawande was the keynote speaker at the Autumn meeting of the American Society of Anesthesiologists. Many anesthesiologists who were in attendance work in settings that have implemented versions of the World Health Organization's surgical safety checklist, which Dr. Gawande's team helped to develop, implement, and research.[6] While some practitioners initially complained about the change, most institutions have now achieved significant cultural acceptance. The benefits of this program include: a check for all practitioners of mundane items that adhere to best practices such as preincision antibiotics, increased information sharing in response to open-ended questions about patient or case-specific concerns, and increased team communication during surgical cases after introductions of all team members. The latter teamwork aspect is less quantifiable but increasingly recognized as vital to patient outcomes. In 2013, a simulation-based trial from Harvard in the *New England Journal of Medicine* reported that teams missed 6% vs 23% of critical actions during a variety of OR events when crisis checklists were accessible versus not.[36]

Although it is always preferable to prevent complications from occurring, the early diagnosis and effective management of complications that do arise can significantly decrease patient morbidity and mortality.[37] Practitioners and health care systems seem increasingly ready to acknowledge this reality, with numerous requests for copies of effective emergency manuals, cognitive aids, or checklists from both Stanford- and Harvard-affiliated[f] simulation centers.

Methodology and History of Stanford Experience

In the implementation framework below, we integrate the relevant published literature with explicit citations, along with our local experience. This section provides an overview of that experience and its evolution. Stanford's simulation-based Anesthesia Crisis Resource Management course has been taught for more than 20 years.[2] Approximately 90% of these courses are attended by residents, although we are conducting an increasing number of courses for experienced practitioners, e.g., during the Maintenance of Certification in Anesthesiology course. The courses have 4 participants each, on average, for a total of 60 to 75 residents per year. Maintenance of Certification in Anesthesiology courses are run similarly, with approximately 5 courses per year.

For more than a decade, specific cognitive aids or full emergency manuals have been available for participants to use during these courses. Many different versions have been developed, with iterative simulation testing and progressive adaptations for usability, but the initial versions were

[d]Staal MA. Stress, cognition, and human performance: a literature review and conceptual framework. NASA technical memorandum. Ames Research Center, 2004.

[e]Bourne LE, Yaroush RA. Stress and cognition: A cognitive psychological perspective. NASA grant NAG2-1561, 2003.

[f]Personal communication, William Berry, Harvard School of Public Health, 2013.

developed in 1988 in work that led to the first extensive "catalog of critical events" for anesthesiologists.[14] In 2003, an updated subset of these critical events was deployed nationally within binders for ORs at all VA hospitals.

In 2009, we piloted adding a brief immersive module near the beginning of resident simulation courses to communicate the value of cognitive aid use and to increase familiarity with the emergency manual format. Over time, our residency program integrated emergency manual use into several other simulation courses, including the new resident orientation, which served to further reinforce the familiarity and perceived utility of emergency manuals. Beginning in 2010, Stanford anesthesia residents in their Clinical Base year were shown how cognitive aids could be used in acute care situations during a program called START (Successful Transition to Anesthesia Residency Training).[g] During residency training, the use of such tools is further encouraged by most faculty within the associated institutions.

As of 2012, accessible emergency manuals have been integrated into anesthetizing and other perioperative locations. OR staff training, including in situ simulation, began in 2012 with a goal of introducing all OR team members to emergency manual use and demonstrating how this fits into CRM strategies. CRM concepts are displayed on the back cover of the emergency manuals for reference, including for event debriefings (Fig. 1). Pertinent examples from various phases of our implementation process are interwoven with relevant published literature throughout the framework presented here.

FOUR-ELEMENT IMPLEMENTATION STRATEGY

In one of the first medical studies of the use of cognitive aids, anesthesia resident teams were observed during scenarios of simulated malignant hyperthermia, with a readily available cognitive aid provided.[27] Many of the teams in this study did not use cognitive aids at all, or did so only sparingly. Teams that consulted a cognitive aid performed more of the critical actions, and did so more quickly, than teams that worked solely from memory. The nonusers seemed to share with the users the same inherent human vulnerability of incomplete memory under pressure, but either did not realize the problem or were not aware that help was easily available.

This study spurred the question of how to help the nonusers to achieve the better success rates of the cognitive aid users. As with other significant improvements in health care, such as decreasing central-line infection rates[38] or early treatment of sepsis,[39] multiple important elements are likely required rather than a single "magic bullet." We propose a 4-element approach that integrates recommendations from the medical literature with examples from our experience. The elements are: create, familiarize, use, and integrate (Fig. 3). The elements are presented in approximate order of execution, although they have multiple, overlapping interconnections that can influence one another, and some contain >1 subelement.

We describe each element in detail below, giving relevant examples from both the nascent medical literature on the use of cognitive aids and from our experiences with iterative testing in simulation courses at our institution over the last decade.

Create

Elements and Attributes

To be of maximum use, emergency manuals must focus on both medical content and design. How the information is presented plays a vital role, as emphasized by an extensive review article that summarizes 5 considerations for creating effective checklists: context, content, structure, images, and usability.[40] A cognitive aid cannot replicate a comprehensive article, but must present the important, current, evidence-based practices and recommendations. Moreover, a set of cognitive aids for a specific context, such as perioperative, should be in a format that is (1) sufficiently complete to encourage consultation without being overwhelming, (2) relevant for the intended clinical environment, and (3) organized in a way that is easy to find any specific cognitive aid during a crisis. Such a design facilitates optimal usability during a critical event. Expertise in both the content and usability aspects is important for creation. Various helpful sets of cognitive aids or checklists, specific for anesthesia and perioperative medicine, have been published in recent years within explanatory articles or standing alone.[5,41,h,42,i,43] These resources have significant commonalities and all are intended to supplement, but not to replace, more in-depth education and clinical judgment. Given many requests from practitioners at other institutions for an emergency manual formatted for clinical usability, the Stanford Anesthesia Cognitive Aid Group[j] has made publicly available a no-cost downloadable document, with a Creative Commons license, which is hosted at http://emergencymanual.stanford.edu.

The emergency manuals that have been integrated into all perioperative areas at our institution address critical events that are mostly rare, but with high potential for mortality. Also included are some common perturbations, such as hypotension and hypoxemia, which may be refractory to initial treatment. The events are organized alphabetically, except that ACLS events are grouped separately in a front section. Simulation testing showed that placing the table of contents on the front cover allows for easy reference (Fig. 4). Each event also has a sidebar name and number at the unbound edge, for easy access (Fig. 5a).

Simulation Testing

Consistent with the cognitive psychology literature described above, we observed during many simulated scenarios and debriefings that having the correct information present in

[g]START program information. Available at: start.stanford.edu. Accessed March 15, 2013. LF Chu, LK Ngai, CA Young, RG Pearl, A Macario, TK Harrison. Preparing interns for anesthesiology residency training: development and assessment of the Successful Transition to Anesthesia Residency Training e-learning curriculum. J Grad Med Educ (in press 2013).

[h]For Reference 41, in the same journal issue there are 24 published "sub-algorithms" for specific critical events, each with explanatory text and a helpful figure.

[i]For Reference 42, this appendix consists of cognitive aids for 21 separate critical events. The first 3 authors collaborated on all events. Authors 4 through 6 contributed on 1-2 critical events each.

[j]Stanford Anesthesia Cognitive Aid Group core contributors in random order: Steven Howard, Larry Chu, Sara Goldhaber-Fiebert, David Gaba, Kyle Harrison.

an accessible emergency manual does not guarantee that stressed anesthesiologists can easily find or apply that information. As for the development of other checklists,[40] we found that it is vital to iteratively test prototypes during simulated emergencies to develop effective manuals. What appears clear to the developers of emergency manuals may be easily missed or misunderstood by the user during stressful crisis situations.

Iterative testing at our institution, during simulated scenarios, has also shown the importance of appropriately emphasizing vital steps. For example, in the cognitive aid for malignant hyperthermia, treating with dantrolene was originally listed as one of many actions. When dantrolene was bolded and a 70-kg adult dose calculated, explicitly showing the number of vials required, practitioners appropriately focused more resources on preparing this critical medication more rapidly, and in debriefings stated that their cognitive load of calculating dose details was decreased (Fig. 5b). In addition, 2-page cognitive aids were initially labeled "continued from prior page" on the top of the second page. However, during simulated crises, multiple teams of trainees and of board-certified anesthesiologists mistakenly started reading from the second page, missing important information on the first page. This issue was effectively addressed by adding large arrows (Fig. 5c), indicating that the material is continued from the prior page. The iterative testing process proved essential in allowing changes to be made to improve accessibility and usability.

Familiarize

Familiarity Is Crucial

The following example, executed during a series of simulation courses, illustrates this concept. A set of large-format ACLS cognitive aids was attached to the code cart, at chest height and partially blocking the defibrillator monitor. As expected, each team moved the aids to see the defibrillator screen, and none felt they hindered their use of the defibrillator. Interestingly, even though all teams touched the ACLS instructions, many did not consult them, even when they were leaving out essential elements of cardiac arrest management. During debriefing, the teams were asked why they had not used the provided cognitive aids. The vast majority answered "Where were they? We never saw them." The participants were perceptually blind[44] to the presence of these large, colorful resources. The video recordings showed the clinicians moving the cognitive aids, but their brains likely viewed them to be extraneous during a stressful event because they were unfamiliar.

Training

An important goal of the training and familiarization described here is to enable clinicians to become proficient in using emergency manuals without neglecting immediate patient care, like the crew that safely landed their plane in the Hudson River, while simultaneously consulting the engine failure section of their emergency manual. In a study of 50 anesthesia residents managing simulated cardiac arrests, McEvoy et al.[45] showed that the residents performed better after they were trained in the use of ACLS cognitive aids. However, simply giving them an unfamiliar card to use failed to improve performance, despite the fact that the card contained all the correct information for managing the specific critical event. They also found that 6 months later the residents' performance, without a cognitive aid, had returned to baseline, echoing many studies showing rapid decay of ACLS training. The use of the familiar card at 6 months improved their performance to levels similar to those seen directly after training, showing promise to increase effectiveness of intermittent trainings.

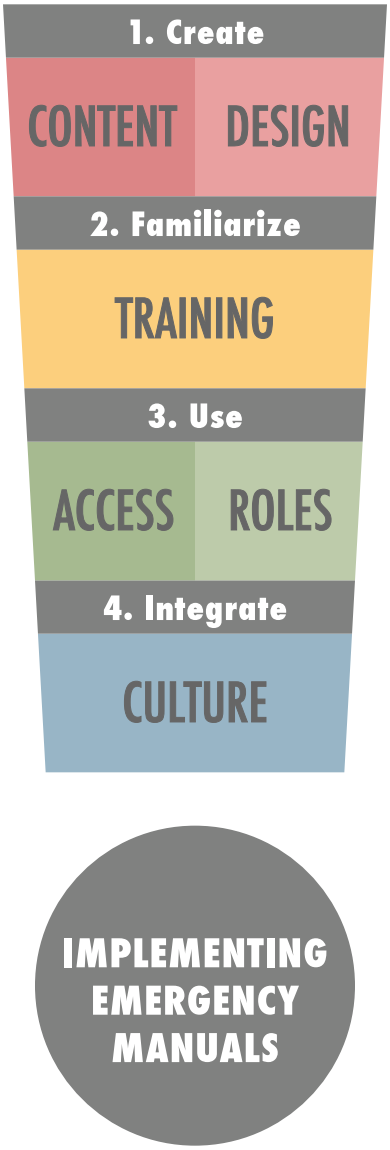
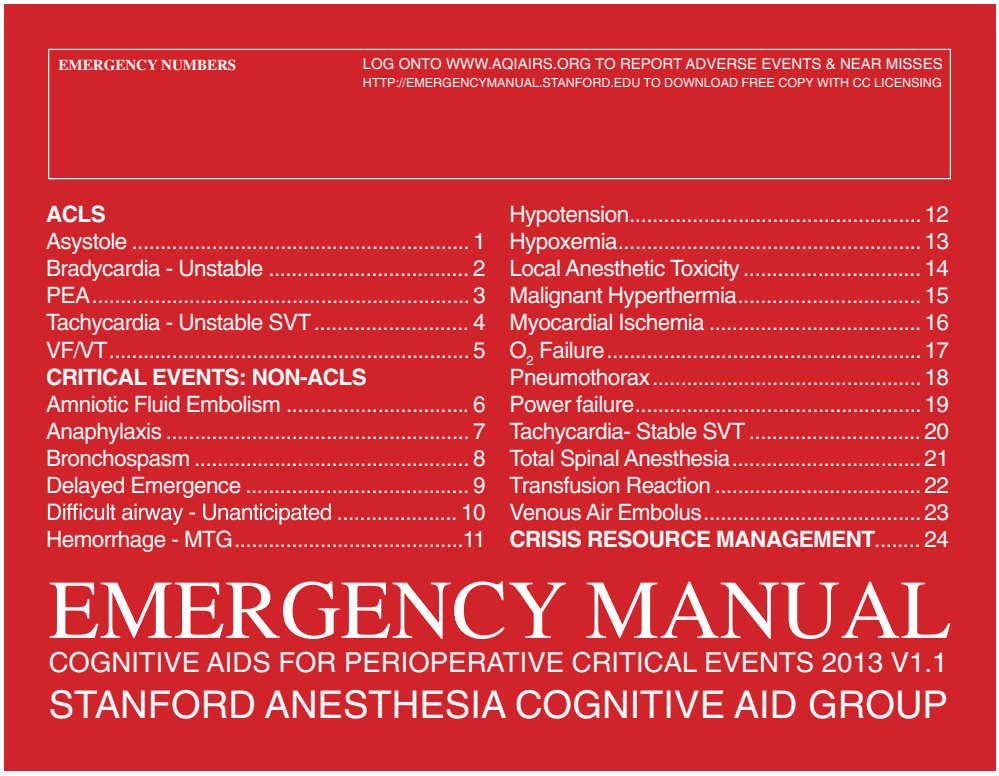


Figure 3. Four vital elements for implementing emergency manuals. © 2012 Diagram: S. Goldhaber-Fiebert and S. Howard.

The findings of 2 national VA studies that examined awareness and use of cognitive aids,[46,47] indicated that even if we could create a useful emergency manual (Element 1), our efforts would be unsuccessful in affecting clinical management until we were able to: (1) increase awareness of the existence of emergency manuals; (2) convince practitioners that emergency manuals can improve their performance; and (3) familiarize practitioners with the manuals' specific formats.


EMERGENCY NUMBERS

LOG ONTO WWW.AQIAIRS.ORG TO REPORT ADVERSE EVENTS & NEAR MISSES
HTTP://EMERGENCYMANUAL.STANFORD.EDU TO DOWNLOAD FREE COPY WITH CC LICENSING

ACLS
Asystole 1
Bradycardia - Unstable 2
PEA 3
Tachycardia - Unstable SVT 4
VF/VT 5
CRITICAL EVENTS: NON-ACLS
Amniotic Fluid Embolism 6
Anaphylaxis 7
Bronchospasm 8
Delayed Emergence 9
Difficult airway - Unanticipated 10
Hemorrhage - MTG 11
Hypotension 12
Hypoxemia 13
Local Anesthetic Toxicity 14
Malignant Hyperthermia 15
Myocardial Ischemia 16
O_2 Failure 17
Pneumothorax 18
Power failure 19
Tachycardia- Stable SVT 20
Total Spinal Anesthesia 21
Transfusion Reaction 22
Venous Air Embolus 23
CRISIS RESOURCE MANAGEMENT 24

EMERGENCY MANUAL
COGNITIVE AIDS FOR PERIOPERATIVE CRITICAL EVENTS 2013 V1.1
STANFORD ANESTHESIA COGNITIVE AID GROUP

Figure 4. Front cover prominently displays table of contents for easy reference. The most recent pdf of this emergency manual, by Stanford Anesthesia Cognitive Aid Group[j], is available for free download at http://emergencymanual.stanford.edu.

Anecdotally, at our institution's simulation courses there has been an upward trend in emergency manual use over the past decade of increased resident exposure, as well as a notable difference between courses when a brief immersive introduction to emergency manuals was provided or not.

Our experience concurs with a recent editorial[32] which stated that if emergency manuals are to be useful during critical events in ORs, then broad integration into simulation trainings for clinicians will help significantly. They should be part of a simulation course's prebriefing about expectations and resources, they must be easily accessible during each simulated scenario, and, when appropriate, they should be consulted during debriefings for review. Given the importance of familiarity, practitioners should be trained during simulations to use the same emergency manuals that they will use clinically. Emergency manuals should also be integrated into clinical training in an experiential manner, increasing awareness of their existence and familiarity with their use.

Use

Accessibility Is Also Crucial

Several years ago, we made a ring-bound set of pocket cards for all first-year anesthesia residents, with larger versions for simulation training. These cards contained both ACLS events as well as perturbations such as hypoxemia and hypotension. Text was combined with effective design elements, such as rhythm strips, icons, and use of color. Anecdotally, the first-year residents commented that they found them helpful for clinical events, for simulation courses, and for review. However, we found that 3 factors limited the clinical use of pocket cards: (1) Size: Any pocket-sized card is inherently limited by available space, and is therefore more difficult to read during a crisis; (2) Set: Because of size and weight limitations, pocket cards cannot include as large a set of potentially relevant critical events; and (3) Location: Depending on clinicians to always carry their pocket cards with them will lead to system failures because the cards will not always be available when needed.

These observations led us to create the large-format, durable, emergency manuals that we currently use for each OR and perioperative location. Because they are located primarily in situ in ORs, just like emergency medications or devices, they are readily available and accessible for clinical use.

Specific Location

After surveying local anesthesiologists and observing pilot clinical use in the ORs, we decided to hang the spiral-bound, laminated book from a hook on the computer arm that connects the anesthesia machine with the anesthesia workstation (Fig. 6). Although the most ideal specific location will differ per institution, emergency manuals should be given a consistent place in each OR that is both visible and easily accessible during a critical event, without blocking daily workflow. There is a balance also between valid concerns for security and unlimited mobility during an event. Initially, we addressed this issue by giving a personal copy to interested anesthesia residents and faculty and by printing them in bulk to keep costs down and to provide for occasional replacement. A small but constant rate of loss led us to readdress this issue, and we decided to attach them by not only a hook but also by a 6-ft long metal chain to allow

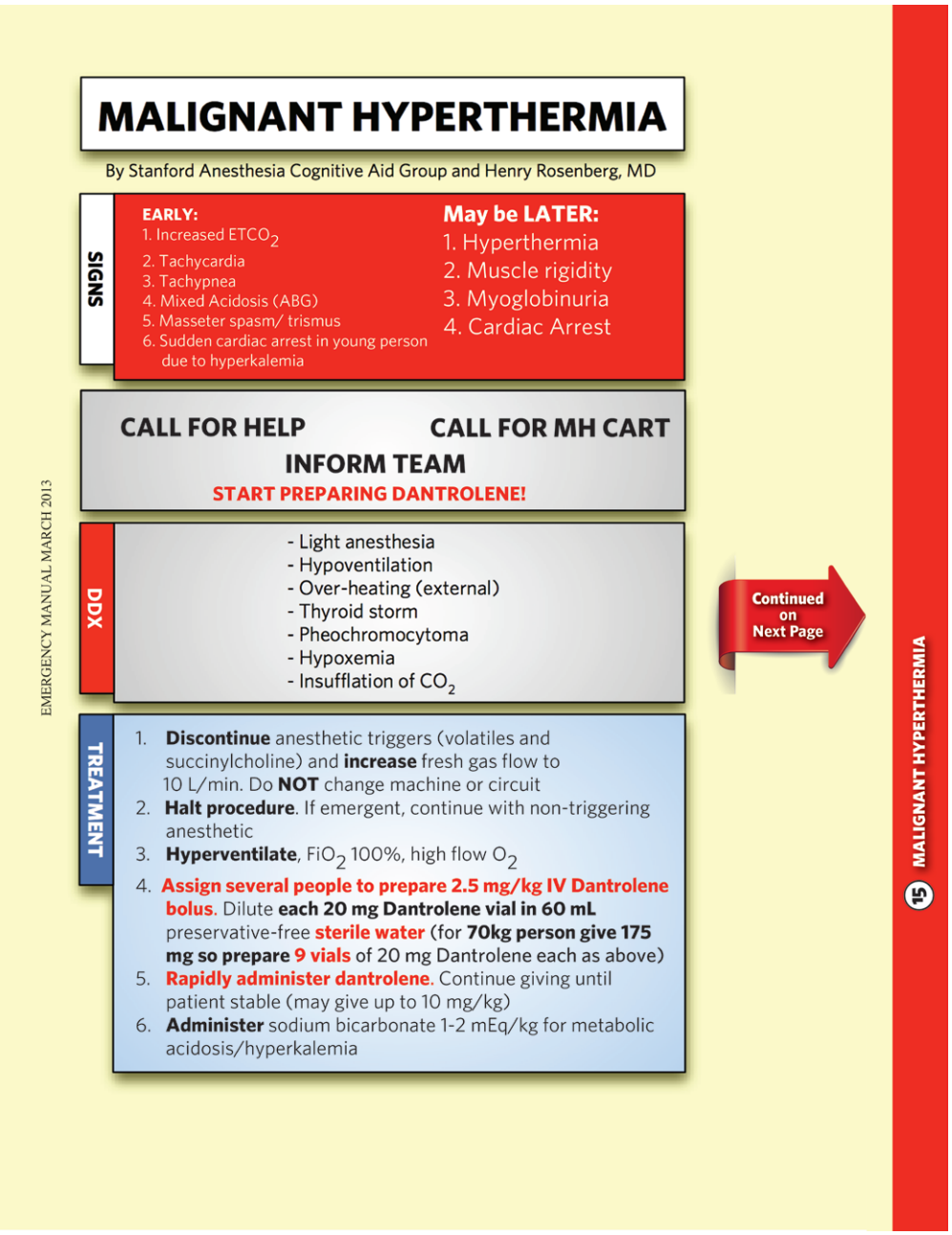


Figure 5. Examples of improvements from iterative simulation testing of 2012 Stanford Emergency Manual using the malignant hyperthermia (MH) cognitive aid, which now includes: (a) distinct sidebars with name and number of critical event listed on each page's unbound edge; (b) emphasized importance of dantrolene, along with readily accessible adult dose calculation and preparation. The calculation showing number of vials for a 70-kg adult has increased the efficient delivery of recommended initial dose of dantrolene in simulated MH cases; (c) large arrows to decrease confusion about where to start reading on 2-page cognitive aids. MH cognitive aid was developed by Stanford Anesthesia Cognitive Aid Group[j] along with Dr. Henry Rosenberg. This cognitive aid was adapted from a prior version, originally published as part of Ref. 42[i].

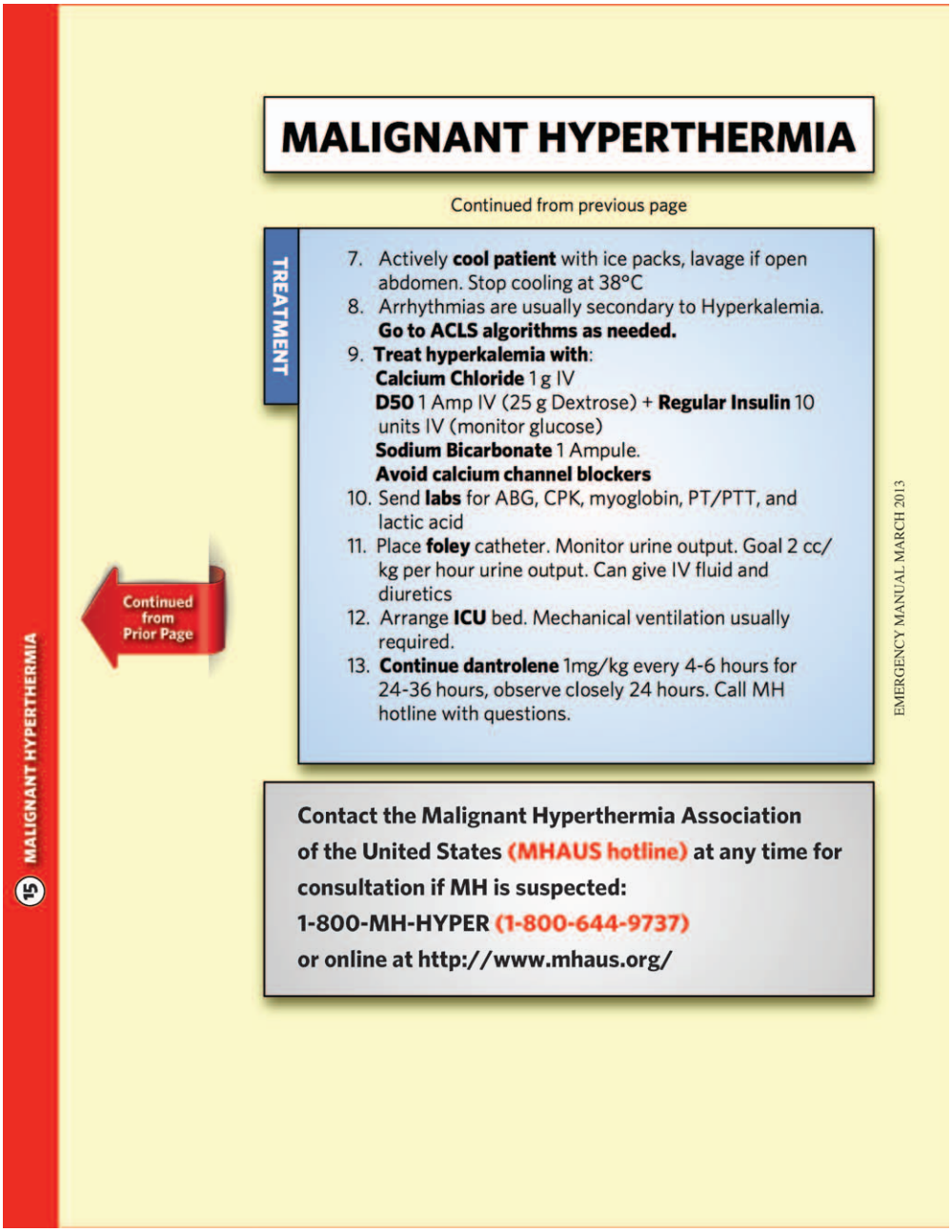
for flexibility with security. Although we provide electronic access to the same information on our internal website, simulation testing has made it clear that physical copies are currently much more useful during a crisis.

Importantly, having an emergency manual accessible is not an alternative to learning and teaching the material in depth. As the format becomes more familiar, emergency manuals will become more useful and can be integrated into educational exercises as noted in the training section above.

Suggested Perioperative Use of Emergency Manuals

There are 3 distinct types of use in the clinical environment, all of which can facilitate one another by increasing familiarity with both content and format: precrisis education, postcrisis debriefing, and during-crisis consultation (Fig. 2).

Precrisis educational "what if" exercises can be conducted with teams, trainees, and for self-review. They can be related to the current patient's history and surgery, highlighting potential complications and how to ideally prevent them, and verbally practicing appropriate responses should



15 MALIGNANT HYPERTHERMIA

MALIGNANT HYPERTHERMIA

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TREATMENT

7. Actively **cool patient** with ice packs, lavage if open abdomen. Stop cooling at 38°C
8. Arrhythmias are usually secondary to Hyperkalemia. **Go to ACLS algorithms as needed.**
9. **Treat hyperkalemia with**:
   Calcium Chloride 1 g IV
   D50 1 Amp IV (25 g Dextrose) + **Regular Insulin** 10 units IV (monitor glucose)
   Sodium Bicarbonate 1 Ampule.
   Avoid calcium channel blockers
10. Send **labs** for ABG, CPK, myoglobin, PT/PTT, and lactic acid
11. Place **foley** catheter. Monitor urine output. Goal 2 cc/kg per hour urine output. Can give IV fluid and diuretics
12. Arrange **ICU** bed. Mechanical ventilation usually required.
13. **Continue dantrolene** 1mg/kg every 4-6 hours for 24-36 hours, observe closely 24 hours. Call MH hotline with questions.

Continued from Prior Page

Contact the Malignant Hyperthermia Association of the United States (MHAUS hotline) at any time for consultation if MH is suspected:
1-800-MH-HYPER (1-800-644-9737)
or online at http://www.mhaus.org/

EMERGENCY MANUAL MARCH 2013

Figure 5. Continued.

these complications occur. This practice has the dual benefit of providing memorable learning for a trainee and improving patient management if the event occurs.

Postcrisis debriefing can help change current or future patient management.[48] Once the patient is stabilized, a cognitive aid can be a resource to guide immediate debriefing, reinforcing learning for future events and potentially helping the current patient if some further actions are indicated. Ideally the entire clinical team should participate in this discussion, however there are many barriers to the review of clinical management after a critical event or near miss. Having emergency manuals accessible in the OR environment, and training all team members in their use, should help make debriefings of events more common and useful. For example, after stabilization from massive hemorrhage, either the anesthesia practitioners or, if practical, the entire OR team can review what went well and any elements that could be improved in the future. This debriefing should include both medical and technical elements, as well as CRM concepts and applicable systems issues (Fig. 1).

During-crisis use of emergency manuals can have the most direct impact on patient management, but is also the most challenging to implement effectively. For many events, initial life-sustaining interventions must be learned as reflex actions, such as the early response to acute hypotension or immediate chest compressions for cardiac arrest. However, emergency manuals can be useful if the condition is rare, such as malignant hyperthermia requiring dantrolene; refractory, such as hypotension unresponsive to usual management;

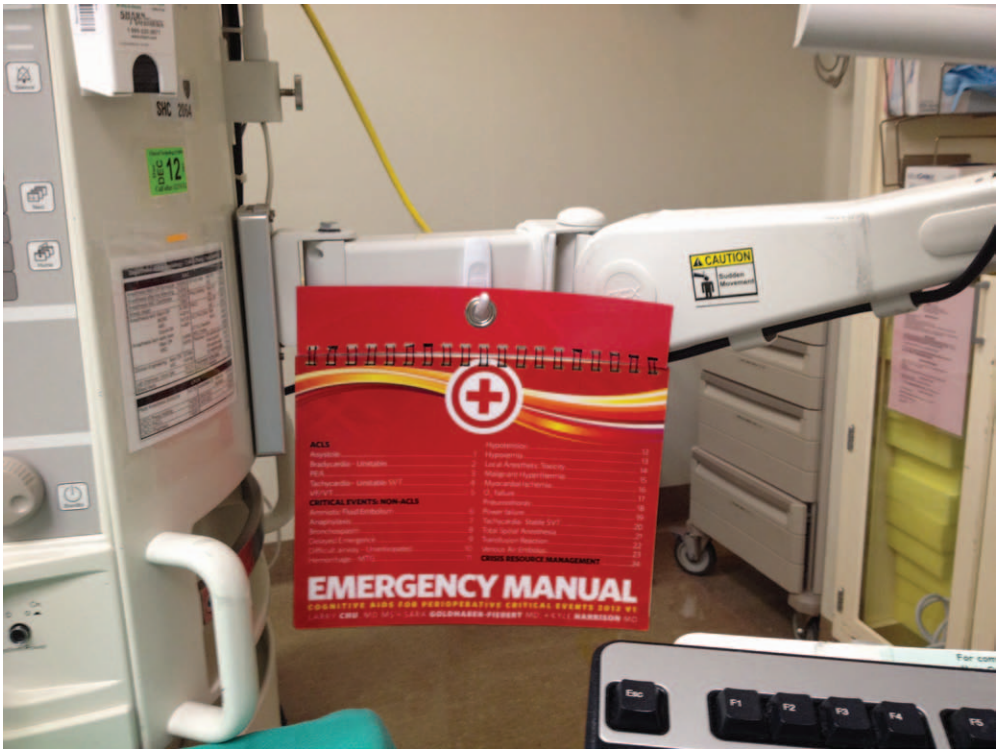

Figure 6. Location of 2012 Stanford emergency manual: hanging from the computer arm near anesthesia machine. Placement should balance the need for accessibility and consistent location, without interfering with routine work flow.

or when sufficient people are present to designate a reader role,[30] such as during a PEA cardiac arrest. The combination of simulation training, precrisis educational uses, and postcrisis debriefings will make emergency manuals more familiar and, therefore, more likely to be used effectively and efficiently during critical events.

Specified Roles

Prior studies found that it is difficult for an event leader to perform all monitoring and communication duties while simultaneously reading from a cognitive aid.[27,29] Burden et al.[30] formally examined the additional role of a cognitive aid reader to assist the leader during simulated critical events. In 31 simulated crises, they found that before the introduction of a reader, fewer than a third of teams consulted the available cognitive aid and no teams completed all necessary steps for malignant hyperthermia or obstetric cardiac arrest events. After a medical student, who was trained as a reader offered scripted assistance, performance of missing steps greatly improved and all teams appreciated the help. There is still significant need to study such a reader role in the clinical environment, including determining who might be the ideal individuals to function as team readers, given staffing and other patient care needs, appropriate training, and potential cultural issues. With multiple copies accessible and familiar, an extra available anesthesia technician or nurse could also look ahead during an unstable event to anticipate and gather needed equipment.

Integrate

An accepting culture is vital for successful implementation of emergency manuals and interacts with all of the other elements. Practitioner feedback and involvement in the other 3 elements (create, familiarize, and use) ensures more successful implementation both by integrating helpful suggestions and by increasing stakeholder buy-in.

The provision of effective training sessions on the use of well-designed and accessible emergency manuals helps to positively influence practitioner attitudes. As the manuals become more familiar and as clinicians become convinced of their potential value through training as well as seeing them used successfully, they will become more likely to use the emergency manuals themselves.[46,47]

System Examples

After the VA's National Center for Patient Safety developed and distributed cognitive aids to all VA ORs, 6 months later it was found that 7% of anesthesia providers had used them during an emergency.[47] Most emergency users had attended a local formal familiarization session and all felt that the cognitive aids were helpful during patient management. About half of all responding providers had actively used the cognitive aids in the OR for educational purposes. No formal sessions were provided nationally, so training was left to local discretion. Both nonusers as well as those unaware of the cognitive aids were much less likely to have attended a training session than the user groups.

Our recent experience has been promising. Even when the scientific data are clear, affecting system changes in the practice of medicine is as difficult as changing personal habits such as diet and exercise. Chip and Dan Heath provide helpful suggestions in their book *Switch: How to Change Things When Change Is Hard*,[49] and we incorporated many of their suggested techniques when

Figure 7. Use of emergency manual during a simulated malignant hyperthermia critical event, to efficiently guide team in key management steps. © 2012: Photo by David Gaba.

we developed the implementation framework described here. Awareness of the manuals and excitement about their potential benefits have grown at our institutions. We included stakeholders from all relevant disciplines: anesthesia practitioners, surgeons, nursing staff, anesthesia technicians, surgical technicians, and hospital leadership. Presentations and interactive discussions during committee meetings served to both educate these stakeholders about emergency manuals, as well as to solicit and integrate their important feedback for successful implementation. Anesthesiologists, surgeons, and nurses started asking when emergency manuals would be made available in every OR.

In 2012, we launched a system-wide Stanford initiative to have emergency manuals accessible in anesthetizing and perioperative locations of all affiliated hospitals. Training sessions have begun for relevant OR clinicians to increase awareness and familiarity. Immersive simulation-based techniques are being used to familiarize clinicians with the format of the emergency manuals, so that relevant medical information can be easily accessed (Fig. 7). Practitioners are also being introduced to the key points of CRM (Fig. 1) and encouraged to include these concepts as part of debriefing sessions after critical events.

Culture change is occurring. Departmental and hospital leaders now want all team members to be trained in their use. Since implementation, practitioners have mentioned that the accessible and familiar emergency manuals were particularly helpful during specific critical events as well as for educational purposes.

CONCLUSIONS: APPLYING THE 4 ELEMENTS OF EMERGENCY MANUAL IMPLEMENTATION

Health care systems and health care practitioners have a challenge to improve the management of many critical events. We believe that the 4-element framework for the

implementation of emergency manuals (create, familiarize, use, and integrate) will help extend the benefits seen in simulation studies to improving patient care. We presented relevant examples from the literature and from the experience at our institution. However, further research is needed to evaluate all of the details of such a framework as well as to determine the potential for broad generalizability. Our observations from many years of teaching simulation courses for multiple institutions, specialties, and levels of experience have reinforced the idea that emergency manuals address an unmet need and resonate almost universally with practicing clinicians. Many studies described in this article have shown that cognitive aids can help to change clinicians' actions, at least in simulated (T1) settings. Since implementing emergency manuals at our institution, we have already gotten reports of several effective uses during critical events, in addition to before and after. In studying the elements of this framework in the future, the most meaningful questions may be whether the complete package is effective in changing practitioner actions in clinical settings (T2) and ultimately in affecting patient outcomes (T3). In the meantime, the costs of not implementing emergency manuals are high too, as observed in countless simulated and clinical scenarios where teams do not optimally apply known best practices. We now have tools to change this, allowing widespread implementation of emergency manuals and research on effectiveness.

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Attestation: Sara N. Goldhaber-Fiebert approved the final manuscript.
Name: Steven K. Howard, MD.
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Attestation: Steven K. Howard approved the final manuscript.
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