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How to Teach Surgical Residents during Damage Control Surgery

Lisa L. Schlitzkus[1] · Brett H. Waibel[1] · Paul J. Schenarts[1]

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Abstract
Purpose of Review Damage control can be difficult to teach. Residents have few operative trauma experiences. During damage control situations, the resident's education may be lost in the stressful and fast, paced operating room due to patient care taking priority. Fortunately, there are numerous other opportunities to teach this important concept outside of the operating room.
Recent Findings Damage control can be taught in a three step cycle from war games to intraoperative teaching during a crisis and ending with an after action review. This process is also applicable to other intraoperative crises and acute medical conditions such as a code event.
Summary This manuscript describes multiple opportunities for education both in and outside the operating room when during the stressful moment, patient care takes priority.

Keywords Damage control · Resident education · War games · Intraoperative teaching · After action review

Introduction

The focus of this manuscript is how to teach during a damage control resuscitation. Therefore, the physiologic criteria, indications, specific operative steps, timing, and outcomes of damage control will not be addressed.

There is significant variability in the duration of trauma surgery rotations in general surgery residencies across the United States. In an 8 year study of 7299 general surgery applicants for the American Board of Surgery Qualifying Exam, Napolitano et al. recently found that the mean duration of the trauma surgery rotations was only 6.3 months with a range of 0–24 months [1]. Currently, the American Board of Surgery requires only 20 operative trauma cases to sit for the qualifying exam [2]. The end result is that graduating surgical residents may have limited clinical exposure to damage control operations and may fail to recognize that they are in or how to exit a time sensitive, complex clinical situation [3].

This manuscript will describe a three step cycle that can be applied to teaching in a wide variety of acute medical conditions. This approach to learning also takes into account that the primary duty of the attending surgeon is to the patient under their care. The initial step occurs well before the patient is injured and involves having the residents work through a series of clinical scenarios in which damage control would be required. Drawing from the military, these "war games" prepare the residents through the use of the Socratic teaching method to learn the indications, steps of the procedure and outcomes without any patient risk. The second step occurs when the patient arrives and involves effective teaching techniques during a time of crisis. The final step is an after action review, when the resident can reflect on his or her performance during the case, and the surgeon can provide feedback. This final step can also be incorporated into a war game scenario, thus completing the cycle.

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✉ Paul J. Schenarts
paul.schenarts@unmc.edu

[1] University of Nebraska Medical Center, College of Medicine, Omaha, NE 68198, USA

War Games

Previous generations of surgical residents learned how to rescue patients by treating real emergencies. However, as a result of changes in duty hour limitations and other requirements, these actual clinical experiences have decreased [4, 5]. Adding insult to injury, when residents are at the bedside, there is little teaching in a crisis. As a result, the inexperienced resident, the one most in need of the experience, is frequently pushed into an observer role by a more experienced clinician [6]. In this new educational environment, the need for the resident to have to work through high-risk clinical decision-making before the need actually arises is a necessary requirement.

To be an effective teacher, the most important requirement is to perform a rapid needs assessment and determine what the resident already knows and what their misconceptions may be. This approach also prevents the attending from wasting their time by covering information the resident already understands. This leads to higher level discussion. Young et al. coined the term "War Games" to describe the process of having learners work through clinical scenarios primarily by requiring the participants to articulate their clinical decision-making [3, 7]. This formalization of the age old practice of senior clinicians asking a series of questions, involves several key elements. First, the resident is provided with basic clinical information or a scenario. Through a process of inquiry, the attending then maneuvers the residents to articulate how the clinical history, examination, laboratory and radiographic data influence their clinical decision-making. In addition, the resident can be asked to describe the technical aspects of an operation. This educational technique can be utilized for all types of clinical problems. However, with respect to damage control surgery, it allows the resident to formulate an approach to high-risk clinical decision-making without any patient risk. While this approach may be combined with a simulator, the primary focus is critical thinking rather than technical skill development.

The educational literature on how to ask questions is well beyond the scope of this manuscript. However, there are several fundamental techniques that will facilitate these sessions. The attending should have an outline of the sequence of questions to be asked, so there is a logical flow to the teaching session. Questions should be open-ended and asked using neutral language that does not give away or lead the resident to the correct response. Ask only one question at a time to a specific resident and do not interrupt. Transition through the sequence of questions logically. The goal is to allow the resident to make mistakes. Allowing the resident to go down an incorrect path and figure out for themselves what they did wrong has a greater impact and is also reminiscent of the way learning was done at the bedside, but without any risk of patient harm. The attending does need to beware of the superficial resident who knows the "buzz words" but lacks in-depth knowledge. These learners typically reveal themselves when they are required to articulate the basis of their statements.

The attending also needs to be cognizant that the next generation of residents has different learning expectations. The attending will be better received if the residents are forewarned that the session will be interactive, by allowing the residents and students to work as teams, permitting the use of electronic devices, and by framing these sessions as a "war game", rather than a pimping session [8, 9•, 10].

The resident will better prepared if they are required to rehearse and articulate their critical thinking and decision-making prior to the arrival of the patient. However, this war game approach is not an adequate substitute for actual clinical experience [3].

Teaching During an Operative Crisis

Teaching damage control in the operating room will ultimately be dictated by the patient's stability and the indication for damage control. Abbreviating a trauma exploratory laparotomy due to acidosis, diffuse, non-surgical coagulopathy, and hemodynamic instability allows for less teaching time compared to a more planned reason for keeping the abdomen open such as for a second look procedure. Initiating an honest, open conversation with the resident sets the stage for learning [11]. The attending must set the expectation of the resident's level of operative involvement, but encourage resident participation. The resident's proactive behaviors must be recognized and valued. Demonstrating concern for the resident's personal development increases the resident's perception of involvement [12].

The first operative opportunity that the attending controls is entering the operating room with the patient and ensuring the resident is present. The resident's presence demonstrates that he/she is a valuable and valid member of the team. If the attending walks into the operating room and states the situation, background, and anticipated events or needs without the resident present, the clear message sent to the resident and the team is that the resident is an accessory to the operation at hand. If the attending is anticipating damage control, loudly and clearly asking for anesthesia to check the temperature and labs specific to acidosis and coagulopathy and asking the circulating nurse for temporary dressings (for example, negative pressure vacuum dressing) may be triggers for the resident. Additionally, the resident can be given a specific task—"Remind me to keep checking on…" This demonstrates

effective teamwork and establishes the attending as the team leader.

The topics covered during the educational encounter must fill an educational void for the resident. It is easy to teach what we know. Teaching what the resident does not know is most helpful to them [13, 14]. This needs assessment can be conducted at the scrub sink, standing next to each other while transferring the patient to the OR table, or grabbing gloves. Examples of initial questions are "Have you ever seen damage control?", "What are the indications for damage control?", or "Do you think this may be an opportunity for damage control? Why?" If it appears the resident has a strong grasp on the damage control concept, then more specific questions may lead to an area of focused conversation intraoperatively. "How technically would you damage control a sternotomy if the pericardium and sternum could not be brought back together?" "So if we damage control this abdomen, when would you return to the operating room?" This questioning may be as straight forward as "We are going to damage control this patient. What do you want to learn about damage control today?" The data suggest that physicians comprehend and retain new concepts when they have control over the learning topic [15–20].

Not only must the topic fill the resident's educational gap, but stressing the relevance to the resident's future endeavors can engage the resident and show them you have a vested interest in them and their education. The knowledge for their future patient care can be a strong motivator for the resident. Adult learners are selective and truly apply themselves when they can appreciate the potential relevance [13, 19, 21].

The clinical situation will dictate the amount of time allotted for teaching in the operation. Rarely is there time for a formal teaching session. It is natural to engage a trainee in the technical aspect of damage control: "Cut the vac sponge this way because…" or "Be sure to create a mesentery around those JP drains with the Ioban." Unfortunately, when a crisis occurs, based on video reviews of intraoperative catastrophes, the attention paid to the resident drastically falls [22].

During an operative crisis, the attending must not only perform at maximum technical level, but utilize nontechnical skills: closed-loop communication, cross-checking and cross-monitoring, leadership, resource utilization, and situational awareness. For residents, these skills do not naturally develop; they must be taught, practiced, and observed [22]. Moreover, during trauma situations we do not know if performance of these skills is worse due to unfamiliarity or the mechanism of penetrating over blunt trauma [23]. However, as a teacher, involving the resident in these skills can facilitate teaching damage control. There may not be time to pontificate on the mechanisms of hypothermia prevention or the latest data about balanced resuscitation, but performing closed-loop communication about operative planning with the scrub tech, circulating nurse, and anesthesia verbalizes thoughts for the resident. Simply stating thoughts aloud and helping coordinate the team sets the example for the resident and reiterates the important concepts of damage control. Once a crisis occurs, the attending goes from leading the resident and scrub nurse to leading the entire operating room [23].

Despite the effort made by the attending to teach intraoperatively, the data suggest that the perceptions of the resident and attending are not aligned [24••, 25, 26]; therefore, do not be discouraged by a single perceived negative experience. Certain intra-operative teaching behaviors have been identified through an extensive literature review and input from expert attending surgeons and medical educators [24••, 27–29]. Table 1 lists these behaviors, but these behaviors also serve as topics of discussion with the resident intraoperatively. Ultimately, the residents recognize that patient safety supersedes teaching [18]. Even in the instance when it feels as if no teaching can occur due to the gravity of the situation, maintaining a positive relationship with the resident and acknowledging their need to learn allows for the opportunity to educate following the operative stress.

The After Action Review

The performance of damage control surgery implies that the situation is complex and that the attending is faced with competing clinical priorities. The methods of preparation and teaching during the crisis have previously been presented. However, it is the after action review or debriefing that may be the most important in solidifying the resident's education. This professional discussion takes little time and is focused on three main points [30]. First, to compare how the recent case compares to performance standards. Second, to empower and enable the surgical resident to discover for themselves what happened, why it happened, and how to sustain strengths and improve on weaknesses. Finally, the attending should also reflect on the same elements of the operation as well as their own teaching performance. The willingness of the attending surgeon to accept critical feedback from the residents should also facilitate acceptance of critical feedback by the resident. Incorporation of other operative team members into the after action will also facilitate future communication and improve performance of a multi-disciplinary team. Because the participants in after action review are encouraged to actively discover what happened and why, they learn and remember more than they would from critique alone. Typically, a critique is from a single vantage point, is

Table 1 Intraoperative teaching behaviors exhibited by master educators [24••, 27–29]

Behaviors serving as topics of discussion	Overall intraoperative behaviors
Discussing previous experiences with damage control	Surgeon-resident relationship is positive
Asking about knowledge of damage control (operative approach)	Demonstrates awareness and sensitivity to trainee learning needs
Assessing understanding of indications (rationale and alternatives)	Explaining trainee expectations; clarifies roles and responsibilities
Asking to describe the steps of damage control	Describing the steps if trainee cannot state
Asking to describe key decision-making points	Allowing trainee to perform operation based on skills
Discussing evidence/scientific information	Stimulates trainee to think critically and problem solve
Discussing potential complications, how to avoid technical complications	Indicates expected outcomes
Explaining why attending takes over due to technical issues or other reasons	Encourages trainee to ask questions
	Maintains climate of mutual respect for all team members

focused only on what went wrong, inhibits candid discussions, and stifles learning and team building. The end goal is to improve resident performance in the areas of clinical decision-making and technique and improve attending surgeon's crisis leadership and teaching skills in order to develop a more cohesive team.

With respect to resident education, after-action reviews may capture some elements of performance that are not easily placed within an end of rotation evaluation [30]. It is also important for the surgeon to understand that there is a difference between a formative assessment and a summative evaluation. The after-action review is an example of a formative assessment—the purpose of which is to provide ongoing feedback, help residents identify strengths, weaknesses, and target areas that need greater attention. These assessments are low stakes, and the resident needs to understand that being open about their self-identified areas for improvement will not be held against them. Summative evaluations are high stakes and completed at the conclusion of a rotation or instructional unit.

Performance of a damage control operation is a stressful and highly dynamic situation. Leading an after action review while the attending, the resident, and the team are still emotional will not be fruitful. Additionally, the patient needs to transition into the intensive care unit for restoration of normal physiologic status [31].

The United States Army has a formal process for after action reviews which provides a good model following damage control surgery [30]. Creating the proper atmosphere may be the most important aspect of the after action review. The leader, typically the attending surgeon, should begin the review by setting out the ground rules of the discussion. Everyone should participate if they have an insight, observation, or question which will help identify and correct deficiencies or maintain strengths. Regardless of position or strength of personality, no one person has all the information or answers. The key is for each participant, particularly the resident to reflect on their own performance, to learn from others, and provide their own observations to other participants, including the attending surgeon. Reinforce that is permissible to respectfully disagree. The after-action review is a formative process and is not a grade of success or failure. There are always weaknesses to improve and strengths to maintain.

Next a chronologic order of events should be presented. Following this clinical summary, the leader should solicit from each of the participants, what went well, what could be improved upon and how should the areas for improvement be addressed in the future? The leader should also use open-ended questions such as "What was your thought process when such and such occurred?" rather than "Why did you do that?" The leader should also be specific, avoid generalizations, and not dwell on issues unrelated to the performance of the case under discussion. The leader can demonstrate they are hearing what has been said by continuously integrating the thoughts of each of the participants. At the conclusion of the after action review, the leader should summarize the key points of discussion and hopefully end on a positive note.

Whereas the after action is focused on individual reflection and identification of areas of weakness, the commonly used "feedback sandwich" technique is the exact opposite. With this technique, the attending surgeon places the negative feedback between two pieces of positive feedback. According to the Harvard Business Review [32], this technique is used because leaders assume that people hear and accept negative feedback when it comes with positive feedback. However, when asked directly, most favor the "meat" or negative feedback, as they feel the positive feedback is not genuine. Leaders also assume that the sandwich technique provides balanced feedback. However, this approach disintegrates when one questions, should we also give negative feedback when giving positive? Another potential down side of the sandwich

approach is that residents will associate any positive feedback waiting for the other shoe to drop thereby becoming suspicious of the attending surgeon [33]. By combining positive and negative feedback together, the worth of the positive feedback is diminished and the impact or need for improvement is also weakened [33].

In addition, to these limitations, research has found that the sandwich technique may actually hinder performance [33–35]. The sandwich approach is being replaced by a more effective and transparent strategy, such as the mutual learning approach, in which the entire team is responsible rather than a single individual. This is a fundamental element of the after action review [33].

To complete the learning cycle and to engage residents and others who were not involved in the initial damage control operation. Integration of the lessons learned during the after action review should be incorporated into the war games format discussed at the beginning of this manuscript.

Conclusions

During the operative stress of a damage control operation does not seem to be the ideal situation for resident education. Likewise, numerous other acute medical situations (for example, emergent cesarean sections or code events) arise where patient safety and leading the healthcare team become the priority, not resident education. However, resident education is not only in the heat of the moment. Discussing indications, exam and laboratory findings, and even operative technique can be undertaken in a controlled situation. This interactive discussion or "war game" style engagement helps the attending gauge the resident's knowledge base. Then, when the situation arises, clear resident involvement and expectations should be stated. Ask what the resident wishes to learn from the clinical situation. Simply verbalizing thoughts and ensuring closed-loop communication provide reinforcement of the previously taught concept. An honest, open after action review allows the team, the resident, and the attending to reflect on the situation and most importantly, reinforcing the concept of damage control for the resident. This three part cycle can be extremely effective for the concept of damage control and other situations where the stakes are high, patient safety is of utmost concern, and yet the resident may only experience the clinical situation once during their training.

Compliance with Ethical Guidelines

Conflict of interest Lisa L. Schlitzkus, Brett H. Waibel, and Paul J. Schenarts declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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