



Step-up approach in trauma surgery training: a pilot course

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Abstract

Trauma Surgery (TS) necessitates proficiency in managing injuries across all body regions including body surface, parenchyma, vessels, nerves, bones, soft tissues, focusing adeptness on damage control approach in life-threatening conditions. Different training courses exist, using artificial simulators, perfused organs, live animals, cadavers. A new three-days course aimed at general surgery residents of 3rd-4th-5th years was conducted at the Advanced International Mini-Invasive Surgery (AIMS) Academy. The course utilizes a step-up approach combining lectures, case discussions, and practical training with isolated-perfused organs and live animals. The pilot course involved twelve students and featured lectures on trauma bay management, organ injuries, and treatment strategies on the first day. Subsequent days focused on surgical procedures on ex-vivo perfused organs and live animal models simulating an operative room environment. A survey utilizing a 5-point Likert scale evaluated various aspects of the course, with the highest scores obtained for staff and tutoring during skill laboratories. Students reported significant improvement in knowledge and skills related to injury repair and expressed increased confidence in trauma patient management. The educational model presented in this manuscript provides a structured approach to trauma surgery training, with a focus on hands-on experience and sequential skill progression, garnering high praise from participants.

Keywords: Trauma Surgery; Simulation; Perfused Organs; Live Animals

1. Introduction

Competency in Trauma Surgery (TS) necessitates skills in managing injuries across all body areas, including the neck, chest, abdomen, pelvis, and extremities. Surgeons should be capable of treating complex wounds of the body surface, such as injuries to internal organs, vessels, nerves, bones, and soft tissues, focusing on damage control approach in life-threatening conditions. This is of paramount importance in the baggage of knowledge and skill for

each general surgeon. Even if trauma is not the main job, most general surgeons will make rotations in emergency where they may be exposed to cases of severe trauma. Moreover, also in elective practice intra-operative complication with critical bleeding or contamination may occur and the surgeon must have the adeptness to remedy.

At the beginning of this century, the Definitive Surgery Trauma Care Course (DSTC) was created for educating surgeons in trauma management. DSTC is a two-and-a-half-day course, comprising lectures, case discussions, and live animal surgical training¹. This course has been widely adopted in South Africa, the US,



Canada, Europe, Japan, and recently, it has been modified with a section dedicated to anesthesiologists (DATC)². Fifteen years ago, under the auspices of the American College of Surgeons, Committee of Trauma (ACS-CoT), the Advanced Trauma Operative Management Course (ATOM) was introduced with the objective of offering general surgeons a one-day course with reproducible and standardized training on complex injuries using live animals, maintaining a 1:1 instructor to student ratio³. Subsequently, in some places, team training was tested with the participation of nurses and technicians in the course. In the Italian version, around each animal, a first and a second surgeon, and a scrub nurse (ideally from the same staff) train together with the ACS instructor⁴. Concurrently, the Advanced Surgical Skill for Exposure in Trauma (ASSET) was developed by ACS as a one-day course on fresh cadavers for teaching major vessels exposure⁵. However, live animals are expensive, and fresh cadavers are scarcely available in many countries. More recently, ex-vivo models using isolated organs perfused with a pump and colored fluid simulating blood were proposed for surgical training⁶. This method has been demonstrated to be effective in improving the surgical skills of residents and young specialists. Recently a Trauma Bay Management Course (TBMC) has been proposed in our institution with one day of theory and one on cadavers⁷. This course was dedicated to professionals working in emergency room and has been limited to the trauma bay life-saving procedures. All the proposed models use a single hands-on approach or only cover a part of the treatment path, which can be incomplete for a training on trauma surgery, particularly when the student has never been exposed before to trauma care.

We developed a three-day course for post-graduated years (PGY)-3rd-4th-5th general surgery residents with no previous exposure to trauma care, employing a step-up approach that combines lectures, case discussions and surgical training with isolated-perfused organs and live animals. The course was conducted at the Advanced International Mini-Invasive Surgery (AIMS) Academy, an Independent Foundation for surgical training at Niguarda Hospital, the level one trauma center in the city of Milano, Italy. The aim was to offer in a single course the opportunity to learn theory of trauma management, principles of surgical repair on perfused organs and finally to acquire the skills to treat organ injuries in the live animals. At the best of our knowledge, this is the first educational program in trauma for surgical residents including theory and a stepwise surgical training from isolated organs to in vivo damage control.

2. Materials and Methods

The pilot course was funded by AIMS Academy and took place for twelve students on November 27-29,

2023, with Niguarda Trauma Center surgeons serving as faculty, course director, co-director, and five instructors. Students were invited to read a book prepared by the instructors before the course. Day one was dedicated to lectures on trauma bay management of major trauma patients, based on the pre-hospital triage categories, as derived from TBMC⁷: patients with unstable hemodynamics and non-responders (*priority one*), patients with unstable hemodynamics transiently responder to initial resuscitation or with neurologic deterioration (*priority two*), patients who are stable with only high energy mechanism of trauma (*priority three*). Patients in priority one or two often need damage control procedures to stabilize vital signs and a description of the procedures and of surgical strategies was done. At the end of day one, students engaged in discussions with the faculty on various clinical scenarios involving the three different types of trauma patients, including also victims of penetrating trauma, women in pregnancy and pediatric patients. The target of the first day was to acquire confidence with the theory of clinical pathways of different categories of trauma patients. On day two, students moved to the skill lab for surgical procedures on ex-vivo perfused organs, including the stomach, duodenum, pancreas, spleen, liver, kidney, heart, and lung. Each student rotated through 12 procedures on perfused organs. The aim of this training was to teach the basic techniques of surgical repair of different injuries in each organ. Day three focused on the live animal model, with four tables simulating an operative room environment and three students per table with one instructor each. The instructor, after moving the students away from the table, produced unseen standardized injuries that the students, once returned to the table, had to recognize and treat according to strategies and techniques learned in the previous days. The rotation was organized so that each junior surgeon handled each injury as both the first and second operator. The injured organs to be repaired were bladder, small bowel, duodenum, kidney, ureter, stomach, spleen, pancreas, diaphragm, liver, inferior cava vein in the abdomen; lung and heart in the chest. The detailed program of the course is available at the provider link. At the end of the three days students completed a survey using a 5-point Likert scale (5 = excellent, 1 = very poor) for each of the 11 specific items regarding the evaluation of the course content, staff, tutoring, and organization. Additionally, they provided free-text comments on the most positive and negative aspects, final remarks, and suggestions.

3. Results

The students demonstrated significant improvement in knowledge and skills in repairing injuries during the course and expressed increased confidence in the general management of trauma patients by its conclusion. Table 1 presents the results

of the students' survey. The highest score was obtained for the staff and tutoring during the two skill laboratories. Junior surgeons particularly appreciated the training in suturing techniques and bleeding control on perfused organs (Fig.1-2), providing a foundation for damage control maneuvers in live animals (Fig.3). The selection of topics in the theoretical part was also deemed important as knowledge of managing major trauma patients was preparatory to the surgical approach. Lower scores were reported for the reception and support of the group of learners, suggesting areas for improvement. In their free-text comments, students highlighted the competence and availability of tutors and the sequential skill progression from ex-vivo organs to live animals. Some criticisms were made regarding the opportunity to discuss more clinical cases, interspersed with lectures, present more videos on surgical techniques, and provide coffee breaks and lunch within the course building. The overall evaluation of the course was encouraging, scoring 4.75.



Fig. 1: A perfused liver with the gallbladder



Fig. 2: A student during a training in suturing an “ex-vivo” perfused organ



Fig. 3: The surgical tables in the wet lab with the instructors and the students while performing “in-vivo” damage control procedures

4. Discussion

The quality of medical care is directly linked to the quality of training provided to students and residents. Trauma surgery covers all body regions with different patterns of injuries and requires a deep knowledge of surgical basis in the management of various organs. Trauma surgery as a specialty has evolved in the US over the past 20 years. Due to the decrease in penetrating trauma and the increase in non-operative management strategies, the number of operations for general surgeons in trauma patients has significantly decreased, making the trauma career less attractive. A new specialty, Acute Care Surgery, encompassing trauma care, emergency general surgery, rescue surgery, and surgical critical care, was developed at the beginning of the new century^{8,9}, with good acceptance by general surgeons, and this model is now spreading in Europe and around the world¹⁰. European countries such as Germany, Belgium, Netherlands, Czech Republic offer to residents the specialization in trauma and acute care surgery. In countries where it is not present, like Italy, trauma patient is principally managed by anesthesiologist, at least in the first phases when vital support can be necessary, with the intervention of different surgical specialists, such as general, vascular, thoracic, neuro, orthopedic surgeons, who have a vision limited to the area of competence, without a global consideration of the patient. Although there is large heterogeneity among different countries, nowadays there is a global consensus about the usefulness of acute care surgery model for emergency services. The goals of a training program in this field should be a broad knowledge of surgical basis with generic surgical skills on visceral

organs of the trunk (chest, abdomen and pelvis) and soft tissues, followed by the acquisition of competence in the assessment of the entire patient and in the choice of priorities. Finally, the acute care surgeon must be able to communicate with the team and interact with different specialists who may need to intervene outside the trunk (mainly orthopedic and neurosurgeons).

Within the context of acute care, education and training in the surgical treatment of injured organs of the trunk are challenging to standardize due to the relative rarity of surgical interventions for general surgeons, especially in life-threatening conditions, and the inability to plan clinical activity. Often, young surgeons must face many emergency situations alone for the first time. In this regard, simulation in laboratory settings is of paramount importance to increase the confidence of surgeons with damage control procedures. The ex-vivo perfused organ model has gained popularity due to its low costs and reproducibility¹¹, but the emotional involvement in an environment resembling an emergency operating room, the need to make critical decisions to control real critical bleeding, and communication within the operating team are conditions achievable only in a live animal laboratory setting. Currently, the replacement of live animal models with artificial simulators as an alternative option remains an aspiration¹². Our model was a combination of didactic and practical training, with the latter increasing in difficulty from ex-vivo organs to live animals. Teaching surgical techniques for injury repair on isolated and perfused organs prepared the students for the challenge of damage control in a living body, such as in a real-life event¹³. Moreover, the final step of our educational model appeared to be useful for learning non-technical skills such as situational awareness, decision-making, teamwork, and communication inside the team.

5. Conclusion

In conclusion, we developed an educational model in trauma surgery with a step-up approach to surgical training that was highly appreciated by the learning group. This model can be proposed as an initial experience in trauma surgery during specialization school in general surgery for residents in their final years.

Table 1. Evaluation of the course

	mean	+/- SD
Evaluation of the course		
Quality of organization	4.50	0.37
Welcome and reception	4.16	0.46
Global evaluation	4.75	0.21
Lectures and theory		
Relevance of topics	4.75	0.24
Global evaluation	4.66	0.16
Ex-vivo laboratory		
Staff	4.83	0.21

Tutoring	5.0	0.0
Global evaluation	4.50	0.38
Live animals laboratory		
Staff	5.0	0.0
Tutoring	4.91	0.08
Global evaluation	4.83	0.11

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