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ORIGINAL ARTICLE

Terror and disaster surgical care: training experienced trauma surgeons in decision making for a MASCAL situation with a tabletop simulation game

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Abstract

Background Mass-casualty incidents, especially in connection with a terrorist attack, can quickly overwhelm the capacities of receiving hospitals. After a mass-casualty terrorist incident, patients often arrive at hospitals in an uncoordinated manner on account of the chaotic situation. Many patients leave the incident site and refer themselves to hospitals independently. Hospital decision makers must, therefore, be able to make quick decisions on diagnostic procedures and treatment for every individual patient and, at the same time, take into consideration available resources. They require decision criteria and aids to properly manage such scenarios.

Materials and methods As part of the preparation of the Terror and Disaster Surgical Care (TDSC®) course, we developed a tabletop simulation game based on a comprehensive and structured review of the literature, the opinions of renowned experts, and the results of specialised conferences. This tabletop simulation game is played four times during each TDSC® course.

Results Our analysis involved 264 of 465 course–participants from 2017 to 2019 and showed that the overall evaluation was very good and that participants grew more positive about the tabletop simulation game during the course. The tabletop simulation game received an average rating of 1.53 (1 = very good, 6 = insufficient). This rating remained consistently high over 19 courses.

Discussion Hospital decision makers must respond to mass-casualty terrorist situations in a defined tactical and strategic approach. Rapid decisions must be made that take into account the special situation and available capacities and resources to maximise the number of survivors even though individual patients may have a poorer functional outcome. As part of the TDSC® course, the tabletop simulation game teaches high-level decision-making algorithms and prepares key hospital personnel for such situations.

Keywords Terror · Disaster · Preparedness · Decision making · Table-top-Exercise · Simulation · Game

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Introduction

Background and objectives of the TDSC®course

The terror and disaster surgical care (TDSC®) course was developed in 2017 to enhance the preparedness of hospital decision makers for mass-casualty terrorist incidents and other major incidents. The course focuses primarily on shortages of capacities at hospitals close to incident sites which provide initial treatment as well as on the associated influx of mass casualties with typical injury patterns caused by, for example, gunshot and blast injuries.

Given global political developments and an increasing number of terrorist incidents in Europe, mass-casualty terrorist incidents are playing a more important role for public services in Germany (see also Paper one of Friemert et al. in this Focus-On – Issue) [1,2].

These situations are especially challenging because of the sudden surge in casualties mostly with penetrating gunshot or blast injuries (see also Paper two of Bieler et al. in this Focus-On – Issue) [3,4].

This is confirmed by studies of the attacks in Madrid in 2004 and in Paris in 2015 [5,6].

The arrival at nearby hospitals of a large number of seriously and critically injured patients, many of whom have life-threatening bleeding, means that hospitals must have a strategy to manage such incidents which can be adapted to available resources and individual situations [7].

An efficient approach is only possible if there is an established and effective hierarchical organisation in which all decision makers accept the priorities of the situation and work together to achieve the best possible outcome for as many patients as possible.

This means that executive and decision-making personnel at a hospital must be designated and trained. The objective of the terror and disaster surgical care (TDSC®) course is to train such hospital executives and decision makers and to teach them about such situations and injury patterns.

The course defines the tasks of the senior triage coordinator (the so-called LArS) and the emergency operational and medical coordinator (EOMC or the so-called ZONK). These tasks are included and trained with a tabletop simulation game (see below; see also Paper one of Friemert et al. in this Focus-On – Issue) [1,2].

Contents and structure of the TDSC®course

The course is held over two and a half days and includes presentations, interactive discussions, numerous case discussions with various scenarios and conditions, and a board-based simulation game to train decision making, which was conducted to clarify, consolidate and practice the above-mentioned theoretical concepts of the TDSC® course. The game is much more challenging than customary triage exercises. Players are forced to make decisions on the basis of different personnel resources and varying availabilities of treatment rooms and beds. Unexpected events are also introduced to disrupt the plans of players. Before our game was developed, there were no suitable alternative products available on the market. We, therefore, decided to develop a tabletop simulation game ourselves. Our game features required contents as well as dynamic patient simulation. The greatest challenge was to create a scenario that is as realistic as possible so that players can achieve learning objectives. At the same time, we needed to limit complexity to ensure the playability of the board game.

Bieler et al. explain the contents of the TDSC® course in their article (see Paper four of Bieler et al. in this Focus-On – Journal). In the present article, we will introduce the tabletop simulation game, present our experiences with it and provide an evaluation of various aspects of it.

Our "hypothesis" is that this game can be used to prepare and train medical professionals with clinical experience, especially surgeons but also anaesthetists and emergency specialists, for such scenarios [8]. After training, they should be able to assume hospital functions such as senior triage coordinator (LArS) and emergency operational and medical coordinator (EOMC = ZONK) (see Paper one of Friemert et al. in this Focus-On – Issue).

Materials and methods

Preliminary work to develop the course

The latent threat of terrorism in Germany and the attacks on Breitscheidplatz in 2016 have made it necessary to address the issue of terror preparedness in terms of services of general interest. For this reason, so-called emergency conferences, organized by the German Trauma Society, were offered in 2017. The aim was to collect contents, questions and suggestions that are in the interest of clinically active colleagues when the care of potential terror victims or a mass casualty incident is necessary. On the basis of these results as well as by means of a corresponding knowledge transfer from the military surgery in the German Armed Forces, a course concept was developed, which imparts corresponding contents to civilian internal clinical decision makers. In addition to the pure theoretical knowledge transfer, the aim was also to train clinical executive personnel in decision-making. After a corresponding analysis, the idea of

a tabletop simulation game was implemented on the basis of corresponding literature recommendations [8].

During the development of this course, we were unsure whether the course contents could be conveyed in a playful way and whether a board game or a tabletop simulation game was suitable for teaching and motivating the abovementioned participants.

Learning objectives

The tabletop simulation game covers decision-making processes and algorithms in hospitals dealing with an influx of mass casualties resulting from a terrorist attack.

The main aim is to train decision makers in hospitals in such a way that they are able to organize a mass casualty incidence at any time and independently of the existing situation, in particular with a corresponding terrorist background, and to ensure continued patient care.

Didactic approach of the TDSC®course and the tabletop simulation game as the centrepiece of the TDSC®course

The didactic approach and the course structure ensure the interest, motivation, and progress of the target group, namely experienced clinical decision makers.

Therefore, the aim of the tabletop simulation game is to integrate not only competence- and content-based learning but also emotional and experience-based learning into the course and to take advantage of relevant synergy effects. Among educational experts, however, a standard definition of what a game is does not exist, but board games have a history of use in therapeutic context and in medicine [9–11]. The basic features of all games such as participation, interaction between individuals, the importance of rules, the integration of emotions and knowledge, and the generation of motivation are essential for every learning process and confirm the usefulness of games for learning. Games allow us to fulfil our innate psychological need for autonomy, competence and connection [12,13].

The motivational aspects of games (tabletop simulation games or computer games) are explained to a large extent by the self-determination theory of Ryan et al. [14,15]. According to this theory, the experience of autonomy, competence and connection fosters intrinsic motivation and the willingness to learn more about important topics. Likewise, factors that reduce or hinder autonomy, competence and connection decrease motivation. Nowadays, most scholarly writing on games in education focuses on computer games. Many important aspects also apply, however, to tabletop simulation games. In the words of Anna Tepe: The objective of simulation games is not only to improve one's ability to manage conflicts and to develop strategies for problem solving, communication and cooperation but also to enable players to experience a subject in all its complexity and multidimensionality and to illustrate different perspectives and interests [16].

The TDSC® tabletop simulation game allows players to experience relatively abstract procedures and algorithms on an emotional and sensory level and to manage and think about critical and complex situations.

Debriefing and evaluation

Directly after each simulation game, which take place for four times in the course, there is an intensive debriefing. The players must analyse their roles in a critical way and reflect on their decisions with the help of key questions. This criteria-based analysis after the simulation is a major component of a thoughtful and conclusive evaluation.

Furthermore, in addition to the immediate game analysis after each game round, a general course evaluation is carried out. This course evaluation includes general questions about the overall course and the theoretical content as well as a scaled query with regard to the individual rounds of play.

Relevant elements of the tabletop simulation game

The board

The game board represents an entire hospital and shows all treatment and care areas that are relevant to a mass-casualty incident. These include a triage area, an emergency reception unit with radiological diagnostic capabilities, a high-care area with an intermediate care unit (IMC) and an intensive care unit (ICU), operating theatres, a general ward, a pathology department, and a patient discharge area (Fig. 1).

In the game, participants move patients in accordance with a predefined time scale from one area to the next if the required capacities are available. For example, a patient who is scheduled for surgery could be transferred from the emergency reception unit to the operating theatre after all required measures have been taken in the emergency reception unit. A game master can adapt available organisational elements and resources to local conditions or to a specific situation. He or she may also choose to make these resources available or not.

To be able to depict personnel resources (PR) directly and as realistically as possible, these are indicated by corresponding playing fields on the game board and must each be staffed with qualified personnel in the form of game pieces. Only then is the implementation of e.g. appropriate treatment measures possible. Further game instructions (GI) on the game board directly formulate essential rules that must be observed during the simulation.

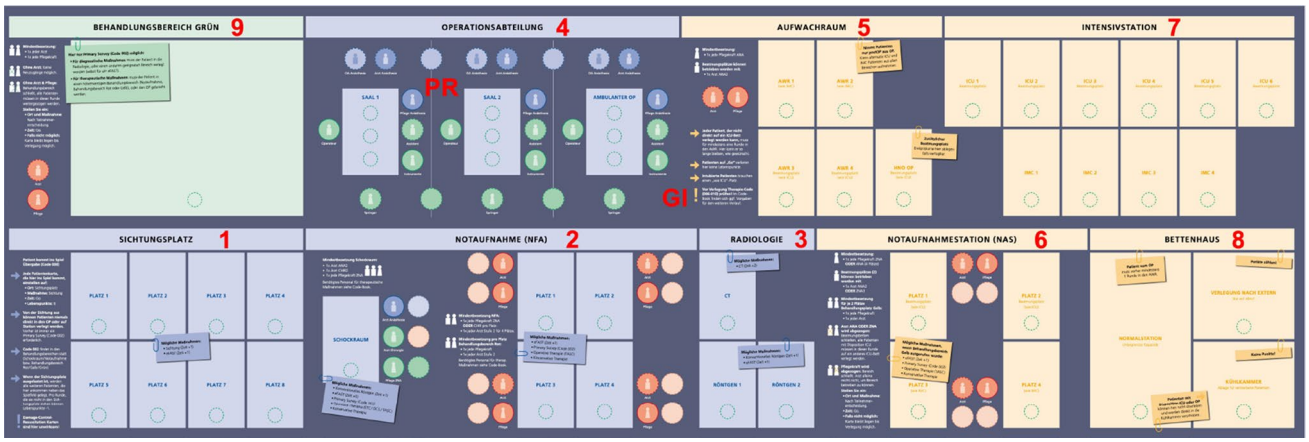

Fig. 1 Shown is the Board Game (which is up to now only available in German). No. **1** represents the triage area where the patients are first sighted ("Categorising" according to the TDSC® —algorithm). From here, the patients are transferred to the emergency department (No. **2**) with connected radiology (No. **3**) for further evaluation and the need for treatment is determined ("Prioritising"). For the further componentes with "Coordinating" and "Implementing" the patients are then—depending on findings and resources scheduled for surgery and transferred to the operating room (No. **4**), especially patients who requires immediate care (red). The operation room is followed by a appropriate recovery room (No. **5**). If an operation is not necessary or not possible depending on capacity, appropriate intensive care capacities are available (No. **7**). Not so seriously injured patients (yellow/delayed priority) can be treated in the emergency ward (No. **6**) or the normal ward (No. **8**), for the green patients with low priority the treatment area green (No. **9**) is available

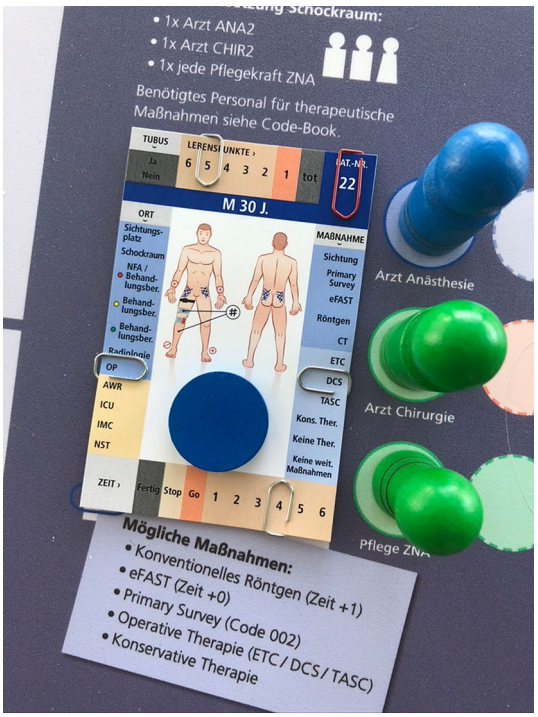

Fig. 2 Patient card representing an injured person. As mentionedabove, various categories describe injuries and patient condition and simulate diagnostic and therapeutic measures for each patient. Here patient 22 (30y, male) is categorized as a red patient, he has got a CT-scan for diagnostic and now he is prioritised for the OR (= OP). There he should be treated according to the Damage Control Surgery (DCS) - principles. For the patient there are still 5 living points (= Lebenspunkte) and 4 time points (= Zeit) left

The patient card

Patient cards represent individual patients (Fig. 2). This approach is also used in other training courses such as the MRMI course as a wide variety of parameters can be simulated [17].

The cards used in the TDSC® course contain information on the sex and age of patients. A code book (see below and Table 1) organised according to card numbers provides further data on injury pattern and initial physiological parameters such as GCS, pulse, blood pressure, etc.

The cards contain options for the triage further imaging workup and further treatment from which the players need to choose when managing the patient represented by the card (see also Paper one of Friemert et al. in this Focus-On – Issue) [1,2].

Real-time conditions are simulated with the help of a timescale, which stipulates the necessary times for, for example, a CT scan or various surgical procedures. Unexpected events, personnel shortages and complications have an impact on the course of the simulation and make planning more challenging, just like in real-life situations. In addition, a health point scale shows the overall physiological condition of the patient. The patient loses health points if he or she has to wait too long for treatment, diagnosis or, first and foremost, surgical stabilisation. Further deterioration of the patient's condition can be avoided by surgical stabilisation or transfer to the intensive care unit. Complications may also reduce health points and consume additional resources. When making decisions, players

Table 1 The code book is divided into group codes (like chapters of a book)

Triage and initial medical assessment	
Group code 0	Hospital admission
Group code 1	Triage findings
Group code 2	Primary survey findings
Diagnostic measures	
Group code 3	eFAST findings
Group code 4	X-ray findings
Group code 5	CT findings
Treatment concept/measures	
Group code 6	Treatment and results in accordance with ETC
Group code 7	Treatment and results in accordance with DCS
Group code 8	Treatment and results in accordance with TASC
Group code 9	Treatment measures and results in accordance with conservative treatment
Group code 10	Patient condition if no treatment is provided
Consequences of coordination and treatment decisions	
Group code 11	Postoperative monitoring and further development of patient
Group code 12	Measures and consequences after patient has been admitted for inpatient treatment

The group codes provide information about patients. For example, group code one contains the initial findings and vital signs obtained during triage for a patient. If, in the course of the game, a decision is made to perform a CT scan as a further diagnostic measure, the relevant information can be found in group code five. If the patient then obtains treatment in accordance with damage control surgery, the relevant information and measures can be found in group code seven. Participants are allowed to look up the information in the code book only after the patient has undergone the examination or received the measure in question

must always consider whether or not quick and temporary treatment involves a higher risk of complications.

The code book

The code book provides comprehensive information on every patient based on group codes to simulate the individual stages for every patient and to ensure developments over the course of the game.

The book contains nine of the group codes, which are presented like chapters in a book. Each group code contains a section on every individual patient. The various group codes are shown in Table 1.

The code book thus makes it possible to accompany each patient through the game. In other words, it reflects the development of individual patients and the overall hospital situation.

The physiological development of patients is thus outlined. The code book describes the results of diagnostic measures and, if damage control surgery is selected for example, states the extent of surgery and the steps involved.

Units of time are also laid down for individual measures such as surgical procedures. Participants then learn about the outcome of procedures before the patient is transferred to the intensive care unit or the general ward.

Figure 3 shows the individual measures that were taken for a patient during a game and provides information from the code book in abbreviated form. Figure 3 illustrates how many different choices players have in terms of both diagnostic and therapeutic measures. Decisions have a wide variety of consequences. For example, an ETC approach takes six time units while a TASC approach requires only two. The operating theatre would thus be available sooner for the next operation.

Basic idea and gameplay

After presenting a specific scenario, the game master introduces a given number of patients at each stage of the game. Three players then manage these patients first in the triage area where they perform triage, conduct the primary survey, and decide on further measures.

Gameplay is directed by the game master, who may also play event cards to introduce further contingencies, which ensures a certain degree of unpredictability. The event cards simulate, for example, technical problems with the CT unit or the unavailability of a transport team. The latter would delay the movement of a patient to the CT unit, which in turn would cause the CT to be occupied for another round and the operating theatre to be unused although surgical resources are urgently required. Positive events can also occur. Hospital management may, for example, be able to transfer an intensive care patient to another hospital and thus make available an additional ICU bed.

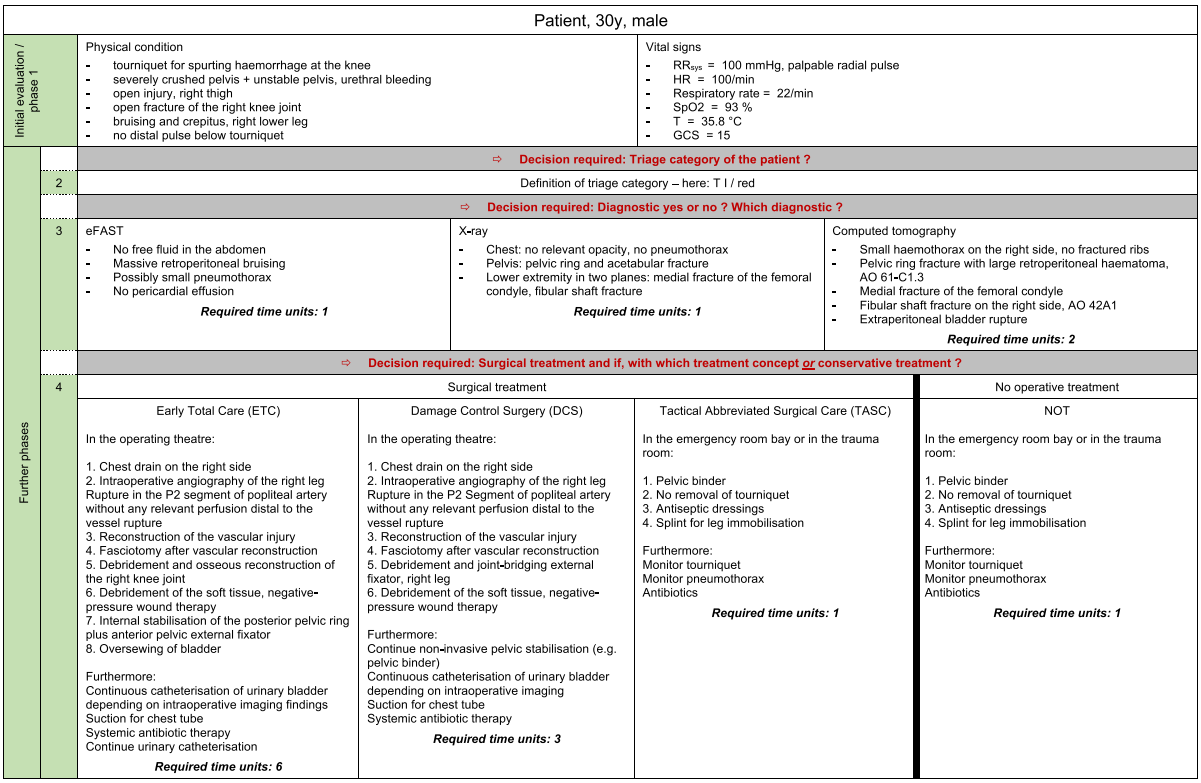

Fig. 3 Diagram of initial evaluation, diagnosis and treatment of patient 22 during the game. Each game is played by three people, who have to make relevant decisions and refer to the code book for the necessary information, for example on the selected surgical approach. The code book also contains information on subsequent steps, in this case the transfer of the patient to the ICU after surgery

Increases in personnel strength at the hospital also occur to varying extents at every stage.

Objectives

The objective of the tabletop simulation game is to allow TDSC® participants to directly experience and put into practice theoretical concepts from the presentations and the case examples. In our opinion, Anna Tepe's requirement that players must be able to experience a subject in all its complexity and multidimensionality is achieved with this game [16]. This is confirmed by course evaluations (see below).

Playing and succeeding at a game or "mission", developing new knowledge, capabilities and skills, visualising progress and success (e.g., through scores), and direct and continuous feedback increase the feeling of competence and the motivation of players [18,19]. The feeling of autonomy is promoted by intuitive rules and gameplay as well as by decision-making opportunities during the game. The feeling of connectedness is mostly achieved in games through teamwork and immersion as well as through mutual support, joint success, and joint failure [20,21].

The tabletop simulation game is played four times during each course, whereby different four different scenarios are performed. This is done for various reasons. First, players are able to familiarise themselves with the elements, gameplay and rules of the game. Second, repetition helps players improve their understanding of theoretical concepts. Third, participants have an opportunity to learn the consequences of the different decisions taken during one game as compared to previous games. Debriefing done following each of the games allows the different teams to compare their results to those of other teams who might have taken a different approach to the same scenario.

The game thus allows players to make the necessary medical decisions in a scenario that would otherwise require a hospital exercise with an enormous infrastructural effort and financial costs.

Results

Course participants

Previous courses have been especially well received by participants, especially with regard to the training in decision-making. Tables 2, 3 provide an overview of previous courses

Table 2 Hospital position of participants

Position of participants in hospitals	Department heads executive senior physicians and surgeons	Senior physicians and surgeons	Specialists	Junior physicians
N	38	145	43	38

from 07/2017 up to 12/2019 and shows that the most participants were experienced medical professionals in positions of responsibility in hospitals.

Evaluation of the tabletop simulation game

Within the above-mentioned courses, 264 participants took part in an evaluation of the courses, they evaluated the overall course, individual themes, and the tabletop simulation game. The evaluation was conducted using a numerical scale from one to six: (1): excellent, (2): good, (3): satisfactory, (4): sufficient, (5): inadequate, (6): insufficient.

Discussion

The numerical ratings, descriptions and comments of participants show that the game fulfils many of the requirements and is a multifaceted, interactive, narrative, and entertaining experience in which feedback plays an important role. We thus believe that the tabletop game helps participants to learn and our experience as well as the evaluation of the course by participants (Fig. 4) has shown, however, that this is possible and that participants are enthusiastic and satisfied.

Comparison with other training courses

The TDSC® course focuses on the special aspects and challenges of a terror and disaster situation. Special emphasis is placed on terrorism on account of political developments in Europe. The authors feel that this issue is in need of urgent attention.

Germany, for example, has included this topic in the new edition of the Whitebook Medical Care of the Severely

Table 3 Overwiev of the paticipants specalization considering the hospital position

	GenS	Anae	IntM	EM	Orth	TraumS	Radio	PlastS	Paed	Others	Total
DH/ESP	1	5	2	2	2	25	1	–	–	–	38
Con	5	35	5	8	4	77	–	2	–	9	145
Spec	5	13	1	2	–	20	–	–	1	1	43
JunP	3	5	–	2	1	23	–	–	–	4	38
Total	14	58	8	14	7	145	1	2	1	14	264

GenS General Surgery and Vascular Surgery, *Anae* = Anaestehsiology, *IntM* Internal Medicine, *EM* Emergency Medicine, *Orth* Orthopaedics, *TraumS* Trauma Surgery, *Radio* Radiology, *PlastS* Plastic and Reconstructive Surgery, *Paed* Paediatrics; *DH/EHS* Department Head, Execcutive Senior Physician, *Con* Consultant, *Spec* Specalist Physician, *JunP* Junior Physician

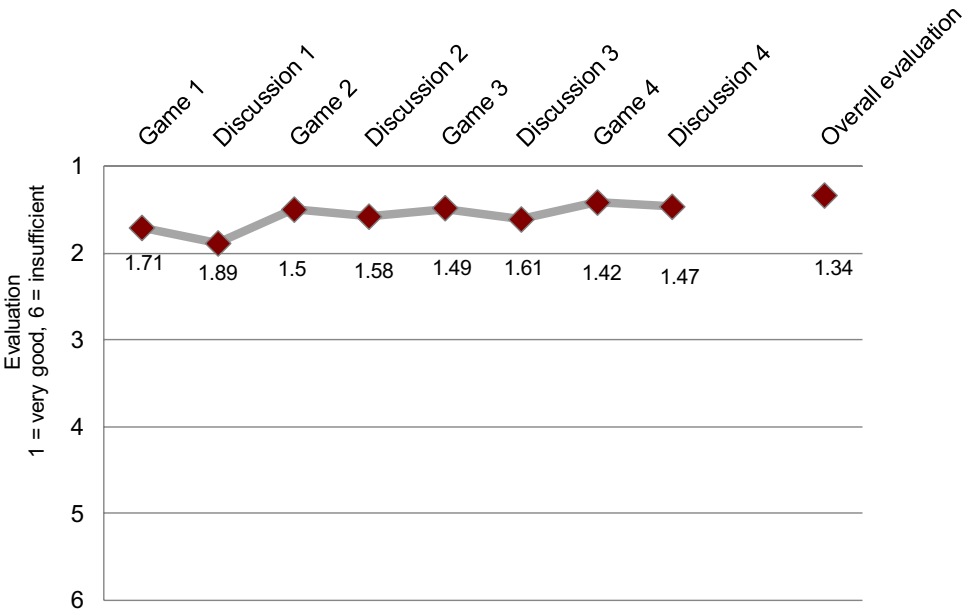

Fig. 4 Evaluation of the tabletop simulation game of the four rounds including an evaluation of the discussions after each round. The evaluations of 264 participants showed that the overall evaluation of the course was very good and that the game received increasingly higher ratings from participants during the course. The evaluation results for the game thus correspond to the overall evaluation for the course

Injured. This publication is a guideline for the day-to-day operation of hospitals as well as for the certification of various trauma hospitals in Germany [22].

Courses that focus on theoretical concepts are insufficient for such scenarios. Key personnel (LArS and EOMC = ZONK) are required for such situations and, therefore, different approaches to training must be taken. A full-scale exercise would be especially useful, but the organisational, infrastructure and financial effort would be enormous. In addition, it makes little sense to perform such a complex exercise without any preparation or adequate training.

Conclusion

We believe that the TDSC® course fills a gap and can provide exactly this type of training. The centrepiece of the course is the tabletop simulation game, which can be used to present knowledge and skills in an entirely novel way. The evaluation results show that this new type of training is effective. Further studies must, however, be conducted to ensure continuous development and improvement.

Compliance with ethical standards

Conflict of interest Friemert B, Achatz G, Franke A and Bieler D are developers of the TDSC – Course and are active as Course-Directors or -Instructors in this Course. Pafrath T is Instructor in the TDSC – Course, Hofmann M is didactic advisor for the TDSC – Course, Blätzinger M and Hinz-Bauer S are members of AUC – Academy for Traume Surgery GmbH and organizer and operator of the TDSC – Course. Trentzsch H created, designed and conseptualized the simulation game in close cooperation with the developers of the TDSC – Course and the didactic advisor.

Ethical statement For this study, there were no test or experiments to humans or animals.

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