Live trauma surgery demonstration with a porcine model is valuable training for physicians and nurses

Yoshimitsu Izawa*1,8 Yasumitsu Mizobata*2 Takashi Fujita*3
Hisashi Matsumoto*4 Michiaki Hata*5 Chikara Yonekawa*1
Takashi Nagata*6 Shuji Hishikawa*7,8 Yukitoshi Makimura*8
Satoshi Kunita*8 Keisuke Yamashita*1 Masayuki Suzukawa*1
and Alan K. Lefor*7,8

Sources of research funding: We gratefully acknowledge the support of the 17th Congress of the Japanese Society for Emergency Medicine support of this program.

Ethical considerations: The program was conducted after receiving approval from the Institutional Animal Experiment Committee of the Jichi Medical University, and in accordance with the Institutional Regulation for Animal Experiments and Fundamental Guideline for Proper Conduction of Animal Experiment and Related Activities in Academic Research Institutions under the jurisdiction of the Ministry of Education, Culture, Sports, Science and Technology of Japan. It was approved on April 9th, 2014. The approval number is 14-225.

Disclosure of conflicts of interests: We gratefully acknowledge the contributions of personnel from Panasonic Corp. who enabled the interactive communication system.

Abstract
Introduction: Live surgery demonstrations have been widely used in surgical education. However, they cannot be used to demonstrate trauma surgery due to the emergency situation and lack of informed consent. The aim of this study was to conduct a live demonstration of trauma surgery with a porcine model to increase educational opportunities in trauma surgery.

Methods: Live demonstration was conducted at the Center for Development of Advanced Medical Technology (CDAMtec), Jichi Medical University, Japan. An experienced trauma surgeon instructed three trainees during a live demonstration using pre-planned injuries in a porcine model. A six-point Likert Scale was used on a written survey to determine the value of the program to the viewers. Free-form written comments were also obtained from the participants. Live images of the surgical field were transmitted to a lecture room by a closed wireless LAN with interactive bidirectional audio capability.

*1 Department of Emergency and Critical Care Medicine, Jichi Medical University, Tochigi, Japan
[Yakushiji 3311-1 Shimotsuke, Tochigi Japan 329-0498]
*2 Department of Trauma and Critical Care Medicine, Graduate School of Medicine, Osaka City University, Osaka
*3 School of Medicine, Department of Emergency Medicine, Trauma and Resuscitation Center, Teikyo University, Tokyo
*4 Shock and Trauma Center, Nippon Medical School Chiba Hokusoh Hospital, Chiba
*5 Acute Care Surgery Unit, Department of Emergency Medicine, Yonemori Hospital, Kagoshima
*6 Department of Advanced Medical Initiatives, Faculty of Medical Sciences, Kyushu University, Fukuoka
*7 Department of Surgery, Jichi Medical University, Tochigi
*8 Center for Development of Advanced Medical Technology, Jichi Medical University, Tochigi

受付：2015年6月17日、受理：2015年10月30日
Introduction

Live surgical demonstrations have been used as an educational tool. They allow interactive communication between the surgeons and viewing participants, which is not possible with recorded video demonstrations\(^1\). Various procedures have been performed as live demonstrations in many institutions\(^2\)\(^3\).

The number of operations performed for chest and abdominal trauma is generally decreasing with non-operative management and a decreased incidence of penetrating injuries\(^4\). Effective tools that do not directly depend on clinical volume are important for trauma education. Various tools have been developed to make up for the decreased clinical experience available to residents\(^5\)\(^6\).

Trauma surgery in practice, in contrast to elective surgery, requires rapid decision-making and treatment in emergent situations. Severely injured patients are often unable to provide information. There is little time to discuss treatment options in the limited time available. Residents may have little chance to learn technical and non-technical skills about management in these acute situations. Effective educational tools are needed to improve the limitations imposed in the treatment of critically injured patients.

Although live demonstrations have been used for trauma education, they are difficult to implement. Trauma surgery is always performed emergently, making live demonstrations impractical for education. It is generally impossible to obtain informed consent for a live demonstration from the patient before the procedure.

There is no advantage to the patient to undergo a surgical operation in a live demonstration\(^7\). Some authors have described that the anxiety of the surgeon performing a live demonstration may be high, which could lead to a worse outcome\(^8\). In a systematic review of live surgical demonstrations, the evidence for live surgery being effective in education and issues regarding patient safety were reviewed\(^8\). The authors concluded that there is scarce evidence for the educational value of live surgery demonstrations.

The aim of this study is to conduct a live demonstration of trauma surgery using a porcine model to increase educational opportunities in trauma surgery.

Methods

This program was conducted after receiving approval from the Institutional Animal Experiment Committee of the Jichi Medical University (9 April 2014, #14-225), in accordance with the Institutional Regulation for Animal Experiments and Fundamental Guideline for Proper Conduction of Animal Experiment and Related Activities in Academic Research Institutions under the jurisdiction of the Ministry of Education, Culture, Sports, Science and Technology of Japan. Trauma injury scenarios with a live porcine model were conducted in the Center for Development of Advanced Medical Technology (CDAMtce), at Jichi Medical University as part of the 17\(^{th}\) Congress of the Japanese Society for Emergency
After induction of general anesthesia, a series of pre-planned injury scenarios in a live porcine model were performed. A crossbred KCG miniature pig weighing about 33 kg, specific pathogen free and tested for the absence of Hepatitis E Virus was used. The animal was treated in accordance with appropriate rules and regulations for the ethical care of laboratory animals.

An experienced trauma surgeon directed communications between the operating room and the auditorium where viewing participants were seated. Another experienced surgeon assisted with the procedures as an instructor, providing guidance during the operation. Three trainees (Postgraduate years 5–8) participated in the demonstration, and two Emergency Department nurses supported the program. There were three scenarios used including a renal injury, cardiac injury and inferior vena cava injury. Each trainee performed one scenario.

In the first scenario, a stab wound was made in the right kidney. Both partial and total nephrectomies were performed. In the second, a cardiac injury, with a stab wound to the center of the right ventricle, was created and repaired. Finally, the anterior wall of the inferior vena cava was lacerated and repaired. All injuries were created just before the scenario started to minimize the physiologic effects on the live animal. After the demonstration, the animal was euthanized in accordance with applicable regulations.

The heart rate, blood pressure and oxygen saturation were maintained in the normal range during the conduct of all scenarios. In each scenario, the anesthesiologist gave suitable information about the scenario patient as needed, regardless of the real vital signs of the animal being operated upon.

The view of the operative field was transferred to an auditorium in another building by closed LAN including live-action images and audio, with interactive communication between the operating room and participants. A sound-concentrating microphone in the operating room captured the audio for transmission to the auditorium.

A total of 83 participants viewed this demonstration and returned the questionnaires. Participants included 45 physicians, 15 nurses, 10 Emergency Medical Services personnel, and 13 others. The “others” included four medical students, two clinical technologists, two pharmacologists, two radiology technicians and three people who did not respond to this item on the questionnaire. Various specialists attended the demonstration, including emergency physicians and nurses, surgeons, internal medicine physicians, ICU doctors and nurses, radiologists, etc.

A six-point Likert scale was used on a written survey following the demonstration to measure the opinion of the participants. The scale used indicated a score of 1 as the lowest, and 6 as the best evaluation. Informed consent from participants was indicated by filling out the questionnaire, as stated on the form. Free-form verbal comments were also allowed on the survey form. The scores were analyzed (Excel, Microsoft Corp, Redmond WA USA), and reported as mean and standard deviation.

**Results**

The level of experience of physician participants is $16.8 \pm 9.7$ years, and nurse participants is $12.9 \pm 6.7$ years. The opinions of participants and a self-assessment of their confidence level after the live demonstration are shown in Table 1. Viewing participants were highly satisfied with the live demonstration, and gave very positive feedback.

Nine free-form comments, from seven doctors, one nurse and one member of the Emergency Medical Service, were submitted (Table 2). “ER doctor” means doctors who work full-time in the
Table 1  Evaluation and self-assessment of confidence after viewing the live demonstration

<table>
<thead>
<tr>
<th></th>
<th>Physicians (n = 45)</th>
<th>Nurses (n = 15)</th>
<th>EMS (n = 10)</th>
<th>Others (n = 13)</th>
<th>Total (n = 83)</th>
</tr>
</thead>
<tbody>
<tr>
<td>My interest in trauma surgery has increased after this demonstration</td>
<td>5.1 ± 0.9</td>
<td>5.5 ± 0.7</td>
<td>4.7 ± 1.6</td>
<td>4.9 ± 0.9</td>
<td>5.1 ± 1.0</td>
</tr>
<tr>
<td>My knowledge of trauma surgery has increased</td>
<td>5.1 ± 0.8</td>
<td>5.3 ± 0.9</td>
<td>4.2 ± 1.2</td>
<td>5.0 ± 0.8</td>
<td>5.0 ± 0.9</td>
</tr>
<tr>
<td>I would like to watch a live demonstration of trauma surgery again</td>
<td>5.2 ± 0.9</td>
<td>5.4 ± 0.8</td>
<td>4.9 ± 1.2</td>
<td>5.1 ± 1.0</td>
<td>5.2 ± 1.0</td>
</tr>
<tr>
<td>I can apply the skills and knowledge to my work</td>
<td>4.5 ± 1.3</td>
<td>4.8 ± 1.5</td>
<td>4.2 ± 1.3</td>
<td>4.7 ± 0.8</td>
<td>4.6 ± 1.2</td>
</tr>
<tr>
<td>I would recommend live demonstration of trauma surgery to others</td>
<td>5.1 ± 0.9</td>
<td>4.8 ± 1.3</td>
<td>4.9 ± 1.0</td>
<td>5.0 ± 0.9</td>
<td>5.0 ± 1.0</td>
</tr>
</tbody>
</table>

Table 2  Free comments after viewing the live demonstration

<table>
<thead>
<tr>
<th>No</th>
<th>Occupation</th>
<th>Post graduate year</th>
<th>Experience in trauma surgery</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ER doctor</td>
<td>3</td>
<td>None</td>
<td>I could watch a live demonstration with useful explanations about trauma surgery.</td>
</tr>
<tr>
<td>2</td>
<td>ER doctor</td>
<td>3</td>
<td>None</td>
<td>Explanations are useful because there is little time to get explanations during the practical operations.</td>
</tr>
<tr>
<td>3</td>
<td>Anesthesiologist</td>
<td>6</td>
<td>30 cases</td>
<td>Leadership in the team was obscure. The vital signs should clearly be shown.</td>
</tr>
<tr>
<td>4</td>
<td>ER doctor</td>
<td>14</td>
<td>20 cases/year</td>
<td>I could not identify who was the leader in the operations. I would like to watch experts’ performances.</td>
</tr>
<tr>
<td>5</td>
<td>ER doctor</td>
<td>20</td>
<td>50 cases</td>
<td>I would like to watch procedures of liver injury.</td>
</tr>
<tr>
<td>6</td>
<td>ER doctor</td>
<td>25</td>
<td>30 cases</td>
<td>I would like to suggest that the participants were allowed to join the decision making.</td>
</tr>
<tr>
<td>7</td>
<td>ER doctor</td>
<td>30</td>
<td>6 cases</td>
<td>E-learning with live demonstration should be made about trauma surgery.</td>
</tr>
<tr>
<td>8</td>
<td>Nurse in ER</td>
<td>22</td>
<td>None</td>
<td>I could get knowledge about trauma surgery with explanations. I would like someone to conduct the same promotion in the congress of emergency nursing.</td>
</tr>
<tr>
<td>9</td>
<td>Emergency Medical Service</td>
<td>20</td>
<td>None</td>
<td>I could get knowledge of anatomy.</td>
</tr>
</tbody>
</table>

ER, regardless of their training. Of the nine comments, three described that this live demonstration showed what trauma surgery is like with useful explanations in terms of technical and non-technical skills to the participants. Two pointed out inadequacies in leadership of the team.

Discussion

A live demonstration of chest and abdominal trauma surgery with a porcine model was conducted, using pre-planned scenarios. A survey from the viewing participants was conducted after the session and most of the participants
were satisfied with the program, and gave very positive feedback concerning the usefulness of this educational program.

Viewing participants included physicians and nurses with significant experience in trauma care, with an average of more than ten years experience, and felt that the live demonstration is an excellent educational tool. They also felt that this live demonstration increased their knowledge of trauma surgery. Free comments stated that the explanation of trauma surgery in this course improves comprehension of the skills of trauma surgery. Trauma surgery is usually urgently performed so that many observers cannot identify what is performed in clinical practice. This demonstration was precious for the participants due to a lack of educational opportunities for trauma care in Japan. Many medical staff do not have enough opportunities dealing with trauma patients requiring surgical intervention, as well as a lack of formal educational programs for trauma surgery. Thus, this live demonstration is a useful tool because it is possible to teach both technical and non-technical skills simultaneously, with explanations to team members who have little direct experience in trauma surgery.

This program was part of a national meeting in which nurses, clinical technologists, pharmacologists and radiology technicians were present. Results in Table 1 show that these specialists, with varied backgrounds and duties, all have great interest in trauma surgery. They recognize that due to its nature, optimal trauma care requires the participation of specialists with a wide range of backgrounds and training. This live demonstration enabled them to better understand the nature of trauma surgery, and was the first experience for some of them. Kallmes et al. described that a live demonstration is useful in teaching new procedures.

The interactive communication during the demonstration was useful, compared to other teaching tools during this demonstration, temporary hemostasis for a cardiac injury using a balloon catheter was added based on the requests of the viewing participants. The instructor talked directly with the viewing participants about each procedure, while performing the surgical operations. Interactive communication while demonstrating procedures is especially meaningful in Japan, which is a developing country regarding trauma care, because a single live demonstration can teach many people involved in trauma care at the same time.

There are some limitations to a live demonstration program. The exact number of people who viewed the program was difficult to determine because of continuous inflow, but the survey response rate was about 75%. A porcine model is not the same as a human, which limits the ability to teach specific technical skills. Although some organs in the pig are similar to those of a human, the liver and spleen are quite different. The injury scenarios used were selected because they emphasize aspects of tissue handling that are common to both the porcine organ and the corresponding human organ.

There are acknowledged limitations of this pilot study. This study obtains outcomes at Kirkpatrick level 1, which is one of the limitations of this preliminary live demonstration. This suggests that further study is needed to determine how participation in this program will affect clinical care of patients among participants in their future practice.

This educational program has great potential for trauma education. In the free comments, some suggested an e-learning system with live demonstrations and live demonstrations which allow participants to participate in decision making. We plan to develop such programs in the next phase, including investigations at levels 2–4 of the Kirkpatrick model, such as pre- and
post-tests, simulations, and follow-up of survival rates in the clinical practice of participants in the care of trauma patients.

We conducted a live demonstration of trauma surgery using pre-planned scenarios in a porcine model. This demonstration provided a live educational program to a large audience to increase educational opportunities in trauma surgery. The viewers evaluated the program as extremely valuable on a post-program survey. Live demonstration in trauma surgery using an animal model is a feasible and effective educational tool to teach both technical skills and non-technical skills, with advantages over surgery on patients in regard to the ethics of live demonstration surgery.

Acknowledgement

Disclosure of conflicts of interests: We gratefully acknowledge the contributions of personnel from Panasonic Corp. who enabled the interactive communication system.

References


