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Simulation as an additional tool for investigating the performance of standard operating procedures in anaesthesia†

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Background. In medicine, the use of standard operating procedures (SOPs) is often evaluated using questionnaires (QUES). However, QUES can have limitations with regard to method, thus leading to errors. Simulation (SIM) offers another opportunity for evaluation. We hypothesized that medical errors in the evaluation of SOPs using QUES could be detected by SIM, and that SIM is better qualified to demonstrate applied medicine.

Methods. We investigated the use of SOPs in anaesthesia, rapid sequence induction (RSI), by means of a QUES (n=42) or SIM (n=42) among 84 anaesthesiologists. Seven measures for preventing aspiration during induction of anaesthesia were examined and evaluated according to a predetermined points system.

Results. The average number of times that precautionary measures to prevent aspiration were mentioned in the QUES [4.8 (0.9)] or performed during SIM [5.0 (1.1)] did not differ between the two groups. Pre-oxygenation was the most frequently described or performed measure (95% *vs* 93%). However, other measures, such as avoidance of positive pressure ventilation (45% *vs* 85%), differed significantly between the two groups.

Conclusions. QUES and SIM are powerful instruments for evaluating the implementation of SOPs such as RSI. SIM demonstrates automated behaviours and thus more clearly represents behaviours used in clinical practice than is possible to demonstrate using QUES. Using a combination of these two instruments, method errors resulting from the individual instruments can be reduced.

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Standard operating procedures (SOPs) are components of clinical pathways that were introduced to improve diagnostic and therapeutic management within medicine. They are based on current studies and recommendations from experts and professional organizations. The introduction of these procedures into everyday use in hospitals has led to a reduction in morbidity, mortality, and hospital costs.[1]

In general, SOPs are often evaluated using instruments such as questionnaires (QUES) or observer studies.[2 3] However, the reliability of an investigation using QUES alone depends on the response rate and the representativeness of the survey.[4] Additionally, method errors can also occur, due to missing data, polarity reversal (1 instead of 6), contradictory, or inconsistent answers or due to answers that tend towards social desirability, all of which can lead to a bias in the results.[5]

Simulation (SIM) enables successful training of technical and non-technical skills.[6] SIM also provides the opportunity to observe and evaluate technical performance.[7–9] Thus, SIM represents an excellent means of evaluating the

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use of SOPs, with a special focus on applied practice. The objective of this study was to examine the results of the evaluation of an SOP with the generally recognized instrument, QUES, and to compare those with the results of a possible new tool, SIM. Currently, we are not aware of any other simulator-supported studies comparing the performance of QUES and SIM. We chose rapid sequence induction (RSI) procedure, which is indicated by any risk of aspiration of the contents of the stomach during induction of anaesthesia. We hypothesized that method errors in the evaluation using QUES could be detected using SIM, SIM is better qualified to demonstrate applied medicine, and that SIM is better suited than QUES to the implementation of medical standards.

Methods

The study was approved by the medical faculty of the University of Heidelberg, Germany, and written informed consent was obtained from all of the participants. The investigation performed by QUES was blinded and the answers could not be traced back to the participants.

Our SIM centre is located in our Department of Anaesthesiology. It comprises an operating room that is separated from the control room by a two-way mirror. The operating theatre includes a standard anaesthetic apparatus (Sulla 808V, Draeger®, Luebeck, Germany), a physiological patient monitor (GE®, Eagle 5000, Sollingen, Germany), an anaesthesia cart, an operating table (Maquet®, Rastatt, Germany), a surgical instrument table, and a patient high-fidelity simulator mannequin (HPS, METI®, Sarasota, FL, USA) located on the operating table. This simulated world presents an environment for administering anaesthesia that is quite close to reality.[10]

An anaesthesia nurse from our department supported the participants from the SIM group during anaesthesia. The nurse was familiar with all of the medical devices. The participants were told ahead of time that the nurse could be trusted and would only provide correct information.

Eighty-four anaesthesiologists from external hospitals and from within our department participated in the study. They were randomized into two groups of equal size with 42 participants each. One group received a QUES; the other group participated in a session of SIM. Participants described anaesthesia or administered it to a 20-yr-old, 72 kg man in good general health who had not undergone any previous operations. For more than 3 h, the patient had been suffering with typical symptoms of acute appendicitis, with nausea and vomiting, and was at an increased risk of aspiration. Participants were told that a stomach tube had been inserted in the emergency room. The stomach had been suctioned, and the tube had been removed by the nurse shortly before anaesthesia induction. All participants had free choice of medical equipment and medications for anaesthesia.

The participants in the SIM group received a brochure about the options and limitations of SIM and the structure of the SIM centre. The SIM session was video-recorded using two cameras. Recording and camera set-up was performed by a member of the study group who had been briefed beforehand.

Participants in the QUES group received an open QUES based on a pilot study done by our department. This QUES contained only basic information as described above, and participants were asked to describe in detail their way of induction of anaesthesia with regard to precautions, choice of drugs, and the order of administration. The QUES were collected and analysed retrospectively.

Criteria for inclusion in the study were participation on a voluntary basis, professional experience of >0.5 yr and no previous experience with simulators. Only QUES that were filled out completely and video recordings that were technically acceptable were included in the analysis process.

To obtain the highest possible level of reliability, two independent anaesthesiologists who had not been involved in collecting the data evaluated the QUES and video recordings.

The participants indicated their degree of anaesthesiological training (anaesthesiologist with board certification *vs* anaesthesiologist without board certification), their gender, and their clinical experience. We used the video recordings and the QUES to evaluate the precautionary measures used to prevent aspiration during the RSI.[2 3] For evaluation, we used investigations that had already been carried out regarding RSI.[2 3] Seven precautions to prevent aspiration were examined.

(1) Pre-oxygenation: Detailed description in the QUES group, or performance in the SIM group, according to the current recommendations[11] (e.g. sealed face mask for >3 min, an $F_{E_{O_2}}$ of 0.9 was achieved).
(2) Change of the horizontal position of the patient: Detailed description in the QUES group, or performance in the SIM group according to the current recommendations[12] (e.g. head down or semi-sitting position).
(3) Performance of a RSI that was truly 'rapid': a truly 'rapid' RSI was considered to be done, when terms such as 'RSI', 'rapid', 'fast', or other similar expressions were described in the QUES, or mentioned in the SIM.
(4) Prepared suction.
(5) Arranged endotracheal tube with stylet.
(6) Applying cricoid pressure.
(7) Avoidance of positive pressure ventilation (APPV) before securing the airway with an endotracheal tube.

The last four precautions were either detailed in the QUES group or judged on performance and orders to the nurse in the SIM group.