Causes of stress and their change with repeated sessions as perceived by undergraduate medical students during high-fidelity trauma simulation

DINKER R. PAI, SHANKER RAM, SIMERJIT S. MADAN, HTOO HTOO KYAW SOE, ANKUR BARUA

ABSTRACT

Background. It is known that simulation training is associated with stress for the trainees, at all levels of trainee experience. We explored the factors which were perceived by the trainees to cause them the maximum stress related to their simulation experience and their temporal changes over three simulation sessions.

Methods. Ninety-seven final year medical students were administered a Likert-type questionnaire on perceived stressors after trauma simulation training. These stressors were classified as intrapsychic (relating to internal feelings); interpersonal (relating to interaction with others) and interactive (related to interaction with the simulated patient). Non-parametric tests were used for statistical analysis.

Results. Death of the simulated patient scored highest of all stressors. When the median scores for intrapsychic, interpersonal or interactive items were plotted session-wise, three distinct types of graphs were obtained. Eight of 13 items had a decrease in perceived stress scores from the first to the second session. Only ‘death of the simulated patient’ showed a significant increase in the score from the second to the third session.

Conclusion. Undergraduate medical trainees experienced stress due to various factors during their first simulation session, which reduced with repeated sessions. However, perceived stress related to simulated death of a patient continued to remain high even after two repetitions. We suggest that simulation training programmes for undergraduate medical students should have at least one repeat session to reduce the stress and that facilitators should consider keeping the simulated patient alive throughout the training sessions.


INTRODUCTION

Gaba defined simulation as ‘a technique—not a technology—to replace or amplify real experiences with guided experiences that evoke or replicate substantial aspects of the real world in a fully interactive manner’. Simulation with high-fidelity technology is an innovative and effective teaching strategy to address increasing student enrolment, faculty shortages and limited clinical sites. The value of simulation in undergraduate medical education is now well established. Lammers stated ‘it is clear that simulation animates the curriculum. It allows learners to try out and operationalize new knowledge, turning general concepts into practical skills and management strategies. It imparts an emotional component to the experience for most learners, thereby firmly implanting new information into memory.’

It is known that simulation training is associated with stress for the trainees, at all levels of trainee experience. One of the important roles of debriefing is to de-stress the participants after a simulation session. We explored factors that were perceived by the trainees as causing them the maximum stress related to their simulation experience. We also examined how the perceived stress caused by these factors changes over repeated simulation sessions. Therefore, we assessed the relative importance of perceived causes of stress faced by our students during trauma simulation sessions; and the temporal changes in these factor scores over three simulation sessions based on the perspectives of the participants.

METHODS

The study was conducted in the Department of Surgery at the Melaka Manipal Medical College of Malaysia, which imparts undergraduate training for medical students leading to the MBBS degree. This was an experimental study by design with simulation training being the intervention and perceived stress scores the outcome. This study was approved by the research and ethical committees of the institution. Trauma management training based
on the Advanced Trauma Life Support (ATLS) protocols is provided on a patient simulator mannequin to all final year students posted to the department of surgery. The objective of these sessions is to impart team-based trauma management skills. All the students who were rotated through the department of surgery between March 2011 and February 2012 were included in this study after obtaining informed written consent. Students participated in groups of 10–12 for three sessions on the simulator over the course of 3 weeks. The first two sessions were conducted on the same day and the third session after 3 weeks. Participants who were absent for any of the training and assessment sessions were excluded from the final analysis. The simulation sessions were run on the mannequin using one of four trauma scenarios (haemorrhagic shock, head injury, tension pneumothorax and cardiac tamponade) created by the first author (DP) on the proprietary software provided with the mannequin. Before the first session, participants were briefed on the expected learning outcomes and the ATLS protocol for trauma management in the form of an interactive lecture. The group was then subdivided into two teams of 5–6 students each who took turns on the simulator, while the other team observed from an adjoining room on closed circuit television. The haemorrhagic shock scenario was used for the first two sessions, since we felt that this was one of the most common clinical presentations following trauma and so it was essential for the students to be familiar with its management. Finally, the third session was conducted after 3 weeks where each team was randomly assigned one of the remaining three trauma scenarios based on the draw of lots. Each session was concluded with a debriefing exercise (Fig. 1). Students predetermined their team roles for each session, and rotated roles for each session so that they gained experience in different aspects of trauma management by the end of the training.

We developed a stressor questionnaire based on a 5-point Likert scale to assess the importance of stressors faced by the participants during the high-fidelity simulation training sessions. Items in this questionnaire were chosen on the basis of the authors’ prior simulation experience wherein the students had identified these factors as causes of stress during the simulation sessions. We found that the causes of stress as perceived by the students during simulation can be subdivided broadly into three groups, namely intrapsychic (factors relating to the participants’ internal feelings and knowledge); interpersonal (factors relating to their interaction with their peers and facilitator during simulation) and interactive (factors related to their interaction with the simulated patient). After formulating the questionnaire, content validation was done by asking four senior educationists with a simulation or clinical psychology background to review the items and comment on their suitability, clarity and relevance. The reviewers were also asked to suggest other items that they felt needed to be included. The questionnaire was then administered to 20 final year medical students after simulation training to test its applicability. Based upon the reviewer’s feedback and the pilot study, the final questionnaire was then prepared for use. This final questionnaire consisted of 13 items (Table I). Cronbach’s alpha score for internal consistency was 0.862. This questionnaire was administered by the first author (DP) to each participant as a hard copy before the start of the first session (pre-session), (ii) after the first session (session 1), (iii) after the second session (session 2), and (iv) after the third session (session 3). The students were asked to indicate the perceived level of stress for each item in the questionnaire on the 5-point Likert scale, with 0 denoting absence of stress and 4 representing the maximum stress.

We analysed the results by using the Statistical Package for Social Sciences (SPSS) Version 17.0. Essentially, the data obtained were analysed in two ways. First, the median perceived stress scores for each item over the three sessions were plotted as a graph with the interquartile ranges being plotted as a box plot and inferences drawn from the scores and the pattern of change over the three sessions; second, the Wilcoxon signed rank test was used to compare the mean rank scores for each item between pairs of sessions to test for significance. A p value of <0.05 was considered statistically significant.

RESULTS
A total of 129 students participated in the trauma simulation training from March 2011 to January 2012. Of these, 32 students were excluded from the study because they were absent for at least one of the sessions and the remaining 97 (75%) formed the study population.

The data from the median plots is presented first, followed by the data from the Wilcoxon signed rank test in the results, and both are also interpreted separately in the discussion.

Relative importance of stressors
The top three items causing maximum perceived stress were: (i) need to do well (item 2), (ii) feeling of incompetence in managing the patient (item 3) and (iii) death of the simulated patient (item 12). All these items had a median score of 3 or above, which was higher than the middle Likert value of 2 (Table I). The items that had the least stress score were: (i) conflict with other students
The Wilcoxon signed rank test was used to compare between session pairs (Table II). This compared the mean rank scores of each item across sessions for statistical significance. The interquartile box plots indicate the direction of the change.

**Comparison of pre-session and session 1 perceived stress scores**

The stress scores increased between pre-session and session 1 for some items, namely difficulty in understanding the content, need to do well, feeling of incompetence in managing the patient and death of the simulated patient. Significant decrease in perceived stress scores occurred for conflict with other students, poor motivation, fear of criticism from the facilitator, not knowing role in the team, and lack of appreciation by team members.

**Table I.** Item-wise analysis for perceived stress scores: Median Likert scores with interquartile range

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Pre-test</th>
<th>Post-test 1</th>
<th>Post-test 2</th>
<th>Post-test 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Difficulty in understanding the content</td>
<td>2 (1–2)</td>
<td>2 (1–3)</td>
<td>2 (1–2)</td>
<td>2 (1–2)</td>
</tr>
<tr>
<td>2</td>
<td>Need to do well (self-expectation)</td>
<td>3 (2–3.5)</td>
<td>3 (3–4)</td>
<td>3 (2–3)</td>
<td>3 (2–4)</td>
</tr>
<tr>
<td>3</td>
<td>Feeling of incompetence in managing the patient</td>
<td>3 (2–3)</td>
<td>3 (3–4)</td>
<td>3 (2–3)</td>
<td>3 (1.5–4)</td>
</tr>
<tr>
<td>4</td>
<td>Feeling compelled to participate in the scenario</td>
<td>2 (1–3)</td>
<td>2 (1–3)</td>
<td>2 (1–3)</td>
<td>2 (1–3)</td>
</tr>
<tr>
<td>5</td>
<td>Poor motivation to participate in the session</td>
<td>1 (0.5–2)</td>
<td>1 (1–2)</td>
<td>1 (0–2)</td>
<td>1 (0–2)</td>
</tr>
<tr>
<td>6</td>
<td>Competition with team members</td>
<td>2 (0.5–2)</td>
<td>2 (0.5–2)</td>
<td>1 (0–2)</td>
<td>1 (0–2)</td>
</tr>
<tr>
<td>7</td>
<td>Conflict with other students</td>
<td>1 (0.5–2)</td>
<td>1 (0–2)</td>
<td>1 (0–2)</td>
<td>1 (0–2)</td>
</tr>
<tr>
<td>8</td>
<td>Apprehension of criticism from the facilitator</td>
<td>2 (0–2)</td>
<td>1 (0–2)</td>
<td>1 (0–2)</td>
<td>1 (0–2)</td>
</tr>
<tr>
<td>9</td>
<td>Not knowing my role in the team</td>
<td>2 (2–3)</td>
<td>2 (1–3)</td>
<td>2 (1–3)</td>
<td>1 (1–3)</td>
</tr>
<tr>
<td>10</td>
<td>Lack of appreciation to my contribution in the team</td>
<td>2 (1–2)</td>
<td>1 (0–2)</td>
<td>1 (0–2)</td>
<td>1 (0–2)</td>
</tr>
<tr>
<td>11</td>
<td>Shortage of time during the training session</td>
<td>2 (2–3)</td>
<td>3 (2–3)</td>
<td>2 (1–3)</td>
<td>2 (1–3)</td>
</tr>
<tr>
<td>12</td>
<td>Death of the simulated patient</td>
<td>3 (2–4)</td>
<td>4 (3–4)</td>
<td>3 (2–4)</td>
<td>3 (3–4)</td>
</tr>
<tr>
<td>13</td>
<td>Participation in debriefing</td>
<td>1 (0.5–2)</td>
<td>2 (1–2)</td>
<td>1 (0–2)</td>
<td>1 (0–2)</td>
</tr>
</tbody>
</table>

Values in parentheses are interquartile range

**Table II.** Wilcoxon signed rank test results (Z score) for session-wise perceived stress scores

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Pre-session v. session 1</th>
<th>Session 1 v. session 2</th>
<th>Session 2 v. session 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Difficulty in understanding the content</td>
<td>-2.203 (0.028)*</td>
<td>-3.016 (0.003)*</td>
<td>-1.010 (0.313)</td>
</tr>
<tr>
<td>2</td>
<td>Need to do well (self-expectation)</td>
<td>-2.780 (0.005)*</td>
<td>-4.204 (0.0001)*</td>
<td>-1.411 (0.158)</td>
</tr>
<tr>
<td>3</td>
<td>Feeling of incompetence in managing the patient</td>
<td>-2.211 (0.027)*</td>
<td>-5.234 (0.0001)*</td>
<td>-0.759 (0.448)</td>
</tr>
<tr>
<td>4</td>
<td>Feeling compelled to participate in the scenario</td>
<td>-1.010 (0.312)</td>
<td>-1.725 (0.084)</td>
<td>-1.090 (0.276)</td>
</tr>
<tr>
<td>5</td>
<td>Poor motivation to participate in the session</td>
<td>-2.204 (0.028)*</td>
<td>-0.836 (0.403)</td>
<td>-0.107 (0.915)</td>
</tr>
<tr>
<td>6</td>
<td>Competition with team members</td>
<td>-0.124 (0.901)</td>
<td>-2.828 (0.005)*</td>
<td>-1.214 (0.225)</td>
</tr>
<tr>
<td>7</td>
<td>Conflict with other students</td>
<td>-2.291 (0.022)*</td>
<td>-1.561 (0.118)</td>
<td>-0.328 (0.743)</td>
</tr>
<tr>
<td>8</td>
<td>Apprehension of criticism from the facilitator</td>
<td>-2.811 (0.005)*</td>
<td>-0.810 (0.418)</td>
<td>-0.774 (0.439)</td>
</tr>
<tr>
<td>9</td>
<td>Not knowing my role in the team</td>
<td>-2.042 (0.041)*</td>
<td>-2.997 (0.003)*</td>
<td>-0.816 (0.415)</td>
</tr>
<tr>
<td>10</td>
<td>Lack of appreciation to my contribution in the team</td>
<td>-2.858 (0.004)*</td>
<td>-1.287 (0.198)</td>
<td>-0.155 (0.877)</td>
</tr>
<tr>
<td>11</td>
<td>Shortage of time during the training session</td>
<td>-1.890 (0.059)</td>
<td>-5.221 (0.0001)*</td>
<td>-1.015 (0.310)</td>
</tr>
<tr>
<td>12</td>
<td>Death of the simulated patient</td>
<td>-1.992 (0.046)*</td>
<td>-3.778 (0.0001)*</td>
<td>-2.954 (0.003)*</td>
</tr>
<tr>
<td>13</td>
<td>Participation in debriefing</td>
<td>-1.157 (0.247)</td>
<td>-2.197 (0.028)*</td>
<td>-0.595 (0.552)</td>
</tr>
</tbody>
</table>

Values in parentheses are p values  * indicates significant p values

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**Fig 2.** Median score stacked graphs for each item session-wise
FIG 3. Box plots of perceived stress score for each item session-wise showing median and interquartile range (n=97)
Comparison of session 1 and session 2 perceived stress scores

When the perceived stress scores of session 1 were compared with the scores of session 2, all items showed a decrease in stress levels, with 8 of 13 items showing a significant reduction in stress scores.

Comparison of session 2 and session 3 scores

Comparison of perceived stress scores between the end of session 2 and session 3 showed that there was no change for all items except death of the simulated patient, where the score increased significantly.

DISCUSSION

Learner stress has been well documented in a variety of simulation settings. Many articles have documented this stress by various means such as a self-administered questionnaire, measurement of participants’ physiological data (pulse, blood pressure, etc.) or measurement of biochemical stress markers (cortisol and salivary amylase). These studies have mainly documented the presence of stress in trainees, but have not attempted to identify the causes of this stress. How this stress changes over repeated simulation sessions is also unclear. LeBlanc, in a review of effects of acute stress on performance, concluded that more research is required in this area to better understand the contributions of these factors to performance under stress and to effectively prepare trainees to participate in this area to better understand the contributions of these factors to performance under stress and to effectively prepare trainees to participate in the simulation experience.

Relative importance of stressors

Of the items studied in the stress questionnaire, it was found that students perceived relatively more stress because of the need to do well, and their feeling of incompetence to manage the patient. This suggests that the participants, who had limited or no practical experience in trauma management, were stressed because of their self-perceived lack of practical skills. ‘Poor motivation to participate’ showed a low median perceived stress score of only 1 across the sessions. Simulation thus seems to encourage students to ‘get their hands dirty’ by active participation. We believe that this would directly translate into better learning outcomes. Death of the simulated patient scored the highest of all stressors, underlining the realism of the simulation experience. Since issues related to death were not a learning outcome in our programme, the persistence of high perceived stress scores for this item across all three sessions may have hindered the students from achieving the trauma team training learning outcomes; and so we suggest that for undergraduate medical students it may be better not to allow the simulated patient to die if dealing with death issues is not part of the learning outcomes.

As stated in the results, we obtained three distinct types of graphs when the median scores across sessions were plotted for each item. All the perceived stressor items dealing with intrapsychic factors, i.e. factors relating to the participants’ internal feelings and knowledge (items 1 to 5) showed a ‘flat line’ type of graph, indicating no change in the median score for these factors across sessions.

All the items relating to interpersonal relations between team members and facilitator showed one of two types of graph in the median score plots. Item 7 (conflict with other students), that started with a low median score of 1 stayed low and flat; suggesting that this item was not perceived as major causes of stress. For items that started with a higher median score (6, 8, 9 and 10: ‘competition with team members’, ‘apprehension of criticism from facilitator’, ‘not knowing my role in the team’, and ‘lack of appreciation to my team contribution’) the graph sloped down and flattened out at a median score of 1, indicating to us that though students rated them high initially, after experiencing the simulation session(s) they felt comfortable in their interpersonal relationship and the perceived stress scores came down.

The third type of median score plot was seen for all the items relating to interactive factors (actual performance in the simulation sessions) (items 11, 12 and 13, namely ‘shortage of time’, ‘death of the simulated patient’, and ‘participating in debriefing’). This graph showed an increase in median scores from the pre-session scores to session 1 scores and thereafter a drop to session 2 scores, which then remained low in the session 3 scores. This suggests that after the theory briefing the students felt confident of their ability to manage the simulated trauma patient, thus explaining the low initial stress scores. However, after they experienced the practical difficulty of trauma management during the first simulation session, they realized that knowledge of theory does not translate into an ability to practically manage a patient and their confidence level dropped, as evinced by the higher perceived stress scores after the first simulation session. The participants performed much better during the second simulation session based on their prior experience and debrief, leading to a drop in stress levels, which stayed the same for the third session. This implies that stress due to interactive factors tends to even out after two simulation sessions, by which time the students get comfortable with the process.

Statistical comparison of stressor scores session-wise (Wilcoxon signed rank test)

Perceived stress scores for most of the intrapsychic factors (difficulty in understanding the content, need to do well, feeling of incompetence in managing the patient and death of the simulated patient) increased from the pre-session to the session 1 questionnaire. Death of the simulated patient also showed a similar pattern. We infer that these students who had no prior experience of simulation did not anticipate stress for these items before their simulation experience, but after their exposure, they perceived these items to cause stress. The scores that decreased from the pre-session questionnaire to the session 1 questionnaire related to interpersonal factors (interaction of the participants with their peers and facilitators). This suggests that before any

Key points

- Trauma simulation appears to cause stress in medical students
- These can be categorized as intrapsychic, interpersonal and interactive; stressor scores in each category show different patterns of change over sessions.
- Perceived stress scores in all items except simulated patient death plateau at a lower level after two sessions, suggesting that students get used to these stressors with experience.
- Simulated patient death scores high as a stressor even after three sessions and should therefore be avoided if not part of the learning outcomes.
experience of simulation, the students were probably unsure of how they would perform in relation to their peers and in front of the facilitator, but after the first session, they felt comfortable with their role in the team and with the supervision of the facilitator. It has been suggested that judgement by others is a barrier to simulation training but our findings indicate that this is a factor only before the hands-on training and it ceases to be a factor after the students actually participate in, and become familiar with, the scenario. Reduction in perceived stress scores was seen in 8 of the 13 items from session 1 to session 2, supporting the need to repeat the simulation session at least once for students to become comfortable with participating in the scenario.

When the perceived stress scores after session 2 were compared with the scores after session 3, except for death of the simulated patient none of the other items showed a significant increase. Thus, we can infer that perceived stress related to all the items except death of the simulated patient tends to plateau out after the second simulation session. This observation is also supported by another study, which showed that learning by repetition of sessions could be effective in preparing trainees for performance under stressful conditions.

An earlier study has shown that cognitive appraisals of a situation by participants to determine the ratio of demands to resources appear to play an important role in determining stress responses. Our study suggests that simulation participants do get more comfortable with the simulation with repetition resulting in reduction of perceived stress score, perhaps by becoming better at cognitive appraisal through experience. This finding reinforces the need for repetition of sessions when using simulation training.

However, stress related to patient outcome in terms of death of a patient still scored high, even after two repetitions, when most of the other perceived stressor scores had evened out at lower levels. It appears that trainees may not come to terms with poor patient outcomes even after three sessions. This may affect learning outcomes especially if resuscitation is not one of them. Therefore, we suggest that such adverse patient outcomes be avoided during simulation sessions for this subset of trainees. This observation is supported by Leighton, who studied student feelings to death of the simulated patient.

Conclusion
We have explored the relative importance of causes of perceived stress in undergraduate medical students undergoing trauma simulation training and the change in these stress levels over repeated simulation sessions; to the best of our knowledge these aspects have not been studied so far. We found that undergraduate medical trainees experienced stress due to various factors during their first simulation session, which reduced with repeated sessions. However, perceived stress related to the simulated death of a patient continued to remain high even after two repetitions. We suggest that in simulation training programmes for undergraduate medical students, there should be at least one repeat session to reduce the stress and that the facilitators should consider keeping the simulated patient alive throughout the training sessions. This study has limitations: first, this was a single-centre study; second, perceived stress score reduction over the longer term (>3 weeks) was not studied; and third, it is still unclear whether this perceived stress translates into poorer performance, both in the simulation setting and in a real setting.

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Funding. None

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