Does TeamSTEPPS affect psychological status?

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Structured Abstract:
Purpose: The Team Strategies and Tools to Enhance Performance and Patient Safety (TeamSTEPPS) program is known to improve team and clinical performance, but the relationship to psychological stress has not been clarified. The authors evaluated team performance, clinical performance, and psychological stress simultaneously in a simulation-based training combined with or without the TeamSTEPPS program.

Design/methodology/approach: This randomized, controlled, prospective pilot study was performed to reveal the impact of TeamSTEPPS on psychological stress. The course included an emergency care training course, the TeamSTEPPS program, and a scenario simulation. Ten medical student teams were randomly allocated into two groups: a TeamSTEPPS group and a non-TeamSTEPPS group. Team performance, clinical performance, and psychological stress were evaluated simultaneously in the course i.e., a questionnaire evaluation and an observational evaluation for team performance; an assessor’s evaluation and a simulator’s evaluation for clinical performance. Autonomic nervous activity, represented by salivary amylase levels and heart rate variability (HRV), were measured as psychological stress indicators.

Findings: Team performance and clinical performance were significantly better in the TeamSTEPPS group, while psychological stress did not differ between the groups.

Originality/value: This is the first report that examined the relationship between TeamSTEPPS and psychological stress. Although only preliminary conclusions can be drawn from this small-scale study, the result suggests the TeamSTEPPS program improved team performance and clinical performance without increasing psychological stress.

Keywords: Education, Teamwork, Stress, Patient simulation, Cardiopulmonary Resuscitation, Emergency care.

Article Classification: Research

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Introduction
The Institute of Medicine released a report on quality improvement and patient safety in 2000 (Kohn et al., 2000), which highlighted a need to establish training programs for healthcare teams and to adopt simulation-based training methods. Based on this proposal, the Agency for Healthcare Research and Quality, in collaboration with the U.S. Department of Defence, released the Team Strategies and Tools to Enhance Performance and Patient Safety (TeamSTEPPS) program as the national standard for healthcare team training programs in the USA (King et al., 2008). Since then, the TeamSTEPPS program has been used in various settings. Simultaneously, simulation-based training has become widely incorporated into student and post-graduate education (Okuda et al., 2009), and the TeamSTEPPS program has been combined with simulation-based training. Under these circumstances, TeamSTEPPS program evaluations have been performed using various methods. Popular TeamSTEPPS program impacts are based on questionnaire surveys and rating sheets, such as the Teamwork Attitudes Questionnaire (T-TAQ) and the TeamSTEPPS Team Performance Observation Tool (TPOT). Validation studies using these evaluation methods have repeatedly reported favorable simulation-based training effects combined with the TeamSTEPPS program (Brock et al., 2013; Sawyer et al., 2013; Robertson et al., 2010). Though the TeamSTEPPS program is known to improve team performance and, consequently, leads to improved clinical performance, TeamSTEPPS program’s influence on psychological stress hasn’t been clarified (Schmutz and Manser, 2013). Studies have examined the relationship between psychological stress and team performance (Driskell et al., 1999), and some reported the relationship between psychological stress and clinical performance (LeBlanc, 2009; Hunziker et al., 2011; Bjorshol et al., 2011; LeBlanc et al., 2008). However, results are inconsistent, and only a few studies examine the interrelations among these three factors. Wetzel et al., (2011) evaluated stress management intervention for surgeons, and they measured teamwork, stress, and technical skills. Ghazali et al., (2016) suggested a study protocol that evaluated clinical performance, team performance, and stress repeated simulation sessions. The literature on these three factors is poor, thus the interrelations has not been clarified. Autonomic nervous activity is a popular psychological stress indicator (Oken et al., 2015; Bosch et al., 2003), and salivary amylase level (Nater and Rohleder, 2009) and heart rate variability (HRV) (Thayer et al., 2012) are two popular indicators. We evaluated the team members’ psychological stress levels during their participation in the TeamSTEPPS program by measuring these parameters.

Methods
Definitions
We defined ‘team performance’ and ‘clinical performance’ as two elements constituting the ‘cardiopulmonary resuscitation (CPR) response capability’. ‘Team performance’ indicates non-technical skills, represented by teamwork and leadership, while ‘clinical performance’ indicates technical skills, represented by medical examination skills and CPR skills (Figure 1).

Figure 1 here

Setting/subjects
This study was undertaken at the simulation center at our institution between September and December 2014. In total, 33 fifth-year medical students participated. Each team consisted of three to four students, and we conducted training for one team per week. Ten teams participated. Participants were consecutive students performing rounds in the Department of Emergency and
Disaster Medicine. To eliminate selection bias, students were randomly allocated to a team. All had completed the Basic Life Support course while they were in their medical school fourth year.

Course design
Before participating in the course, all students completed the pre-training test which aimed to check their CPR knowledge. Additionally, the participants’ medical seminar attendance history was investigated. Participants were also given a test containing 35 true-or-false questions to evaluate their emergency medicine basic knowledge. All teams participated in a three–hour emergency care training course. Course content included the primary ABCD survey (Airway, Breathing, Circulation, and central nervous system Dysfunction), the SAMPLE history assessment (Symptoms, Allergies, Medications, Past medical history, Last oral intake, Events leading to incident), the OPQRST assessment (event Onset, Provocation or palliation, Quality [description] of pain, Region and radiation, Severity, Time course), the secondary ABCD survey (Airway, Breathing, Circulation, and Differential diagnosis), and cardiopulmonary arrest (CPA) management. The course included didactic and simulation sessions using a patient simulator (ALS Simulator®; Laerdal Medical Inc.). Five teams participated in a three-hour TeamSTEPPS program. The TeamSTEPPS key principles were identified as: Team Structure, Communication, Leadership, Situation Monitoring, and Mutual Support through the didactic session. During the TeamSTEPPS program, instruction focused on team performance and not clinical performance. At the end of the course, all teams participated in a scenario simulation using a patient simulator (Resusci Anne®, QCPR®, and SimPad®; Laerdal Medical Inc.). The scenario was as follows: a patient experienced chest pain while in the hospital. Participants performed the primary ABCD survey, checked his medical history, performed the secondary ABCD survey, and called for a senior doctor. Subsequently, the patient experienced CPA, and the participants were required to perform advanced life support.

Evaluating team performance
The T-TAQ was used to evaluate teamwork attitudes. All participants completed a questionnaire before and after the course to evaluate changes in their attitudes toward teamwork. The 30 item T-TAQ is a five-grade Likert-type scale with ratings from 1 to 5 and was used to evaluate teamwork skills. The 23 item TPOT is a five-grade Likert-type scale with ratings from 1 to 5.

Evaluating clinical performance
Activity during the emergency care scenario was observed, and the participants’ medical examination skills were evaluated by an assessor using rating sheets (Table I). The assessor was not notified whether the group is a TeamSTEPPS attendance group or not. Each item was graded: ‘unexecuted’, 0; ‘imperfectly executed’, 1; and ‘executed perfectly and timely’, 2. The rating sheets included 20 questions on medical examination skills: (1) primary ABCD survey; (2) O2–IV–monitor; (3–8) SAMPLE history assessment; (9–14) OPQRST assessment; (15) secondary ABCD survey; (16) search for underlying causes; and (17–20) CPA management (assess responsiveness, check pulse within ten seconds, rotate compressor every two minutes, adrenaline dose every 3-5 minutes).

Table I here
The CPR skills were evaluated in each group using Resusci Anne®, QCPR® and SimPad® (Laerdal Medical Inc.). The evaluation items were: chest compression fraction (CCF) rate (%); correct hand position during chest compression (%); average chest compression depth (mm); full chest recoil rate (%); sufficient chest compression rate (%); proportion of adequate chest compressions rate (%); average chest compressions rate (/min); average ventilation volume (mL); time from CPA until CPR start (min); and proper ventilation volume rate (%).

**Evaluating psychological stress**
Salivary amylase level was measured using a portable monitor (Nipro Co., Japan). Levels were measured before and after the emergency care scenario. We performed HRV measurement twice every five minutes for the team leader using Check My Heart® (DailyCare BioMedical Inc., Taiwan, Japanese Marketing Approval Holder: TRYTECH Co., Ltd., Japan). Measurement before the emergency care scenario was performed while the subject was at rest and sitting in a chair. During measurement performed immediately after the start of the emergency care scenario, the leader could remain standing but was forbidden to move and was only allowed to give verbal instructions to the team. The change in low frequency (LF) to high frequency (HF) ratio was used as HRV.

**Statistical analysis**
For the pre-training test and the demographics survey, we used the Fisher exact test and the student t-test to compare the two groups. The Wilcoxon rank sum test was used to compare two independent groups, and the Wilcoxon signed-rank test was used to test for differences between paired observations. All values were reported as the mean ± SE, where applicable, and all statistical tests were two-tailed, with \( p < 0.05 \) considered statistically significant. All other analyses were performed using JMP for Macintosh, version 9 (SAS Institute Inc.).

**Ethical approval**
All protocols were approved by our institution’s ethics committee (date: August 4, 2014; number 14-047). Written informed consent was obtained from all participants.

**Results**
**Demographics and pre-training test**
Thirty-three participants participated in this study: 16 in the TeamSTEPPS non-attendance group, and 17 in the TeamSTEPPS attendance group. Participants age (mean ± sd) was 23.1 ± 0.8 years for the TeamSTEPPS non-attendance group and 23.8 ± 1.4 years for the TeamSTEPPS attendance group (\( p = 0.09 \)). Significant differences in previously attended medical seminars and the pre-training test scores were not seen between the two groups.

**Team performance**
Significant differences in the average before-training and after-training scores for each T-TAQ question were not seen in the TeamSTEPPS non-attendance group. After-training score was significantly higher than before-training score in the TeamSTEPPS attendance group (\( p < 0.01 \)) (Figure 2A). The average score for each TPOT question was significantly higher in the TeamSTEPPS attendance group than in the TeamSTEPPS non-attendance group (\( p = 0.01 \)) (Figure 2B).
Clinical performance
The average score for each item on the rating sheet for medical examination skills was significantly higher in the TeamSTEPPS attendance group than in the TeamSTEPPS non-attendance group ($p = 0.01$) (Figure 2C). The TeamSTEPPS attendance group’s CPR skills scores were significantly higher than the non-attendance group (Table II). Four items showed significant differences between the two groups: chest compression depth ($p = 0.03$), full chest recoil ($p = 0.01$), sufficient chest compression ($p = 0.01$), and time from CPA until CPR start ($p = 0.05$). One TeamSTEPPS non-attendance group began CPR immediately after observing a monitor change without checking pulse or respiration, and the data for this group was excluded from ‘time from CPA until CPR start’.

Table II here
Psychological stress
No significant differences in the average salivary amylase levels and the LF/HF scores were observed between the TeamSTEPPS attendance group and the non-attendance group (Figure 3A, 3B).

Discussion
Crew Resource Management (CRM) was first used in the aviation field in the late 1970s to improve nontechnical skills, such as team training, and was adapted to healthcare for medical error and patient safety team training, eventually spreading to anesthesiology and surgery (Vincent, 2011). Given this background, accumulated evidence regarding team training in the medical field has been less than that available for other fields, and little is known about team training effect on psychological stress (LeBlanc, 2009). Therefore, we attempted to evaluate participants’ psychological stress. The salivary amylase level and HRV were selected as physiological stress indicators. However, significant changes in these indicators were not observed. This result suggested that the TeamSTEPPS program had no influence on the autonomic nervous activity, and we concluded that the TeamSTEPPS program improved team performance and clinical performance without increasing psychological stress.

Several aviation studies in consistently report that CRM affects psychological stress levels (Salas et al., 2001). Team training did not affect psychological stress in our study. One reason for this difference might be the difference in the backgrounds. While aviation accidents are infrequent, they are highly visible and tend to cause massive fatalities. After an accident, strict measures are taken, including thoroughly investigating causal factors, official reports and corrective actions. Medical adverse events occur on an individual basis, and many are not reported or revealed to the public. Furthermore, there is no standardized investigation or documentation (Helmreich, 2000; Thomas et al., 2003). A previous study indicated that medical staff and cockpit crews have different backgrounds, and their stress, fatigue and teamwork perceptions also differ (Sexton et al., 2000). Although the detailed mechanism is unknown, these differences might have led to the different results for different fields. Our study suggested that the TeamSTEPPS program had no effect on psychological stress.
Limitations

Our study had limitations. First, participant numbers were limited, and we might not obtain definitive results. Second, we only measured two indicators regarding autonomic nervous activity. In some physiology studies, the psychological stress profile is evaluated using a surface electromyogram (SEMG), electrodermal activity (EDA), skin temperature (TEMP), blood volume pulse (BVP), respiration (RESP), and an electroencephalogram (EEG). The indicators that we used in might not have been appropriate for psychological stress evaluation. Future studies should use other indicators. Third, the blind procedure might have been unreliable. The assessor who evaluated the TPOT and the clinical performance was not notified whether the group is a TeamSTEPPS attendance group or not. However, the assessor must have discovered it unconsciously during the course of the evaluation. For example, if the items showed good results at the early stage of evaluation, the assessor might identify that the team is TeamSTEPPS attendance group at that time. Hence, a selection bias can occur and might cause improvement of the team’s total score. Lastly, the study protocol might have been problematic. Regarding salivary amylase level and HRV measurement, timing might have been inappropriate. Salivary amylase levels were measured only before and after the emergency care scenarios. Salivary amylase level changes in a short period (Takai et al., 2004); thus, we should measure this parameter more often throughout the simulation. As for HRV, participants were examined while in a standing position and were allowed to give oral instructions. Ideally, however, HRV should be measured while the subject is supine or sitting with keeping a calm as changes in body position have an impact on HRV (Lipsitz et al., 1990; Pomeranz et al., 1985). In our study, since no change was observed in salivary amylase level or HRV, we concluded that autonomic nervous activity was not influenced by the TeamSTEPPS program. However, a larger and more sophisticated study is needed to confirm the current results.

Conclusions and recommendations

We examined TeamSTEPPS program effect on psychological stress during CPR. The TeamSTEPPS program was thought to improve team and clinical performance without affecting autonomic nervous activity negatively. Although a larger and more sophisticated study is needed to confirm the current results, we recommend that a simulation-based training should be combined with the TeamSTEPPS program.

References


Table 1: Clinical performance (medical examinations skills)

<table>
<thead>
<tr>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary ABCD survey and O2–IV–monitor</strong></td>
</tr>
<tr>
<td>1. primary ABCD survey</td>
</tr>
<tr>
<td>2. O2–IV–monitor</td>
</tr>
<tr>
<td><strong>SAMPLE history assessment</strong></td>
</tr>
<tr>
<td>3. symptoms</td>
</tr>
<tr>
<td>4. allergies</td>
</tr>
<tr>
<td>5. medications</td>
</tr>
<tr>
<td>6. past medical history</td>
</tr>
<tr>
<td>7. last oral intake</td>
</tr>
<tr>
<td>8. events leading to incident</td>
</tr>
<tr>
<td><strong>OPQRST assessment</strong></td>
</tr>
<tr>
<td>9. onset of the event</td>
</tr>
</tbody>
</table>
10. provocation or palliation
11. quantity of the pain
12. region and radiation
13. severity
14. time course

Secondary ABCD survey
15. secondary ABCD survey
16. search for underlying causes

CPA management
17. assess responsiveness
18. check pulse within ten seconds
19. rotate compressor every two minutes
20. adrenaline doses every 3–5 minutes

Notes: Each item was graded as follows: ‘unexecuted’, 0; ‘imperfectly executed’, 1; and ‘executed perfectly and timely’, 2.

Table II: Clinical performance (CPR skills)

<table>
<thead>
<tr>
<th></th>
<th>TeamSTEPPS (-) Median (IQR)</th>
<th>TeamSTEPPS (+) Median (IQR)</th>
<th>P Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest Compression Fraction (%)</td>
<td>74.4 (52.1–75.8)</td>
<td>71.0 (61.5–80.0)</td>
<td>1.00</td>
</tr>
<tr>
<td>Correct hand position</td>
<td>(%)</td>
<td>(%)</td>
<td></td>
</tr>
<tr>
<td>during chest compression</td>
<td>100.0 (56.0–100.0)</td>
<td>100.0 (83.0–100.0)</td>
<td>0.80</td>
</tr>
<tr>
<td>Average depth of chest</td>
<td>(mm)</td>
<td>(mm)</td>
<td></td>
</tr>
<tr>
<td>compression</td>
<td>42.0 (32.0–50.0)</td>
<td>58.0 (56.0–61.0)</td>
<td>0.03†</td>
</tr>
<tr>
<td>Full chest recoil rate (%)</td>
<td>72.0 (21.5–95.5)</td>
<td>98.0 (97.5–100.0)</td>
<td>0.01†</td>
</tr>
<tr>
<td>Rate of sufficient chest</td>
<td>(%)</td>
<td>(%)</td>
<td></td>
</tr>
<tr>
<td>compression (%)</td>
<td>6.0 (4.5–46.0)</td>
<td>96.0 (88.0–99.5)</td>
<td>0.01†</td>
</tr>
<tr>
<td>Proportion of adequate chest</td>
<td>(%)</td>
<td>(%)</td>
<td></td>
</tr>
<tr>
<td>compressions rate (%)</td>
<td>52.0 (21.0–59.5)</td>
<td>3.0 (2.0–71.0)</td>
<td>1.00</td>
</tr>
<tr>
<td>Average chest compression rate</td>
<td>(1/min)</td>
<td>(1/min)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>120.0 (118.5–132.0)</td>
<td>125.0 (118.5–134.0)</td>
<td>0.68</td>
</tr>
<tr>
<td>Average ventilation volume</td>
<td>(mL)</td>
<td>(mL)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>387.0 (114.0–444.5)</td>
<td>442.0 (339.0–472.0)</td>
<td>0.40</td>
</tr>
<tr>
<td>Proper ventilation volume (%)</td>
<td>(%)</td>
<td>(%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>50.0 (11.0–74.0)</td>
<td>57.0 (21.5–81.0)</td>
<td>0.68</td>
</tr>
<tr>
<td>Time from CPA until CPR start</td>
<td>(s)</td>
<td>(s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>63.0 (41.0–75.3)</td>
<td>30.0 (24.0–36.0)</td>
<td>0.05†</td>
</tr>
</tbody>
</table>
Notes: IQR, interquartile range; CPR, cardiopulmonary resuscitation; CPA, cardiopulmonary arrest
* Wilcoxon rank sum test
† $p < 0.05$
‡ Data from groups in which CPR was started immediately after the monitor change (without checking the pulse) were excluded.

Figure 1: Definitions

CPR RESPONSE CAPABILITY

TEAM PERFORMANCE
i) T-TAQ: questionnaire evaluation (teamwork attitudes)
ii) TPOT: observational evaluation (teamwork skills)

While team performance improves clinical performance, the means by which team performance improves clinical performance remain unclear.

CLINICAL PERFORMANCE
i) assessor’s evaluation (medical examination skills)
ii) simulator’s evaluation (CPR skills)

Notes: We defined ‘team performance’ and ‘clinical performance’ as two elements constituting ‘CPR response capability’. Team performance was evaluated using T-TAQ and the TPOT. Clinical performance was evaluated using assessor and simulator’s evaluations. Psychological stress was evaluated using salivary amylase level and HRV.

Figure 2: Team performance and clinical performance
Notes: A) The T-TAQ evaluation (Wilcoxon signed rank test). B) The TPOT evaluation (Wilcoxon rank sum test). C) clinical performance (Wilcoxon rank sum test).

Figure 3: Physiological stress.
Notes: A) salivary amylase levels (Wilcoxon signed rank test). B) LF/HF scores (Wilcoxon signed rank test).