Original Research Article

DEVELOPING AN EFFECTIVE TEAM-BASED EMERGENCY TRAINING PROGRAM FOR MEDICAL STUDENTS

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ABSTRACT

Introduction: Team-based patient management in critical care demands a knowledgeable, skillful, and responsive doctor who collaborates well on teams. Medical education is responsible for producing competent graduates who meet the above requirements. However, the current medical curriculum in Indonesia tends to focus only on individual knowledge and appraisal. There was no standardized university-based group emergency training and examination with comprehensive emergency topics beyond cardiac and trauma cases. **Objective:** This study aimed to develop and evaluate a team-based emergency training program that enhances medical students' preparedness and teamwork skills in dealing with future emergencies in the workplace. **Methods:** We developed Acute Life Threatening Events Management (ALTEM), a three-day emergency training program consisting of pre-test, lectures, guided skill practice, group (case-based) simulation exam, and post-test. Group simulation occurred in a virtual hospital with high-fidelity mannequins, actual medical equipment (i.e., beds, monitors, drugs, tools, pads), two-way mirror rooms, and simulated patient family to resemble real hospital situations. The program was then evaluated by a modified Kirkpatrick evaluation model, which measures individual perception, satisfaction, understanding, and performance related to the program. **Results:** A total of 114 participants were involved in this study. Most subjects (>80%) had a good experience with the program. ALTEM training program significantly increased communication and teamwork (p <0.001) and decision-making towards critical patients (p <0.001) in the univariate analysis. Communication and teamwork remained related considerably in the multivariate analysis (aOR 7.866; p = 0.005). **Conclusion:** The ALTEM simulation program obtained a good response from the subjects and was a prospective program to improve medical students' competence and teamwork skills in emergencies.

Keywords: ALTEM; Critical Care Training; Education Policy; Emergency Medical Training; Health Emergency Preparedness; Health System; Medical Education

ABSTRAK

Pendahuluan: Manajemen pasien kritis berbasis tim membutuhkan dokter yang berpengetahuan luas, terampil, dan responsif serta dapat bekerja baik dalam tim. Pendidikan kedokteran bertanggung jawab dalam menghasilkan lulusan kompeten yang memenuhi standar tersebut. Akan tetapi, kurikulum pendidikan kedokteran saat ini cenderung hanya berfokus pada pengetahuan dan penilaian secara individu. Belum ada pelatihan dan ujian kegawatdaruratan terstandar dari universitas yang berisi topik kegawatdaruratan secara komprehensif, lebih dari kasus jantung dan trauma. **Tujuan:** Penelitian ini bertujuan mengembangkan dan mengevaluasi program pelatihan kegawatdaruratan berbasis tim yang meningkatkan kesiapan dan keterampilan kerjasama tim mahasiswa kedokteran dalam menangani kasus kegawatdaruratan di tempat kerja yang akan datang. **Metode:** Kami mengembangkan *Acute Life Threatening Events Management* (ALTEM), program pelatihan kegawatdaruratan berdurasi tiga hari yang berisi *pre-test*, kuliah, latihan keterampilan terbimbing, ujian simulasi kelompok (berbasis kasus), dan *post-test*. Simulasi kelompok dilaksanakan di rumah sakit virtual dengan manekin berteknologi tinggi, peralatan medis (tempat tidur, monitor, obat, peralatan), ruangan dengan cermin dua arah, dan keluarga pasien simulasi agar menyerupai situasi nyata di rumah sakit. Program tersebut kemudian dievaluasi dengan modifikasi model evaluasi Kirkpatrick, yang mengukur persepsi, kepuasan, pemahaman, dan performa subjek terhadap program. **Hasil:** Sebanyak total 114 subjek berpartisipasi dalam penelitian ini. Sebagian besar subjek (>80%) memiliki pengalaman yang baik terhadap program. Program ALTEM secara signifikan meningkatkan keterampilan komunikasi dan kerjasama tim (p<0,001) serta kemampuan pengambilan keputusan (p<0,001) dalam analisis univariat. Keterampilan komunikasi dan kerjasama tim tetap memiliki hubungan signifikan dalam analisis multivariat (aOR 7,866; p = 0,005). **Kesimpulan:** ALTEM memperoleh respon yang baik dari subjek dan merupakan program dengan prospek baik yang dapat menunjuang kompetensi lulusan kedokteran di bidang kegawatdaruratan.

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INTRODUCTION

Critical care is a complex management requiring multidisciplinary collaboration, various life-saving procedures, and rapid team response. Emergency care should be done cautiously and swiftly because any delay or incorrect action could compromise patient safety. Hard skills (i.e., knowledge, practical skills) and soft skills (i.e., leadership, communication, teamwork, and decision-making) are essential to good patient care (1–3).

Patient safety is a crucial indicator of healthcare quality and is the responsibility of all stakeholders, including medical education. Medical education is vital in introducing and cultivating hard and soft skills as early as possible. Medical faculties are also responsible for producing competent doctors and the capacity to work in teams because teams manage patients in hospitals. However, medical education, including in our university, tends only to appraise knowledge and individual performance. Furthermore, medical students are not specifically trained to be leaders or collaborators, whereas doctors are leaders and collaborators in patient care. These phenomena could lead to medical students' unpreparedness in real emergencies (1–3).

Simulation is one of the strategies in medical education to increase patient safety. The simulation-based education system is proven to be better than the conventional education system, especially education for critically ill patients due to advanced medical conditions and requires rapid resuscitative effort (1–3). There were several training courses, such as Advanced Cardiac Life Support (ACLS) and Advanced Trauma Life Support (ATLS). However, in Indonesia, those programs were completed by individuals separately after they finished the government medical internship program, which was a year after graduating from the university, making medical faculties unable to assess the group performance of the medical students, including their responsiveness in emergencies.

In emergency medical care, the importance of a standardized protocol and comprehensive training cannot be overstated (4,5). WHO Global Health Estimates for 2019 stated that stroke was the leading cause of mortality, followed closely by ischemic heart disease, tuberculosis, neonatal conditions, diabetes mellitus, cirrhosis of the liver, diarrheal disease, Chronic Obstructive Pulmonary Disease (COPD), lower respiratory infections, and HIV/AIDS (6). Remarkably, the existing training programs, such as Advanced Trauma Life Support (ATLS) and Advanced Cardiac Life Support (ACLS), inadequately address this spectrum of life-threatening conditions because they focus on cardiac and trauma management, respectively. The need for a comprehensive, all-encompassing emergency standardized protocol and training becomes evident, aiming to bridge the gap in addressing critical conditions associated with those top leading causes of mortality.

Recognizing the imperative to address the deficiencies in existing emergency training, we have developed a new initiative, the Acute Life Threatening Events Management, at our institution, Universitas Gadjah Mada. This pilot training and study have been meticulously

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designed to fill the void in management protocols for critical or life-threatening conditions associated with the leading causes of mortality identified in Indonesia and other diverse medical emergencies.

This program is a practical response to our institution's urgent healthcare needs and is a blueprint for a nationwide solution. Understanding that these critical conditions transcend regional boundaries, we aspire to catalyze a broader impact by envisioning the integration of this training and study at a national level. The ultimate goal is to empower healthcare providers across the country with the knowledge and skills necessary to effectively manage acute life-threatening events associated with the prevalent causes of mortality. By fostering a culture of preparedness and responsiveness, we hope to contribute significantly to reducing the alarming mortality rates attributed to these conditions nationwide. The Acute Life Threatening Events Management initiative at Universitas Gadjah Mada signifies a localized effort and a visionary step towards enhancing emergency medical care across Indonesia.

METHODS

Program Development

Acute Life Threatening Events Management (ALTEM) is a simulation-based training program designed by the Department of Anesthesiology and Intensive Therapy, Gadjah Mada University / Dr. Sardjito General Hospital, Indonesia. This 3-day course (total: 30 hours) was incorporated into the medical curriculum, and the participants were trained directly by anesthesiologists from Dr. Sardjito General Hospital. The program was done periodically 4-5 times a year. Each class consisted of 30-50 participants.

A few days before the program, each participant was handed a t-shirt and manual book comprising more comprehensive topics, ranging from cardiorespiratory emergency management to emergency in neurology and internal medicine, such as acute liver failure and seizures. The manual book was written by the Department of Anesthesiology and Intensive Therapy of Gadjah Mada University.

ALTEM combines theory, practice, and exams, consisting of a pre-test, lectures, guided skill practice, group (case-based) simulation, and post-test (7).

1. Individual pre-test

The individual pre-test consisted of 20 multiple-choice choices about emergency management. This study did not collect the pre-test results of the participants.

2. Refreshment lectures

The anesthesiologists and lecturers of Dr. Sardjito General Hospital / Faculty of Medicine, Gadjah Mada University, presented lectures. Fifteen topics were presented in 3 days. The topics were (7):

a. Emergency Airway-Breathing Management
b. Management of Patients with Respiratory Distress
c. Early Detection and Principle of Management of Critical Patients
d. Rapid Sequence Intubation and Intubation Technique in Critical Patients
e. Oxygen Therapy and Ventilation
f. Critical Patient Monitoring
g. Management of Patients with Circulatory Problems and Vasoactive Drugs Usage
h. Management of Patients with Cardiac Arrest
i. Management of Patients with Arrhythmia
j. Management of Seizure and Decrease of Consciousness
k. Pain and Sedation Management in Critical Patients
l. Critical Patient Management System in the Hospital

m. Hemorrhagic Shock
n. Blood Gas Analysis in Critical Patients
o. Distributive Shock (Sepsis and Anaphylactic Shock)

Each session lasted 40 minutes, with a 30-minute coffee break to maintain the participants' focus. Five topics were given on the first day, six topics on the second day, and the rest on the last day (7).

3. Guided-skill group practice

The event divided participants into six small groups. There were three skill stations, and one room comprised two small groups. Each room has medical equipment and one instructor. The instructors are Dr. Sardjito General Hospital anesthesiologists and lecturers at the Faculty of Medicine, Gadjah Mada University. Every group did a role-play to perform team-based critical care management. The group roles were leader, airway and breathing manager, circulator, and drugs and documentation handler. After finishing one station, each group will rotate to the next room and perform different cases. The cases were (7):

a. Management of Patients with Respiratory Distress
b. Oxygen Therapy and Ventilation
c. Management of Patients with Circulatory Problems and Vasoactive Drugs Usage
d. Management of Patients with Cardiac Arrest and Arrhythmia
e. Management of Seizure and Decreased Consciousness.

4. Group (case-based) simulation exam and debriefing

Each group took turns conducting the group exam. The anesthesiologist rated each group's performance. The case information was given step by step, depending on the participant's actions. The emergency simulation setting can be in the intensive care unit or the ward. Patient management is correct if the patient (the mannequin) is eventually stated to be alive and is judged incorrect if the patient dies.

The mannequin used in the simulation is a high-technology computerized full-body mannequin with heart rate, lung sounds, chest movement, flexible mouth and neck, and a hollow mouth-to-trachea that enabled intubation. The room consisted of a hospital bed, oxygen tube, vital sign monitor, and emergency trolley consisting of an intubation and bagging set, oxygenation cannula/mask, defibrillator machine, and emergency drugs. Furthermore, an anesthesiology resident role-played the patient's family. The simulation room was also equipped with a camera from numerous points of view so the other groups could watch and evaluate the group's performance in real-time. The instructor performed a debriefing session afterward. Debriefing is done by reviewing each group's performance by asking questions, initiating discussion, and giving feedback to all groups. All participants were also welcome to provide questions, comments, or suggestions to other groups. Furthermore, there was an announcement of the best group and the best group leader.

5. Individual post-test

Similar to the pre-test, the post-test consisted of 20 multiple-choice questions about emergency management. The questions were identical to the pre-test, but each ALTEM period had slightly different questions to minimize fraud.

Program Evaluation
Study design and participants

The study utilized a cross-sectional design. The participants were medical students in their final year at the Faculty of Medicine, Public Health, and Nursing, Gadjah Mada University, Indonesia. The exclusion criteria

were students with previous participation in ALTEM, failure to complete the training, or incomplete questionnaire filling. Of the 200 participants, 114 were eligible for the study.

Modified Kirkpatrick model

The program has been running since 2017, yet its effectiveness has not been objectively measured. The Kirkpatrick model was a widely recognized mode of evaluation. This model had a simple approach, only a few variables, simple evaluation criteria, and was independent of individual or environmental variables. The original Kirkpatrick consisted of 4-level measurements (8–11). Our study used a modified Kirkpatrick model with 3-level measurements.

Data collection and evaluation

We distributed an online questionnaire in *Google Forms* using a modified Kirkpatrick evaluation model. The questionnaire consisted of 3 levels: level 1 (reaction), level 2 (learning), and level 3 (behavior). Level 1 measures individual perception and satisfaction regarding the program. Level 2 measures individual learning, which involves transferring knowledge and managerial skills. Level 3 assesses performance by assessing the improvement in the workplace due to previous ALTEM training. Subjects rated the extent to which they agreed with the statement on a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). The answers from the questionnaires were then recapitulated and analyzed.

Statistical analysis

We analyzed the data using SPSS v.26 for Windows. Before the questionnaire distribution, we examined the questionnaire's validity and reliability and concluded that the questionnaire was reliable and valid. Afterward, we conducted cross-tabulated frequencies of the variables and univariate tests for association with the chi-square statistic. We carried out correlation and multivariate ordinal regression tests where indicated. The P-value of <0.05 was considered significant.

Ethical approval

The Institutional Review Board (IRB) granted approval on 18 May 2022 from the local IRB at the Faculty of Medicine, Public Health, and Nursing, Gadjah Mada University (KE/FK/0589/EC/2022). Written informed consent was obtained from the research participants.

RESULTS AND DISCUSSION

A total of 114 subjects participated in the study, with 61.4% of them being women. The mean age was 23.92 ± 1.18, and most subjects did a great job in the post-test (mean score 93.90 ± 10.32). The first-level questionnaire revealed that most subjects liked and enjoyed the training (89.5%), thought the training was relevant (97.4%), considered the training applicable (86.3%), had a positive experience (98.2%), was satisfied with the instructor (84.2%), and was pleased with the skill station session (86.9%). However, certain subjects were not content with the lecturers (0.9%), training materials (7.0%), and overall training design (1.8%) (Table 1).

On level 2, we conducted a post-test to explore the subject's understanding of the emergency topics. Participants who thought this program trained protocol implementation and management algorithm of critically ill patients got a higher score (p = 0.002) (Table 2). On level 3, ALTEM training increased communication and teamwork skills (p <0.001) and decision-making towards critical patients (p <0.001) in the univariate analysis (Table 3). Communication and teamwork remained significantly related in the multivariate analysis (OR 7.866; p = 0005) (Table 4).

Table 1. Subject Perception Regarding ALTEM (level 1 Kirkpatrick questionnaire)

Response (n = 114)	n (%)
Enjoyment of the training	
Neutral	12 (10.5%)
Agree	61 (53.5%)
Strongly agree	41 (36.0%)
The training was relevant to the healthcare provider	
Neutral	3 (2.6%)
Agree	32 (28.1%)
Strongly agree	79 (69.3%)
The training was easy to comprehend. #	
Disagree	4 (20.2%)
Neutral	23 (20.2%)
Agree	62 (54.4%)
Strongly agree	25 (21.9%)
The lessons were practical and applicable.	
Neutral	7 (1.8%)
Agree	39 (34.2%)
Strongly agree	68 (59.6%)
The participant had a good experience with the program	
Neutral	2 (1.8%)
Agree	44 (38.6%)
Strongly agree	68 (59.6%)
The participant was satisfied with the lecturer	
Strongly disagree	1 (0.9%)
Neutral	26 (22.8%)
Agree	60 (52.6%)
Strongly agree	27 (53.7%)
The participant was satisfied with the instructor	
Neutral	18 (15.8%)
Agree	56 (49.1%)
Strongly agree	40 (35.1%)
The participant was satisfied with the training material	
Disagree	8 (7.0%)
Neutral	29 (25.4%)
Agree	54 (47.4%)
Strongly agree	23 (20.2%)
The participant was satisfied with the skill station session	
Neutral	15 (13.2%)
Agree	59 (51.8%)
Strongly agree	40 (35.1%)
The participant was satisfied with the overall training design	
Disagree	2 (1.8%)
Neutral	22 (19.3%)
Agree	62 (54.4%)
Strongly agree	28 (24.6%)

*n = the number of subjects. # = items containing the answers 'disagree' or 'strongly disagree.' There are five scales: strongly disagree, disagree, neutral, agree, and strongly agree. The scales with zero results (not chosen by the subjects) are omitted.

The study aimed to evaluate the effectiveness of the ALTEM training program in increasing the knowledge and skills of medical students of the Faculty of Medicine, Gadjah Mada University. Evaluation is needed to know the upsides and downsides of the program, which aids in improvement in the future. The modified Kirkpatrick model evaluated the ALTEM program in the form of a 3-level questionnaire.

Table 2. ALTEM Learning Assessment (level 2 Kirkpatrick questionnaire)

Learning (n = 114)	Poor score	Fair score	Excellent score	p-value[a]
The program taught about leadership skills.				0.882

Neutral (n = 4)	0	0	4	
Agree (n = 47)	0	3	45	
Strongly agree (n = 62)	1	3	58	
The program taught about communication and teamwork				
Disagree (n = 1)	0	0	1	0.301
Neural (n = 3)	0	1	2	
Agree (n = 44)	1	1	42	
Strongly agree (n = 66)	0	0	66	
The program taught knowledge regarding emergencies.				
Neutral (n = 2)	0	0	2	0.270
Agree (n = 33)	1	0	32	
Strongly agree (n = 80)	0	6	74	
The program taught about rare emergency cases.				
Neutral (n = 6)	0	1	5	0.559
Agree (n = 50)	1	2	47	
Strongly agree (n = 58)	0	3	55	
The program taught about decision-making.				
Neutral (n = 5)	0	1	4	0.145
Agree (n = 43)	1	0	42	
Strongly agree (n = 66)	0	5	61	
The program taught about confidence in managing critically ill patients.				
Neutral (n = 14)	0	1	13	0.546
Agree (n = 49)	1	1	47	
Strongly agree (n = 51)	0	4	47	
The program facilitated the competence of the health workers in the critical areas of the hospital.				
Neutral (n = 3)	0	0	3	0.539
Agree (n = 43)	1	1	41	
Strongly agree (n = 68)	0	5	63	
The program emphasized the implementation of management algorithms for critically ill patients.				
Disagree (n = 1)	0	1	0	**0.002***
Neutral (n = 6)	0	0	6	
Agree (n = 38)	1	1	37	
Strongly agree (n = 68)	0	4	64	
The program was efficient with comparable efficacy to other similar events				
Neutral (n = 9)	0	0	9	0.788
Agree (n = 53)	1	3	49	
Strongly agree (n = 53)	0	3	49	
The program gave the participants the experience as expected	0	0	1	
Disagree (n = 1)	0	1	5	0.810
Neutral (n = 6)	1	2	51	
Agree (n = 54)	0	3	50	
Strongly agree (n = 53)				

[a]*Chi-square* test; *p <0.05: Significant

Level 1 revealed that ALTEM gained an overall positive response from the subjects. However, a few participants wanted more from the lecturers (0.9%), training materials (7.0%), and comprehensive training design (1.8%). Based on consumer satisfaction theory, satisfaction is an integration of two components. The first component is the individual emotional experience, which refers to interest, pride, and achievement regarding the service provided. It is closely related to the individual's enthusiasm and mental health condition. The second component, i.e., expectation confirmation theory, defines satisfaction as the conformity between expectation towards service and the perceived service experience. In medical education, factors affecting student satisfaction were the

students' emotional experience towards the institution or program, learning experience, educational (knowledge and skill) accomplishment, and expectation fulfillment (12–15).

Table 3. ALTEM performance (Level 3 Kirkpatrick questionnaire)

Perceived performance	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	P-value[a]
The program taught about leadership skills.						
Neutral (n = 2)	0	0	1	1	0	0.322
Agree (n = 25)	0	0	4	20	2	
Disagree (n = 29)	0	0	5	16	8	
The program taught about communication and teamwork						
Disagree (n = 1)	0	0	0	0	1	<0.001*
Neutral (n = 1)	0	1	0	0	0	
Agree (n = 27)	0	0	5	20	2	
Strongly agree (n = 30)	0	1	3	11	15	
The program taught about rare emergency cases						
Neutral (n = 3)	0	0	0	1	2	0.485
Agree (n = 27)	0	0	2	9	16	
Strongly agree (n = 29)	0	0	1	16	11	
The program taught about decision-making.						
Neutral (n = 2)	0	1	0	0	1	<0.001*
Agree (n = 24)	0	0	1	11	12	
Strongly agree (n = 33)	0	0	2	13	18	
The program taught about confidence in managing critically ill patients						
Neutral (n = 9)	0	0	0	2	7	0.895
Agree (n = 29)	0	0	2	9	18	
Strongly agree (n = 21)	0	0	1	6	14	
The program trained competence of the health workers in the critical areas of the hospital						
Neutral (n = 2)	0	0	0	1	1	0.992
Agree (n = 24)	0	0	1	11	12	
Strongly agree (n = 33)	0	0	2	14	17	
The program emphasized the implementation of management algorithms for critically ill patients						
Neutral (n = 4)	0	0	0	3	1	0.635
Agree (n = 23)	0	0	1	8	14	
Strongly agree (n = 32)	0	0	2	12	18	
The program is efficient with comparable efficacy to other similar programs						
Neutral (n = 7)	0	0	0	4	3	0.558
Agree (n = 30)	0	0	5	10	15	
Strongly agree (n = 21)	0	0	2	12	7	

[a]*Chi-square* test; *p <0.05: Significant

Table 4. ALTEM effectiveness

Increased performance	aOR	p-value	95% CI
ALTEM training and increased communication and teamwork	7.866	**0.005***	-2.899 s/d -0.514
ALTEM training and increased decision-making skills	0.166	0.684	-1.264 s/d 0.829

*p <0.05: significant; CI = confidence interval; aOR = adjusted odds ratio
We analyzed the data using an ordinal regression test

In this study, 1 of 114 subjects (0.9%) reported dissatisfaction with the lecturers, and 8 of 114 participants (7.0%) reported dissatisfaction with the training material. We hypothesized that the reason for the blow was an incorrect perception regarding the ALTEM training program. ALTEM training program aimed to enhance the management skills of medical students. The participants were assumed to have a fair understanding of emergency management and have done independent study, so the lectures were brief and only contained knowledge that directly correlate or is helpful for clinical practice. Furthermore, a comprehensive discussion could be found in the ALTEM module, handed out a few days before the course. The questionnaire also did not ask about the identity of the lecturer(s) with whom the subjects feel dissatisfied, so we could not conclude whether the dissatisfaction came from one specific lecturer or overall lecturer performance. Moreover, the proportion of discontent towards the lecturers was extremely little (1/114; 0.9%), so it did not depict the perception of all participants.

A few subjects needed help understanding the materials (20.2%). According to Spencer (2003) and Ghasemi et al. (2018), the factors affecting material comprehension were the student and the teacher. The student factor includes the degree of motivation, interest in the materials, and concentration. The teacher has communication skills, especially asking questions, explaining, active listening, and sensitivity to students' verbal and nonverbal cues. The study by the Faculty of Medicine, National Autonomous University of Mexico in 2020 reported another factor affecting the student perception regarding the lecturer: the lecturer's knowledge about the materials, the treatment towards the students, the willingness of the lecturer to share their personal experience to the student, and the time spent together with the pupils ($p = 0.001$) ([15–17]).

Linton et al. (2014) found that writing could enhance students' comprehension of complex concepts ([18]). Writing about an idea entails the student conducting systematic thinking, which helps to connect the dots. The report could also help the students self-evaluate and increase metacognition because they could know their ability or inability to elaborate on a concept. Daou et al. (2020) compared students having peer discussions, lectures, and a combination of both. They found that the combination of peer discussion and lectures boosted understanding because the combination enforced the use of a simplified approach to elaborate complex concepts ([19]). Therefore, future ALTEM lectures could integrate interactive questions, writing, peer group discussion, and the lecturers' experience managing critical patients in the emergency units as additional teaching methods to enhance understanding.

Level 2 questionnaire revealed that participants who thought this program trained protocol implementation and management algorithm of critically ill patients got a higher score ($p = 0.002$) ([Table 2]). The result aligns with our program's aim to implement a critical patient management algorithm. Hailikari et al. (2008) reported that prior knowledge, especially procedural knowledge, significantly determined the student score ($p < 0.05$). As a result, future ALTEM studies would incorporate pre-test scores. Moreover, ALTEM pre-test and post-test quizzes would be multiple choices, consisting of medical theory and case-based essays, which could further measure the student's knowledge and managerial skills before and after training ([20]).

We carried out the level 3 questionnaire by comparing the learning obtained in ALTEM and the subjects' performance in the workplace. ALTEM training program was proven to improve communication and teamwork in the workplace in univariate (p <0.001) and multivariate (OR 7.866; p = 0.005) analysis. Communication and teamwork are essential components in the healthcare system, especially regarding patient safety. Miscommunication regarding the patient status and management plan during care transition (between care areas or health worker shifts) could endanger patient safety. Moreover, ineffective communication between health workers, i.e., clinicians, pharmacists, and nurses, could cause medication errors. The fundamentals of good teamwork were that all members identified the objectives of patient treatment (including the patient himself), recognized the roles and responsibilities of himself and other team members, had effective communication, measurable process and outcome, and the leader had good leadership capability (21–24).

The lecturers explained team-based emergency management and team roles to the lecture participants. Later in the skill station session and simulation exam, the participants simulated medical management with a prior discussion with each other. The role discussion, division, and simulation helped the participants understand each member's management objectives, roles, and responsibilities and practice effective communication. The leader also had the chance to practice leadership skills. All of these contributed to the increased communication and teamwork of the subjects after the ALTEM training program.

The ALTEM training program did not significantly affect leadership ability (p = 0.322) or confidence in facing critical patients. Each group only did a one-time simulation in the simulation exam, meaning that only one person in each group could become the leader. The one-time simulation might contribute to a lack of perceived leadership skill enhancement by the subjects. Furthermore, the limitation of having only one simulation case per group decreased confidence and competence, particularly in managing rare cases, after the training program.

The ideal solution to increase leadership and decision-making skills is to give each participant several opportunities to lead the simulation. The multiple opportunities can be achieved by providing more instructors, rooms, and facilities so that more groups can perform simultaneously during the simulation exam.

However, a few alternatives can be considered due to time and resource limitations. One week before the course begins, each participant can be given a scenario and requested to create a short video of him (less than 5 minutes) leading the case in groups (role play). One person acts as the narrator, one person as the leader, and 2-3 persons as the team members doing the leader's instruction. The video does not need to use real medical devices or mannequins. The role play urges participants to deepen their knowledge, communication, and leadership skills. The video submission is due on the first day of the course. The instructors then grade the video and give feedback during the skill station the next day. Participants seen as incompetent will have more intensive drilling during the skill station (25).

Action learning (i.e., tutorial sessions) is also a feasible leadership training for short-term courses. The tutorial session consists of five to eight persons per group, guided by one instructor. The instructor presents the scenario; then, participants collaboratively explore solutions using a combination of open questions, appreciative inquiry, and diverse

perspectives. The objective is to facilitate and empower individuals to speak up, train critical thinking, and foster a dynamic and participatory approach to leadership development (25).

The program was not an independent factor in increasing perceived decision-making skills in the workplace after ALTEM (p = 0.684). Decision-making should be made as quickly and appropriately as possible in emergencies. Case-based and timed simulation in ALTEM trains subjects to make rapid and correct decisions based on the patient's condition and medical knowledge. However, decision-making in the workplace does not only rely on the doctor's medical judgment or fundamental knowledge, but other factors also play a role, such as ethical considerations, sociocultural aspects, hospital policies, patient or family preferences, and cost-effectiveness analyses. On that account, future simulation cases should also involve the ethical, sociocultural, financial, or policy aspects so that the participants can learn to think beyond the medical aspects of treating or making a medical decision, therefore taking a more holistic approach to decision-making (21–24).

In the context of reliability, ALTEM has a manual book and checklists for instructors and is now developing simulation videos and a mobile application to standardize the program. However, there are simulation cases rated as 'very important' and 'additional' cases. The necessary cases should be simulated in every period of the ALTEM course, but the additional cases can vary. The necessary cases are taught in the lectures and skill stations, and the additional cases are written in the manual book.

Furthermore, the background of simulation cases can be tailored to address specific local medical requirements, allowing for the customization of simulation scenarios based on prevalent or critically important cases within a given medical education setting. For example, shock is one of the necessary cases in ALTEM. However, the background of the patient suffering from shock can be adjusted (e.g., heart attack, dengue fever, motor vehicle accidents, etc). Therefore, medical students living in dengue-endemic areas can be given cases of dengue shock syndrome. This adaptability ensures that ALTEM remains standardized yet flexible to medical students' competency requirements.

The assessment of learning and performance was subjective. Therefore, there was a possibility of bias. Moreover, the absence of essay-based questions in the questionnaires limited our ability to capture the underlying reasons behind subjects' responses. The study also did not include the pre-test data. Nevertheless, it is essential to highlight that this study comprehensively evaluated the effectiveness of ALTEM from various perspectives, employing a validated questionnaire and evaluation model. This approach ensures that the feedback gathered is valuable for assessing and refining the upcoming ALTEM program.

CONCLUSION

ALTEM training program received good responses from the subjects and demonstrated good effectiveness in enhancing communication and teamwork. Several improvements were needed, but the overall program was a prospective initiative toward improving medical students' competence and collaboration in emergency management. We anticipate widespread acceptance and implementation across universities, envisioning a positive impact on emergency medical care throughout Indonesia.

Authors' Contributions
PH, BA, RFN, AZR: study concept and design, acquisition of the data, critical revision of the manuscript for important intellectual content, obtaining funding, administrative, technical, or material support, study supervision.

CA: analysis and interpretation of the data, drafting of the manuscript, critical revision of the manuscript for important intellectual content, statistical expertise, administrative, technical, or material support

REFERENCES

1. Ariyo P, Hartsell T, Pronovost P. Preventing Morbidity in the ICU. In: Hall J, Schmidt G, Kress J, editors, editors. Principles of Critical Care. 4th ed. New York: McGraw-Hill Education; 2015. [Webpage]

2. Mundell WC, Kennedy CC, Szostek JH, Cook DA. Simulation technology for resuscitation training: A systematic review and meta-analysis. Resuscitation. 2013 Sep;84(9):1174–83. [PubMed]

3. Oropello J, Kvetan V, Pastores S. Critical Care. New York: McGraw-Hill Education; 2016.

4. Panchal AR, Berg KM, Hirsch KG, Kudenchuk PJ, Del Rios M, Cabanãs JG, et al. 2019 American Heart Association Focused Update on Advanced Cardiovascular Life Support: Use of Advanced Airways, Vasopressors, and Extracorporeal Cardiopulmonary Resuscitation during Cardiac Arrest: An Update to the American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Vol. 140, Circulation. Lippincott Williams and Wilkins; 2019. p. E881–94. [Webpage]

5. Galvagno SM, Nahmias JT, Young DA. Advanced Trauma Life Support® Update 2019: Management and Applications for Adults and Special Populations. Vol. 37, Anesthesiology Clinics. W.B. Saunders; 2019. p. 13–32. [PubMed]

6. Global Health Estimates 2020: Deaths by Cause, Age, Sex, by Country and by Region, 2000-2019. Geneva: World Health Organization; 2020. [Webpage]

7. Departemen Anestesiologi dan Terapi Intensif FK-KMK. Acute Life Threatening Events Management. 1st ed. Vol. 1. Yogyakarta: PERDATIN; 2020.

8. Heydari MR, Taghva F, Amini M, Delavari S. Using Kirkpatrick's model to measure the effect of a new teaching and learning methods workshop for health care staff. BMC Res Notes. 2019 Jul 10;12(1). [Webpage]

9. Dorri S, Akbari M, Dorri Sedeh M. Kirkpatrick evaluation model for in-service training on cardiopulmonary resuscitation. Iran J Nurs Midwifery Res. 2016 Sep 1;21(5):493–7. [PubMed]

10. Shinohara M, Nakamura T, Kunikata N, Okudera H, Kuroda Y. A half-day stroke workshop based on the Kirkpatrick model to improve new clinical staff behavior. J Adv Med Educ Prof. 2020 Jan 1;8(1):10–7. [PubMed]

11. Campbell K, Taylor V, Douglas S. Effectiveness of Online Cancer Education for Nurses and Allied Health Professionals; a

Systematic Review Using Kirkpatrick Evaluation Framework. Journal of Cancer Education. 2019 Apr 15;34(2):339–56. [PubMed]

12. Abdullah SINW, Arokiyasamy K, Goh SL, Culas AJ, Manaf NMA. University students' satisfaction and future outlook towards forced remote learning during a global pandemic. Smart Learning Environments. 2022 Dec 1;9(1). [Webpage]

13. Alzahrani L, Seth KP. Factors influencing students' satisfaction with continuous use of learning management systems during the COVID-19 pandemic: An empirical study. Educ Inf Technol (Dordr). 2021 Nov 1;26(6):6787–805. [PubMed]

14. Gu Q, Lu G. Factors influencing the satisfaction level of college students in China: Literature analysis based on grounded theory. Front Psychol. 2023 Jan 24;13. [Webpage]

15. Martínez-Flisser G, Flisser A, Castro-Guerrero MA, Plett-Torres T. Measuring student satisfaction as the first assessment of the Program of Combined Studies in Medicine, an MD/PhD-like program of the Faculty of Medicine, National Autonomous University of Mexico. BMC Med Educ. 2020 Dec 1;20(1). [Webpage]

16. Ghasemi MR, Karimi Moonaghi H, Heydari A. Student-related factors affecting academic engagement: A qualitative study exploring the experiences of Iranian undergraduate nursing students. Electron Physician. 2018 Jul 25;10(7):7078–85. [PubMed]

17. Pacifico JL, Donkers J, Jacobs J, van der Vleuten C, Heeneman S. Understanding teaching and learning conceptions among clinical faculty as a means to improve postgraduate training. Int J Med Educ. 2020 Aug 28;11:175–85. [PubMed]

18. Linton DL, Pangle WM, Wyatt KH, Powell KN, Sherwood RE. Identifying key features of effective active learning: The effects of writing and peer discussion. CBE Life Sci Educ. 2014 Sep 2;13(3):469–77. [PubMed]

19. Daou D, Sabra R, Zgheib NK. Factors That Determine the Perceived Effectiveness of Peer Feedback in Collaborative Learning: a Mixed Methods Design. Med Sci Educ. 2020 Sep 1;30(3):1145–56. [PubMed]

20. Dong A, Jong MSY, King RB. How Does Prior Knowledge Influence Learning Engagement? The Mediating Roles of Cognitive Load and Help-Seeking. Front Psychol. 2020 Oct 29;11. [Webpage]

21. Babiker A, El Husseini M, Al Nemri A, Al Frayh A, Al Juryyan N, Faki MO, et al. Health care professional development: Working as a team to improve patient care [Internet]. Vol. 14, S. 2014. Available from: http://www.sudanjp.org

22. Masic I. Medical Decision Making. Acta Informatica Medica. 2022;30(3):230–5. [PubMed]

23. Rosen MA, DiazGranados D, Dietz AS, Benishek LE, Thompson D, Pronovost PJ, et al. Teamwork in healthcare: Key discoveries enabling safer, high-quality care. American Psychologist. 2018 May 1;73(4):433–50. [PubMed]

24. Pereira VC, Silva SN, Carvalho VKS, Zanghelini F, Barreto JOM. Strategies for the implementation of clinical practice guidelines in public health: an overview of systematic reviews. Vol. 20, Health Research Policy and Systems. BioMed Central Ltd; 2022. [Webpage]

25. Chen TY. Medical leadership: An important and required competency for medical students. Vol. 30, Tzu Chi Medical Journal. Wolters Kluwer Medknow Publications; 2018. p. 66–70. [PubMed]