

# Building Trauma Care Capacity through multidisciplinary Simulation in Nepal: descriptive mixed- methods educational research

**Roshana Shrestha**

Dhulikhel Hospital – Kathmandu University School of Medical Sciences

**Anmol Purna Shrestha**

shresthanmol@kusms.edu.np

Dhulikhel Hospital – Kathmandu University School of Medical Sciences

**Kristopher Brickman**

University of Toledo Medical Center

**Heather Klepacz**

University of Missouri–Kansas City

**Cristina Alvarado**

University of Toledo

**Kristin Calkins**

University of Toledo

---

## Research Article

**Keywords:** Advanced trauma life support, debriefing Kirkpatrick levels, TNCC, Nepal, multidisciplinary healthcare professionals, simulation-based education, trauma training

**Posted Date:** October 19th, 2026

**DOI:** <https://doi.org/10.21203/rs.3.rs-10983087/v1>

**License:**  This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

**Additional Declarations:** No competing interests reported.

---

# Abstract

## Background

Trauma is a significant cause of morbidity and mortality in Nepal, yet structured simulation-based training programs remain limited. In April 2025, Nepal's first Advanced Trauma Life Support and Trauma Nursing Core Course were introduced in a hybrid format. This study evaluated training with participant satisfaction and engagement (Kirkpatrick Level 1: reaction) and pre to post changes in self-reported confidence across trauma management skill sets (Kirkpatrick Level 2: learning) as primary outcomes and the qualitative perceptions of the training as the secondary outcome.

## Methods

A descriptive, cross-sectional, mixed-methods study was conducted using structured questionnaires post-training. The quantitative data included participant satisfaction (Kirkpatrick level 1) and pre- and post-training self-reported confidence across eight trauma management skill sets (Kirkpatrick Level 2). A structured 5-point Likert-scale 13-item tool was used to evaluate the simulation experience across 4 domains: learning, confidence, debriefing, and transferability to clinical practice. Qualitative data were obtained from open-ended questions capturing participants' reflections, experiences, and suggestions. Statistical analysis was performed via paired t tests, and thematic analysis was used for qualitative data.

## Results

The response rate was 86% (37/43). Thirty-four (92%) participants rated the course as very good or excellent. Pre to post confidence gains across all eight trauma management skill sets was significant ( $p < 0.001$ ). The simulation-based learning experience was highly rated across all four domains, with a mean evaluation score of 4.45/5 (SD = 0.67) across all 13 items and excellent internal consistency (Cronbach's  $\alpha = 0.95$ ). Qualitative feedback emphasized participant perceptions, challenges, barriers, and suggestions. The key themes included preparation, engaging simulations, reflective debriefing, and enhanced clinical readiness after training. The participants identified areas for improvement, such as resource adaptation and time allocation.

## Conclusions

Simulation-based multidisciplinary trauma training is feasible and impactful in low-resource settings. The study revealed high participant satisfaction and engagement and significant confidence gains across all trauma domains. The simulation-based learning experience was highly rated across four domains, and the study yielded actionable insights into barriers, challenges, and suggestions for future

training. These findings support the expansion of simulation programs in Nepal to strengthen trauma care capacity.

## Background

Trauma is a significant global health issue, leading to approximately 5 million deaths annually and disproportionately affecting low- and middle-income countries (LMICs) [1, 2]. Despite its significant impact, trauma care remains underfunded and underdeveloped globally [3]. It is the leading cause of death for those under 35 years of age and a major source of disability worldwide [4]. Reducing injury mortality rates in LMICs to match high-income countries could save over 2 million lives annually and provide substantial economic benefits [5]. Despite its impact, trauma care and injury prevention have received less attention than other medical specialties [6]. Addressing this "hidden pandemic" requires increased awareness, policy changes, and international collaboration to improve trauma care and injury prevention worldwide [1, 6]. Trauma is a significant health concern in Nepal, with falls and road traffic accidents being the most common causes [7]. Nepal experiences a disproportionate burden due to limited healthcare infrastructure and training opportunities, particularly in rural and under resourced areas where prehospital and hospital trauma care systems are underdeveloped [4].

While global standards such as Advanced Trauma Life Support (ATLS) and Trauma Nursing Core Course (TNCC) have been proven to improve trauma outcomes [8, 9], their introduction to Nepal has been limited by resource constraints and a lack of trained faculty. Both courses are globally validated and utilize simulation-based education (SBE) to teach critical assessment, decision-making, and procedural skills. Studies have shown that ATLS training enhances healthcare professionals' knowledge, critical decision-making skills, and standardized approaches to trauma management [8]. The implementation of ATLS training in hospitals has led to significant improvements in patient care, including reduced mortality rates and shorter durations in emergency departments and shorter operation times [10]. These findings underscore the importance of integrating ATLS training into medical education and hospital protocols to improve trauma care outcomes globally. Similarly, the TNCC is a standardized approach to trauma patient care that is traditionally offered to emergency nurses but is increasingly recommended for all nurses involved in trauma care [9].

SBE has been increasingly recognized as a powerful tool for improving clinical skills, decision-making, and interprofessional communication, particularly in high-stakes conditions such as trauma care [11]. SBE in trauma management has shown promise in developing essential skills for healthcare professionals. Studies have demonstrated that simulation-trained residents perform better in crisis management and teamwork than those receiving traditional lectures do [12]. Simulation offers a safe environment in which to practice technical skills, critical concepts, and nontechnical abilities such as leadership and communication [13]. The American College of Surgeons recommends integrating simulators into medical education to ensure patient safety and reduce errors. Dhulikhel Hospital-Kathmandu University Hospital has been at the forefront of introducing SBE in Nepal, incorporating simulation into both undergraduate and postgraduate medical education [14–16].

In April 2025, Nepal's first ATLS and TNCC were delivered in a hybrid format, combining online didactics with in-person simulation exercises, which provided an immersive and practical approach to preparing healthcare providers for complex trauma scenarios. This initiative aimed to increase trauma care capacity by providing contextually relevant, structured training. We aimed to explore how learners experienced the course, what aspects contributed to their learning, and what challenges they faced. The widely adopted four-level hierarchical framework, the Kirkpatrick model [17], was used to evaluate the training. Level 1 (reaction), which assesses participant satisfaction and engagement with the training experience, and level 2 (learning), which assesses changes in knowledge, skills, attitudes, or self-reported confidence, remain the most commonly assessed outcomes in healthcare simulation research [18]. A range of validated instruments have been developed to operationalize these evaluation levels. The Student Satisfaction and Self-Confidence in Learning scale and the Simulation Design Scale assess learner satisfaction and the quality of simulation design at Kirkpatrick Level 1 [19]. The debriefing assessment for simulation in healthcare (DASH) evaluates debriefer performance and the quality of the post simulation discussion, which is widely regarded as the primary mechanism of learning in simulations [20]. The Creighton Competency Evaluation Instrument 2.0 targets Level 2 by measuring observable clinical competencies and procedural proficiency [21]. Each instrument offers a distinct evaluative lens; however, most address a single dimension—satisfaction, competency, debriefing quality, or teamwork—without integrating these elements into a unified assessment framework. The simulation effectiveness tool-modified (SET-M), developed and psychometrically validated by Leighton et al. [22], addresses this limitation by simultaneously evaluating learner perceptions across four interrelated domains: pre briefing and learning, confidence, debriefing, and clinical transferability. The SET-M captures the subjective learning experience and confidence through self-reports, making it scalable across various learner cohorts. Its brevity, established reliability, interdisciplinary applicability, and simultaneous alignment with Kirkpatrick Levels 1 and 2 make it particularly well suited for evaluating novel simulation programs in low-resource settings such as Nepal.

The primary objective of this study was to evaluate training with participant satisfaction and engagement with ATLS and TNCC training (Kirkpatrick Level 1: Reaction) and to assess changes in self-reported confidence across eight trauma management skill sets via pre- and post-training ratings (Kirkpatrick Level 2: Learning). The secondary objective was to evaluate the simulation-based learning experience across four domains (learning, confidence, transferability, and debriefing) via a validated 13-item tool and to explore participants' perceptions of challenges, barriers, and suggestions for future training through qualitative analysis.

## Methods

### Aim, Design and Setting

A descriptive cross-sectional educational mixed-method was employed to evaluate the participant's perception and self-reported learning outcomes (Kirkpatrick Levels 1 and 2) which was collected after completion of the ATLS and TNCC courses at a tertiary care university hospital in Nepal in April 2025.

The hospital is a 400-bed tertiary care teaching hospital located 30 kilometers east of Kathmandu, Nepal. Serving as a referral center, the hospital manages a high volume of trauma and emergency cases and has a growing reputation for innovation in medical training for medical, nursing, and allied health students. Its role as both a trauma care provider and an academic institution makes it a suitable site for evaluating simulation-based trauma training through ATLS and TNCC courses.

## Participants

The participants included multidisciplinary healthcare professionals (physicians, nurses, and allied health staff from different hospitals) who attended the April 2025 ATLS and TNCC courses. The inclusion criteria were course completion and consent for participation.

## Interventions

The hybrid-format courses integrated online pre course modules covering trauma principles, followed by intensive in-person simulation and skills sessions. The simulations used manikins and contextualized team-based scenarios addressing blunt and penetrating trauma, airway management, hemorrhage control, and cervical spine stabilization. Interprofessional health professionals from various departments dealing with trauma cases were formed to reflect real-world trauma care environments. The training emphasized multidisciplinary teamwork, clinical skills, and decision-making. Debriefing followed the advocacy-inquiry model to encourage reflection and feedback [23].

## Outcome Measures

### Primary outcome measures

Kirkpatrick Level 1 (Reaction) was assessed through overall course satisfaction ratings and participants' endorsement of course content and learning objectives.

Kirkpatrick Level 2 (Learning) was assessed through pre- and post-training self-reported confidence ratings across eight trauma management skill sets: initial assessment, cervical spine immobilization, airway management, needle/tube thoracostomy, circulation and hemorrhage control, intraosseous line insertion, teamwork and communication skills, and secondary survey.

### Secondary outcome measures

The simulation-based learning experience was assessed via a 13-item 5-tier Likert-scale tool evaluating four domains: learning (4 items), confidence (3 items), transferability to clinical practice (3 items), and debriefing quality (3 items).

Qualitative data from the open-ended questions provided additional secondary outcome data, which explored participants' perceptions of challenges, barriers, and suggestions for improving future training.

## Data collection tools

The evaluation tool was derived from the SET-M tool. The content validity of the data collection tool was ensured through expert review by faculty experienced in simulation-based education and trauma training, whereas face validity was confirmed by three medical education faculty members who assessed the clarity, appropriateness, and completeness of the items. A pilot test of the adapted tool was conducted with a small group of healthcare professionals before the main training to assess content validity, clarity, and appropriateness. On the basis of feedback, we made adjustments to ensure cultural and contextual relevance while maintaining the integrity of the original domains. The final survey included self-rated pre- and post-training confidence levels in trauma-specific skill sets; 5-tier Likert-scale items assessing learning, confidence, transferability, and debriefing; and open-ended questions for qualitative feedback.

## Statistical analysis

Quantitative data were analyzed via descriptive statistics (means, standard deviations, frequencies) and paired t tests to compare pre- and post-training confidence levels in skills. Reliability analysis was conducted on the adapted 13-item scale used in this study by calculating the internal consistency via Cronbach's alpha, which was calculated with SPSS (version 21), and the significance threshold for the p value was  $< 0.05$ . Qualitative data from open-ended responses were analyzed thematically to identify recurrent themes related to learner experiences.

## Results

### Participant characteristics

A total of 43 participants attended simulation-based training (32 physicians in two ATLS batches and 11 nurses and paramedics in one TNCC batch). Thirty-seven (86%) participants responded to the survey (31 ATLS and 6 TNCC participants). The majority [23 (62.2%)] were faculty consultants [General Practice/Emergency Medicine-13 (56%), ortho-8 (34%), Surgery-2 (10%)], followed by residents [8 (21.6%)], nurses [4 (10.8%)], and paramedics [2 (5.4%)]. Clinical experience ranged from less than 1 year to more than 6 years, with  $> 6$  years = 21 (56.8%), 4–6 years = 7 (18.9%), 1–3 years = 7 (18.9%), and  $< 1$  year = 2 (5.4%).

### Primary Outcomes

Kirkpatrick Level: Reaction (Satisfaction and Engagement): Thirty-four (92%) participants rated the course content as very good/excellent and agreed that the learning objectives were clearly defined and met. The overall mean score across all 13 evaluation items was 4.45/5 (SD = 0.67), indicating high participant satisfaction. The evaluation tool demonstrated excellent internal consistency (Cronbach's  $\alpha = 0.95$ ). The key satisfaction and engagement indicators are summarized in Table 1.

Table 1  
Kirkpatrick Level 1 (Reaction): Participant Satisfaction and Engagement Indicators.

| Indicator                                                 | Result             |
|-----------------------------------------------------------|--------------------|
| Overall course rating: Very Good or Excellent             | 34/37 (92%)        |
| Learning objectives clearly defined and met               | 34/37 (92%)        |
| Mean evaluation score across all 13 items (5-point scale) | 4.45/5 (SD = 0.67) |
| Internal consistency (Cronbach's $\alpha$ )               | 0.95               |
| SD=Standard Deviation                                     |                    |

Statistically significant increases in self-reported confidence were observed across all eight trauma management skill sets ( $p < 0.001$  for all comparisons). The greatest gains were observed in needle/tube thoracostomy ( $\Delta = +1.38$ ), airway management ( $\Delta = +1.11$ ), and initial assessment ( $\Delta = +1.03$ ). The full pre- and post-training confidence data are presented in Table 2.

Table 2  
Pre/Post Confidence Gains Across Eight Trauma Management Domains

| Skill / Domain                                                                                                                                                                | Pre-Training Mean $\pm$ SD | Post-Training Mean $\pm$ SD | Mean difference $\pm$ SD | T (df)    | p-value (Paired t-test) |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|-----------------------------|--------------------------|-----------|-------------------------|
| Initial assessment                                                                                                                                                            | 3.27 $\pm$ 0.96            | 4.30 $\pm$ 0.81             | 1.03 $\pm$ 1.19          | 5.25 (36) | < 0.001*                |
| Cervical spine immobilization                                                                                                                                                 | 3.65 $\pm$ 1.10            | 4.49 $\pm$ 0.69             | 0.84 $\pm$ 1.24          | 4.12 (36) | < 0.001*                |
| Airway management                                                                                                                                                             | 3.35 $\pm$ 1.10            | 4.46 $\pm$ 0.65             | 1.11 $\pm$ 1.22          | 5.53 (36) | < 0.001*                |
| Needle/tube thoracostomy                                                                                                                                                      | 2.81 $\pm$ 1.30            | 4.19 $\pm$ 0.85             | 1.38 $\pm$ 1.42          | 5.90 (36) | < 0.001*                |
| Circulation and hemorrhage control                                                                                                                                            | 3.35 $\pm$ 0.98            | 4.27 $\pm$ 0.87             | 0.92 $\pm$ 1.21          | 4.62 (36) | < 0.001*                |
| Intraosseous line                                                                                                                                                             | 2.89 $\pm$ 0.97            | 3.95 $\pm$ 0.91             | 1.05 $\pm$ 1.37          | 4.67 (36) | < 0.001*                |
| Teamwork and communication skills                                                                                                                                             | 3.43 $\pm$ 0.76            | 4.38 $\pm$ 0.86             | 0.95 $\pm$ 1.13          | 5.10 (36) | < 0.001*                |
| Secondary survey                                                                                                                                                              | 3.41 $\pm$ 1.00            | 4.35 $\pm$ 0.82             | 0.95 $\pm$ 1.13          | 5.10 (36) | < 0.001*                |
| Confidence rated on a 5-point scale (1 = not confident; 5 = very confident); SD: standard deviation; All p-values by paired t-test * Statistically significant P value < 0.05 |                            |                             |                          |           |                         |
| Secondary Outcomes: Simulation-Based Learning Experience (Four Domains)                                                                                                       |                            |                             |                          |           |                         |

The mean scores across all four evaluation domains were high and consistent, ranging from 4.43 to 4.47/5. The confidence domain scored highest ( $4.47 \pm 0.60$ ), followed by learning ( $4.44 \pm 0.67$ ) and transferability ( $4.44 \pm 0.73$ ), with debriefing at  $4.43 \pm 0.69$ . The full domain scores and survey items are shown in Table 3.

Table 3  
The Mean Score of domains of Simulation-Based Learning Experience

| Domain                    | Survey Items                                                                                                                                                                                                                                                                                                                                                                                              | Mean (SD)      |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Learning<br>(4 items)     | 1. The hands-on workshop and simulation-based learning enhanced my understanding of trauma care<br><br>2. The simulation during the training provided an opportunity to practice clinical decision-making<br><br>3. I was able to apply knowledge from the online content in the workshop and simulation scenarios<br><br>4. The simulation and hands-on workshop helped me identify gaps in my knowledge | 4.44<br>(0.67) |
| Confidence<br>(3 items)   | 1. I feel more confident in managing trauma patients after this training<br><br>2. I am more comfortable performing technical skills related to trauma<br><br>3. I feel more confident communicating with a trauma team during emergencies                                                                                                                                                                | 4.47<br>(0.60) |
| Transferability (3 items) | 1. The scenarios reflected realistic situations I may encounter at work<br><br>2. I feel better prepared to handle high-pressure trauma situations<br><br>3. I will apply what I learned in this course in my clinical setting                                                                                                                                                                            | 4.44<br>(0.73) |
| Debriefing<br>(3 items)   | 1. The feedback (debriefing) session helped me reflect on my performance<br>2. Facilitators provided constructive feedback during debriefing<br><br>3. I felt psychologically safe during the skill stations, simulation and debriefing                                                                                                                                                                   | 4.43<br>(0.69) |

Items rated on 5-point Likert scale (1 = strongly disagree; 5 = strongly agree). Cronbach's  $\alpha = 0.95$ .

Qualitative findings: Participant perceptions, challenges, barriers, and suggestions

Figure 1 summarizes the qualitative themes aligned with the 4 domains (learning, confidence, transferability and debriefing). Table 4 presents a summary of these qualitative themes. Thematic analysis of the open-ended responses identified five key themes.

Table 4  
Summary Table of Themes

| Theme                       | Description                                                            |
|-----------------------------|------------------------------------------------------------------------|
| Value of Training           | Emphasis on simulation and practical exposure                          |
| Challenges                  | Time constraints, limited equipment, short duration                    |
| Clinical Application        | Increased confidence, structured approach, and team leadership         |
| Suggestions for Improvement | Longer training, more simulation time, and better pre-course materials |
| Positive Sentiment          | Gratitude, motivation for future participation                         |

### Theme 1: Perceived Value of Training

The participants consistently appreciated the course for its emphasis on practical training and simulation, which helped bridge theoretical knowledge with real-world application. Precourse materials, including online modules and self-directed learning resources, were considered useful for foundational knowledge. Hands-on skill stations and simulation scenarios were particularly valued for their realism, engagement, and promotion of multidisciplinary teamwork. Structured debriefing sessions were seen as supportive, although some participants suggested extending their duration.

Representative quotes include *“The practical sessions were truly well organized.” “Simulation after theory teaching was most valuable.” “These simulation sessions will help me work with my team under time pressure.”*

### Theme 2: Challenges Faced During Training

The participants identified logistical and instructional challenges that limited engagement with the material. The limited time for hands-on practice, particularly for complex procedures, and the short overall course duration were noted as barriers to comprehensive skill acquisition. Additionally, the limited availability of high-fidelity mannequins affects the realism of simulation scenarios.

Representative quotes: *“Most of the session, I practiced for the first time.” “Some skill stations needed slightly more time for all to practice.”*

### Theme 3: Impact on Clinical Practice

The training positively influenced participants’ approach to trauma care. Many reported increased confidences in managing trauma patients, improved organization and prioritization using ATLS protocols, and greater preparedness to lead teams and teach colleagues.

Representative quotes: *“I will follow the ATLS protocol for every trauma patient from now onward” “Now I feel more organized in the algorithm of treatment of trauma victims.” “I will apply close-loop communication*

*in my daily practice."*

#### Theme 4: Suggestions for improvement

The participants offered constructive feedback to enhance future training. Recommendations included extending the course duration to allow more hands-on practice, incorporating structured discussions for each module, and improving equipment and simulation fidelity.

Representative quotes: *"More time in skills improvement and simulation exercises."* *"It would have been better with more hands in practice with high-fidelity manikins."*

#### Theme 5: Positive sentiment and gratitude

Despite these challenges, overall feedback reflected strong appreciation for the training opportunity. The participants expressed gratitude and a desire for more frequent simulation-based trauma courses in Nepal.

Representative quotes: *"Very thankful and lucky to be part of the first ATLS in Nepal."*

Thank you for the opportunity to be part of this wonderful training.

## Discussion

This study evaluated the feasibility, effectiveness and learner satisfaction of Nepal's first ATLS and TNCC simulation-based multidisciplinary training in a low-resource setting. The high internal consistency of the evaluation tool (Cronbach's  $\alpha = 0.95$ ) confirms its suitability for use in the Nepali context. The participants reported significant increases in self-reported confidence across all technical and nontechnical trauma management skills.

The qualitative findings provide a valuable context for these results. The participants valued the realism of the simulation scenarios, the structured nature of the debriefing, and the opportunity to integrate theoretical knowledge into practical action. At the same time, they identified challenges such as limited course duration, restricted practice time, and reliance on lower-fidelity equipment. The findings of this study build on our previous work on pediatric emergency simulation in Nepal, where we documented improvements in procedural competence, confidence, and interprofessional teamwork [16]. These results indicate that simulation-based trauma training is both effective and feasible in Nepal but requires adaptation for sustainability and long-term impact.

Our participants valued the realistic nature of the simulations and supportive debriefing environments, which facilitated the learning of the technical and nontechnical skills essential for trauma care. Previous research on learner perspectives of multidisciplinary trauma training through simulation has revealed consistently positive outcomes across different healthcare settings. The significant gains in confidence and positive feedback on realism and debriefing align with global evidence supporting simulation-based

education as a transformative tool for clinical practice [15]. In previous studies, learners identified key benefits, including enhanced teamwork, improved communication, and a better understanding of roles and responsibilities [24]. Another study described a medical student-focused simulation-based training program that effectively teaches trauma-informed care principles and their application in acute care settings, improving students' confidence and familiarity with these skills [25].

A key finding from our study was the improvement in teamwork skills and interprofessional communication. The participants emphasized that the simulation sessions allowed them to practice role allocation, closed-loop communication, and coordination under time pressure-elements that are crucial for effective trauma resuscitation. These findings are consistent with those of previous studies demonstrating that simulation-based team training improves teamwork behaviors, reduces errors, and enhances patient safety. Falcone et al. reported measurable improvements in team-task completion rates (65% to 75%) over time following simulation-based training [26]. In another study, learners emphasized that effective trauma teamwork requires specific communication tailored to emergency contexts, collaborative decision-making, standardized approaches, and proficient leadership [27].

The inclusion of multidisciplinary health care professionals created a shared mental model and improved the understanding of mutual roles. In a previous study performed by Murphy et al., the multidisciplinary approach was particularly valuable, as it helped team members understand different specialty perspectives and improved their ability to function as cohesive units despite being "flash teams" that form quickly with unstable membership [28]. This is particularly important in the Nepali context, where trauma teams are often ad hoc and assembled from available staff. By rehearsing standardized approaches such as primary surveys, secondary surveys, and rapid decision-making together, participants reported feeling more prepared to function as a cohesive trauma team in real clinical scenarios.

Our study was limited to Kirkpatrick program evaluation Levels 1 and 2 [17], with a focus on participants' perceptions and self-reported confidence. While this provides valuable insight into learner satisfaction and perceived relevance, it does not objectively measure knowledge retention, behavioral change, or patient outcomes. The evidence from previous studies of ATLS and TNCC demonstrates the effectiveness of the Kirkpatrick model at a relatively high level. A comprehensive scoping review by McLaughlin et al. [29] of 47 studies confirmed that simulation-based training consistently improves teamwork, task performance speed, knowledge, and provider satisfaction, although standardized reporting methodologies remain variable across studies. Future research should aim to include these higher-level evaluations to capture the full impact of simulation-based trauma training on clinical practice and health system performance.

Our findings confirm that debriefing was a highly valued element of ATLS and TNCC training, with participants rating it consistently highly. The qualitative responses emphasized that debriefing provided a safe, structured space to reflect on performance, clarify doubts, and integrate theoretical knowledge into clinical reasoning. The impact of debriefing on learning is well supported by the literature [23].

Structured debriefing has been shown to promote deeper reflection, reinforce key concepts, and enhance the retention of both technical and nontechnical skills. In our study, the participants specifically highlighted that debriefing helped them organize their thinking around the ATLS algorithm, improving their confidence in prioritizing and sequence interventions during trauma care. However, several participants suggested that the time allocated for debriefing was too short and recommended longer or more structured debriefs. This feedback is important, as rushed debriefings may limit opportunities for participants to process emotions, analyze decision-making, and generalize lessons to clinical practice.

### Implications for trauma training in Nepal

Our findings have several practical implications for trauma education and health system strengthening in low- and middle-income countries (LMICs). The significant gains in confidence and perceived transferability suggest that simulation-based trauma training can help healthcare providers respond to trauma, a leading cause of preventable morbidity and mortality in Nepal. The blended learning design, which combines asynchronous online pre-course modules with in-person simulation, optimized the contact time for skills practice while reducing logistical demands and enhancing the program's scalability. Interprofessional training across physicians, nurses, and paramedics fostered shared mental models and communication skills, both of which are critical determinants of team performance in real emergencies. The participants identified the need for more complex clinical scenarios and improved equipment, underscoring the importance of locally adapted simulation design, creative use of low-cost task trainers, and phased investment in higher-fidelity resources. Faculty development and a train-the-trainer model are essential for sustaining and scaling trauma simulations within national training frameworks.

Resource sharing between high-income institutions and LMICs represents an underutilized mechanism for building simulation capacity globally. Simulation centers that periodically upgrade their equipment often retire monitors, manikins, and task trainers who remain fully functional. Systematic donation and repurposing of such resources could substantially reduce the financial barriers that constrain simulation-based education in resource-limited settings. Strategic partnerships of this kind, supported by faculty exchange and codeveloped curricula, can accelerate the establishment of sustainable, context-appropriate trauma training infrastructure in LMICs.

### Challenges and potential solutions

Several implementation challenges warrant consideration. The participants most commonly identified insufficient time for hands-on practice, particularly for technical procedural skills. Addressing this may require either extending the course duration or introducing iterative refreshing modules to support skill consolidation. A stepwise model comprising shorter, repeated workshops rather than a single intensive course may prove more feasible and effective in busy clinical environments where extended leave is difficult to justify. Simulator fidelity also presented constraints; lower-fidelity manikins reduced scenario realism at certain skill stations. While high-fidelity simulators remain costly, the structured use of low-cost alternatives, including purpose-built task trainers and moulage, can meaningfully enhance

immersion. Strategic investment in high-fidelity platforms could reasonably be prioritized for high-volume training centers where utilization would justify the cost.

Instructor capacity poses a further challenge. The limited pool of trained faculty resulted in suboptimal facilitator-to-learner ratios in some sessions, reducing opportunities for individualized feedback and coaching. A train-the-trainer model would expand the local instructor base, improve supervision quality, and strengthen the long-term sustainability of the program. Finally, as a novel initiative reliant on international partnerships and external funding, the program's continuity remains contingent on securing durable financial and institutional support. Integrating trauma simulation training into national health education frameworks, establishing formal links with relevant professional societies, and diversifying funding through both local and international sources will be essential for embedding this training as a sustainable component of the Nepali healthcare system.

### Strengths and Limitations

A major strength of this study is the mixed-methods design, which captured both quantitative improvements in confidence and qualitative insights into learner experiences. The use of a validated tool adds rigor, and the high response rate strengthens the representativeness of the findings.

However, there are limitations. The study relied on self-reported measures, which may overestimate actual performance. The sample size was modest, and the limited follow-up precluded the assessment of long-term retention or patient outcomes. In addition, resource limitations (e.g., course duration, equipment) may have influenced both participant experiences and results. Future studies should incorporate objective performance assessments, multi-institutional samples, and longitudinal follow-up.

## Conclusions

This study demonstrates that simulation-based ATLS and TNCC training is feasible, effective, and effective in Nepal. The participants reported significant gains in confidence, valued the practical and team-based nature of training, and expressed readiness to apply skills in real clinical scenarios. While challenges related to time, equipment, and sustainability remain, potential solutions such as modular delivery, investment in faculty development, and creative low-cost simulation strategies can address these barriers. By scaling and sustaining such initiatives, Nepal has the opportunity to build a stronger trauma care system, enhance multidisciplinary teamwork, and ultimately improve outcomes for trauma patients.

## Abbreviations

ATLS Advanced trauma life support

DASH Debriefing assessment for simulation in healthcare

LMICs Low- and middle-income countries

SBE Simulation based education

SD Standard deviation

SET-M Simulation effectiveness tool-Modified

TNCC Trauma nursing core course

## Declarations

**Ethical approval and consent to participate:** The study was approved by the Institutional Research Committee of Kathmandu University School of Medical Sciences (IRC-KUSMS Approval no. 130/25). The study was conducted in accordance with the principles of declaration. of Helsinki. Informed consent was obtained from all participants prior to enrollment. All data were anonymized and used solely for scientific purposes.

**Consent for publication:** Not applicable.

**Availability of data and materials:** All data supporting the findings of this study are available within the paper and its Supplementary Information.

**Competing interests:** The authors have no competing interests as defined by BMC, or other interests that might be perceived to influence the results and/or discussion reported in this paper.

**Funding:** This research did not receive any funding.

**Authors' contributions:** All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work. RS and APS contributed equally to this work and are designated as co-first authors. Concept and design were conducted by RS, APS, KB, and HK. Acquisition, analysis, or interpretation of data involved RS, APS, CA, and KC. Drafting of the manuscript was performed by RS and APS, while critical review of the manuscript for important intellectual content was carried out by RS, APS, KB, HK, CA, and KC. RS provided overall supervision.

**Acknowledgement:** The authors gratefully acknowledge the University of Toledo for their generous support in providing the ATLS and TNCC course resources and high-fidelity simulation manikin, which significantly enhanced trauma training capacity and advanced simulation-based education at the institution.

## References

1. Graham SM, Laubscher M, Lalloo DG et al. A tale of three pandemics: Shining a light on a hidden problem. 2022, 20:231–6. <https://doi.org/10.1016/j.surge.2021.04.005>

2. Dijkink S, Nederpelt CJ, Krijnen P, Velmahos GC, Schipper IB. Trauma systems around the world: A systematic overview. *J Trauma Acute Care Surg.* 2017;83:917–25.  
<https://doi.org/10.1097/ta.0000000000001633>.
3. Chao TE, Chu K, Hardcastle TC, et al. Trauma care and its financing around the world. *J Trauma Acute Care Surg.* 2024;97:60–4. <https://doi.org/10.1097/ta.0000000000004448>.
4. World Health Organization. Global status report on road safety. (2023).  
[https://books.google.com/books/about/Global\\_status\\_report\\_on\\_road\\_safety\\_2023.html](https://books.google.com/books/about/Global_status_report_on_road_safety_2023.html)
5. Kotagal M, Agarwal-Harding KJ, Mock C, Quansah R, Arreola-Risa C, Meara JG. Health and economic benefits of improved injury prevention and trauma care worldwide. *PLoS ONE.* 2014;9:e91862.  
<https://doi.org/10.1371/journal.pone.0091862>.
6. Sakran JV, Greer SE, Werlin E, McCunn M. Care of the injured worldwide: trauma still the neglected disease of modern society. *Scand J Trauma Resusc Emerg Med.* 2012;20:6.  
<https://doi.org/10.1186/1757-7241-20-64>.
7. Thapa A, Parajuli R, Shrestha S, Shrestha R. Trauma patients presenting to the emergency department of a tertiary care hospital: Trauma patients presentation to ED. *J Gen Pract Emerg Med Nepal.* 2024;11:32–6. <https://doi.org/10.59284/jgpeman267>.
8. Dogjani A, Haxhirexha K, Gjata A, Subashi K. The ATLS® course: Empowering healthcare professionals for excellence in trauma care. *Albanian J Trauma Emerg Surg.* 2023;7:3.  
<https://doi.org/10.32391/ajtes.v7i2.350>.
9. Silva S, Whalen KC. Trauma nursing core course for nonemergency nurses. *J Emerg Nurs.* 2014;40:486–7. <https://doi.org/10.1016/j.jen.2014.05.007>.
10. Wang P, Li N-P, Gu Y-F, et al. Comparison of severe trauma care effect before and after advanced trauma life support training. *Chin J Traumatol.* 2010;13:341–4.  
<https://pubmed.ncbi.nlm.nih.gov/21126391/>.
11. Okuda Y, Bryson EO, DeMaria S Jr, et al. The utility of simulation in medical education: what is the evidence? *Mt Sinai J Med.* 2009;76:330–43. <https://doi.org/10.1002/msj.20127>.
12. Knudson MM, Khaw L, Bullard MK, et al. Trauma training in simulation: translating skills from SIM time to real time. *J Trauma Acute Care Surg.* 2008;64:255–64.  
<https://doi.org/10.1097/ta.0b013e31816275b0>.
13. Cherry RA, Ali J. Current concepts in simulation-based trauma education. *J Trauma Acute Care Surg.* 2008;65:1186–93. [10.1097/TA.0b013e318170a75e](https://doi.org/10.1097/TA.0b013e318170a75e).
14. Shrestha R, Badyal D, Shrestha AP, et al. In situ simulation-based module to train interns in resuscitation skills during cardiac arrest. *Adv Med Educ Pract.* 2020;11:271–85.  
<https://doi.org/10.2147/amep.s246920>.
15. Shrestha R, Shrestha AP, Shrestha SK, Basnet S, Pradhan A. Interdisciplinary in situ simulation-based medical education in the emergency department of a teaching hospital in Nepal. *Int J Emerg Med.* 2019;12:12245–019. <https://doi.org/10.1186/s12245-019-0235-x>.

16. Shrestha R, Alianiello L, Aouthmany S, et al. Simulation education to advance emergency medicine and pediatric critical care in Nepal. *Int J Crit Care Emerg Med*. 2020;6:4.  
<https://clinmedjournals.org/articles/ijccem/international-journal-of-critical-care-and-emergency-medicine-ijccem-6-105.php?jid=ijccem>.
17. Reio G Jr, Tonette S, et al. A critique of Kirkpatrick's evaluation model. *Horizons Adult Educ Hum Resource Dev*. 2017;29:35–53. <https://doi.org/10.1002/nha3.20178>.
18. El Nsouli D, Nelson D, Nsouli L, et al. The application of Kirkpatrick's Evaluation Model in the assessment of interprofessional simulation activities involving pharmacy students: A systematic review. *Am J Pharm Educ*. 2023;87:10. <https://doi.org/10.1016/j.ajpe.2023.02.003>.
19. Unver V, Basak T, Watts P, et al. The reliability and validity of three questionnaires: The Student Satisfaction and Self-Confidence in Learning Scale, Simulation Design Scale, and Educational Practices Questionnaire. *Contemp Nurse*. 2017;53:60–74.  
<https://doi.org/10.1080/10376178.2017.1282319>.
20. Brett-Fleegler M, Rudolph J, Eppich W, et al. Debriefing assessment for simulation in healthcare: development and psychometric properties. *Simul Healthc*. 2012;7:288–94.  
<https://doi.org/10.1097/sih.0b013e3182620228>.
21. Manz JA, Todd MJ, Iverson L, Ball SJ, Manning L, Topp R. Validity and reliability testing of the Creighton Competency Evaluation Instrument 2.0© (CCEI 2.0). *Clin Simul Nurs*. 2020;103:10.  
<https://doi.org/10.1016/j.ecns.2025.101736>.
22. Leighton K, Ravert P, Mudra V, Macintosh C. Updating the Simulation Effectiveness Tool: Item modifications and reevaluation of psychometric properties. *Nurs Educ Perspect*. 2015;36:317–23.  
<https://doi.org/10.5480/15-1671>.
23. Maestre JM, Rudolph JW. Theories and styles of debriefing: the good judgment method as a tool for formative assessment in healthcare. *Rev Esp Cardiol (Engl Ed)*. 2015;68:282–5.  
<https://doi.org/10.1016/j.rec.2014.05.018>.
24. Murphy M, McCloughen A, Curtis K. The impact of simulated multidisciplinary Trauma Team Training on team performance: A qualitative study. *Australasian Emerg Care*. 2019;16:1–7.  
<https://doi.org/10.1016/j.auec.2018.11.003>.
25. Lee CH, Santos CD, Brown T, Ashworth H, Lewis JJ. Trauma-Informed Care for Acute Care Settings: A Novel Simulation Training for Medical Students. *MedEdPORTAL*. 2023, 19:9.  
[https://doi.org/10.15766/mep\\_2374-8265.11327](https://doi.org/10.15766/mep_2374-8265.11327)
26. Falcone RA Jr, Daugherty M, Schweer L, Patterson M, Brown RL, Garcia VF. Multidisciplinary pediatric trauma team training using high-fidelity trauma simulation. *J Pediatr Surg*. 2008;43:1065–71. <https://doi.org/10.1016/j.jpedsurg.2008.02.033>.
27. Coulthard SL, Algur E, Kaufman EJ. Leading diverse teams in high-stress trauma environments. *Curr Trauma Rep*. 2025;11:10. [10.1007/s40719-025-00288-0#citeas](https://doi.org/10.1007/s40719-025-00288-0#citeas). <https://link.springer.com/article/>.
28. Murphy M, McCloughen A, Curtis K. Enhancing the training of trauma resuscitation flash teams: A mixed methods study. 2018, 21:143–9. <https://doi.org/10.1016/j.auec.2018.10.002>

29. McLaughlin C, Barry W, Barin E, et al. Multidisciplinary simulation-based team training for trauma resuscitation: A scoping review. J Surg Educ. 2019;76:1669–80.  
<https://doi.org/10.1016/j.jsurg.2019.05.00>.

## Figures

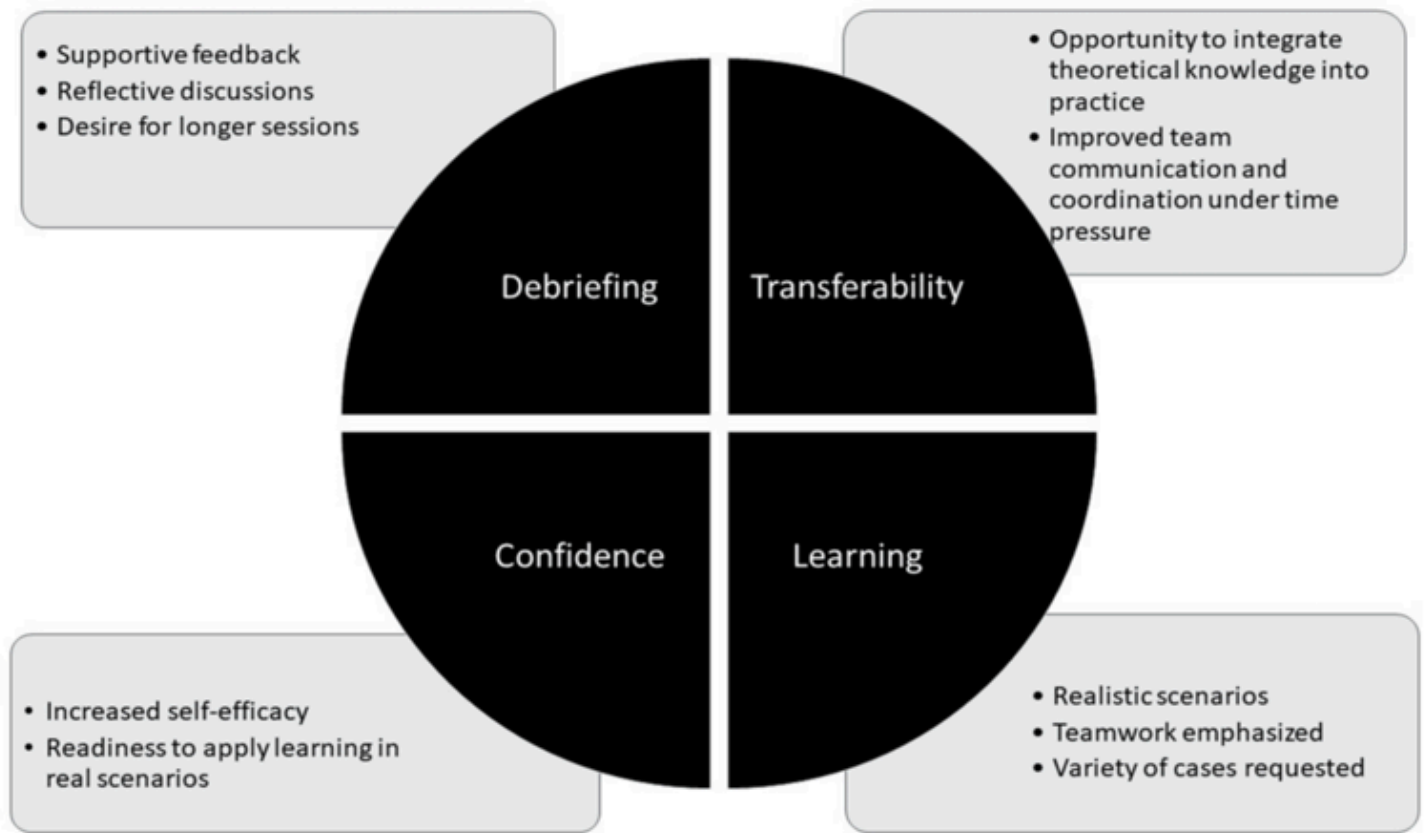


Figure 1

Qualitative themes aligned with the 4 domains (learning, confidence, transferability and debriefing)