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PISTACHIO (Primary Trauma Care Course Impact & Outcome): A prospective before and after intervention study of the Primary Trauma Care course effect on road trauma morbidity and mortality in two Vietnamese hospitals

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ABSTRACT

Background: Road trauma is a major public health problem in Vietnam. The Vietnamese medical education system is deficient in providing education to address this. The Primary Trauma Care (PTC) course has been used but not yet been evaluated for its impact on patient outcomes'. We conducted this study to assess the impact of the PTC course on patient outcomes in 2 local hospitals in Vietnam.

Methods: The research was a prospective before and after intervention study. The intervention (PTC course) was run over 2 days in 2021. The outcomes reported here are mortality at 24 hours, 30 days, and length of hospital stay. Univariate analyses were conducted using χ^2 to investigate the effectiveness of the course. Multivariate analysis was also taken to control for confounding factors. Fisher's exact test was used to discern statistical significance.

Result: The PTC course halved 24-hour and 30-day mortality from 2.9 % and 4.6 % in the pre-course to 1.0 % and 2.4 % in the post-course period respectively ($p < 0.01$). However, it failed to shorten the length of hospital stay from 9.0 ± 7.8–8.2 ± 7.1 days ($p = 0.458$).

Conclusion: The PTC course was effective in two Vietnamese hospitals in improving road trauma survival without reducing the length of hospital stay.

Introduction

Vietnam is a fast-growing Low and Middle Income Country (LMIC) in terms of both population and the economy [1]. Road trauma is a major health concern, with around 26.4 fatalities per 10^5 population and an equal rate of severe injuries per annum for the last 15 years [2,3]. This mortality figure is double that of high income countries (HICs) [4]. While inadequate road infrastructure and the preponderance of motorcycles are likely to be a major driver of these statistics, another explanation may lie in deficiencies in the Vietnamese medical system. The system has been shown to be not adapting to the change in Vietnam's disease and trauma profile, and as a consequence, contributing to high number of road trauma deaths [5]. Equipping front-line hospital staff with a systematic and timely approach to the initial evaluation and treatment of road trauma patients therefore may improve patient outcomes.

One of the initiatives to improve the quality of trauma care in the healthcare system has been to conduct short courses to address medical

" To Prof. Quyet Thang Cong, an venerables supervisor. This paper is dedicated to you, In the heaven. We all miss you"- Author team

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staff training deficiencies. Such courses include the advanced trauma life support (ATLS), trauma team training (TTT), trauma evaluation and management (TEAM), and the primary trauma care (PTC) course. The last of these is the most popular short course in Vietnam. It was conducted for the first time in Quy Nhon, Binh Dinh, on 1st May 2006. Since then numerous international and local instructors have run courses [6–9]. The course was designed to educate participants to gain knowledge, confidence, and skill in evaluating and treating injured patients [10]. All these courses have limited evidence on whether the course had any impact on patient outcomes. [11]. For this reason, we conducted PISTACHIO to investigate the impact of PTC course on patients' mortality and length of hospital stay.

Methods

Sites

The study sites were Ninh Binh (NB) and Thanh Hoa (TH) hospitals. These are frontline healthcare centres for trauma victims in northern Vietnam and serve regional populations of 3.7 million and 1 million respectively. Their role in road trauma is to receive, triage, treat and transfer severe cases to higher trauma centres in Hanoi which lies 95 km (1½ hours by road) and 168 km (2½ hours) respectively north of the study sites. [12] Both sites Emergency Departments (EDs) have 86 staff (35 doctors and 51 nurses) and 78 beds.

Study design

The study was a prospective pre- and post-intervention design conducted over 2021–22. The pre-course period was from July 2021 to February 2022. The post-course period was from February 2022 to September 2022. Road trauma patients were identified by ED staff. Data were collected contemporaneously in Vietnamese on admission and 24 hours post-ED attendance face-to-face if admitted or by telephone if discharged, and at 30 days post-ED attendance by telephone for survivors. Data collected included age, gender, types of injury (head, neck, thoracic, abdominal, limb or other trauma), International Severity Score (ISS), Revised Trauma Scores (RTS) [13], final ED disposal and vital status.

Intervention

All ED staff participated in a '2 days format' PTC course at each site in rotation to ensure appropriate staffing in the ED. In TH courses ran from the 17th to 20th of February 2021 and in NB courses from the 3rd to 6th of March 2021. The PTC course is a combination of knowledge transfer and hands-on skill stations which cover a range of clinical situations such as head trauma, abdominal trauma, limb trauma, airway management, spinal immobilization, and lock roll [10]. The detail of PTC course including list of lectures and scenarios can be found in the supplemental files.

Analysis

Stata 15.0 (College Station, TX: StataCorp LLC) was used for data analysis.[14] RTS/ISS were derived from clinical data collected at admission and used to control for injury severity [13]:

$RTS = 0.9368 \times Glasgow\ score + 0.7326 \times Systolic\ blood\ pressure + 0.2908 \times Respiratory\ rate$

$ISS = Sum\ of\ 3\ (most\ severe\ regional\ body\ trauma\ score)^2$

The outcome was 24-hour mortality. Univariable analyses were conducted using the chi-square (χ^2) test or Fisher's exact test for categorical variables and the *t*-test or Mann–Whitney *U* test for continuous variables, depending on distribution. Variables with a p-value < 0.10 in univariable analysis and those supported by existing literature or clinical relevance were included in the multivariable logistic regression model to identify factors independently associated with mortality. Adjusted odds ratios (ORs) with 95 % confidence intervals (CIs) were reported. Statistical significance was set at $p < 0.05$ in the final model. We also stratified mortality at 24 hours by level severe of ISS (Minor 1–8, Moderate 9–15, Severe 15–24, and Critical 25–75).

Length of hospital stay (LOS), another outcome, was also assessed. Due to its right-skewed distribution, LOS was log-transformed prior to analysis and analyzed using linear regression. Back-transformed estimates were presented for interpretation. All statistical tests were two-sided.

Participants

Participants for this study were patients who attended the NB and TH hospital EDs with road trauma over the specified pre- and post-intervention periods in 2021/22. Inclusion criteria: All road trauma patients presenting to participating hospitals' emergency departments at any level of severity (based on ISS-International Severity Score) [13]. Exclusion criteria were road trauma patients who were dead on arrival and where patient or family members (when the patient was unable to provide consent) declined consent. The "*patient/family member consent form*" (with detailed information on PISTACHIO) can be found in the appendix.

Outcomes

The primary outcome of PISTACHIO was educational outcomes for clinicians and are reported in a previous paper [15]. This paper reports the pre-specified secondary outcomes of 24 hour and 30 day mortality and the length of hospital stay. Vital status of participants at 24 hours and 30 days post-attendance was established by directed method if admitted to hospital, or telephone contact with the participant or a family member if discharged. Because there is no National Death Index in Vietnam there was no method of checking vital status in those lost to follow-up.

Trail registration, ethics, and funding

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Results

General demographic

During the study periods 8173 road trauma patients attended the EDs in the 2 hospitals. Consent could not be obtained from 2483 patients or their next of kin leaving a total of 5690 (70 %) participants recruited into the study. Of these, 2965 were in the pre-course period (July 2021 to February 2022) and 2725 in the post-course period (March to September 2022) (Fig. 1). Their baseline characteristics are shown in Table 1. In summary, they were predominantly male (2/3rds), and relatively young (mean age 38.6 years). The patient age of post course was greater than one of pre course with significant. The pre-course ISS was significantly greater than the post course (5.2 ± 6.1 vs 4.6 ± 5.2 $p < 0.01$). However, the RTS remained equal in both phases.

Brain, limb, and face trauma were the commonest injuries. Most participants were transferred to a general ward from the ED. A total of 92 either died in the ED or were discharged to die at home, as is the custom in Vietnam. All the later cases were confirmed by telephone by a family member.

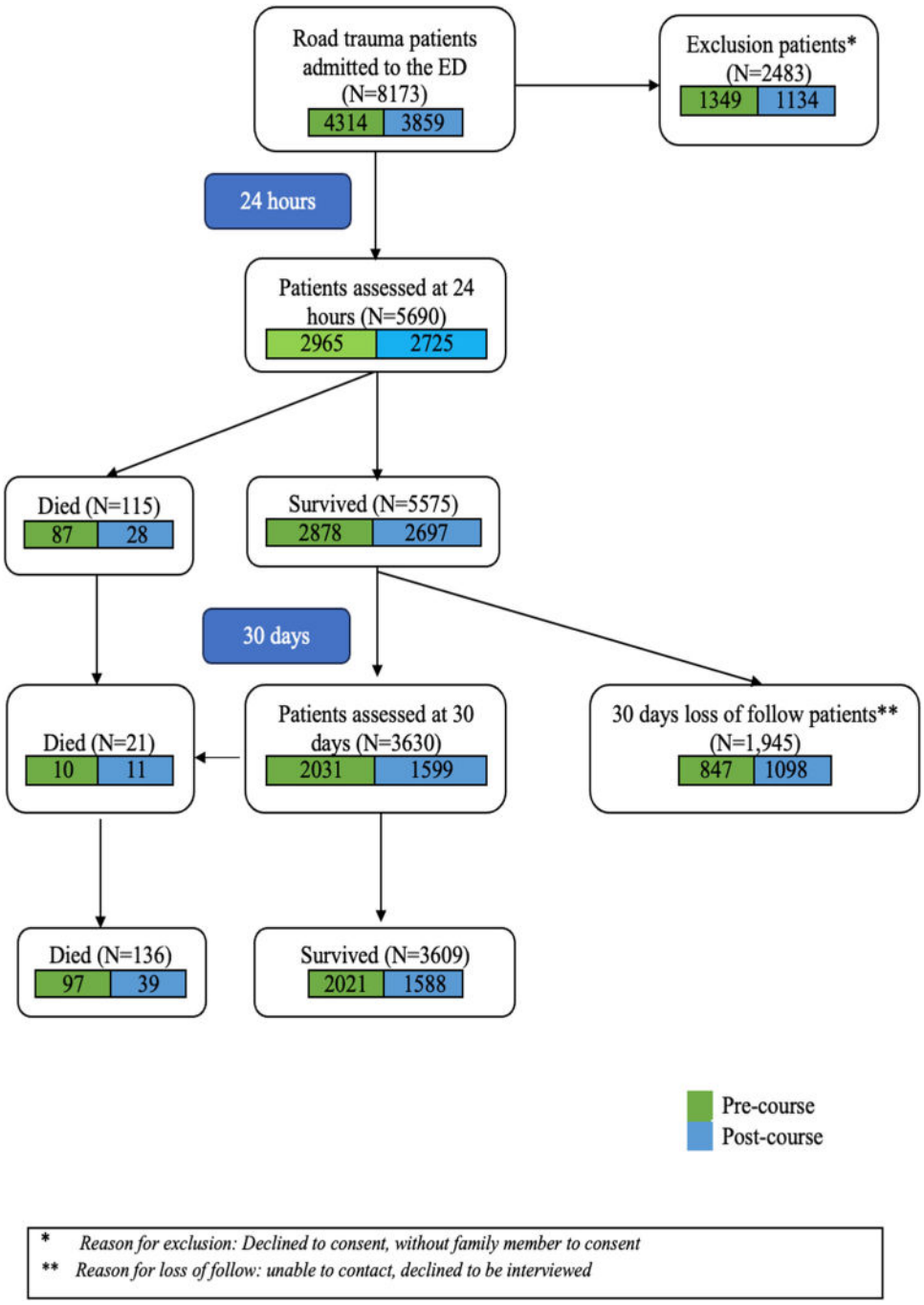

Fig. 1. Recruitment and follow-up of participants.

Severity indices

The RTS could be calculated in 98.5 % of participants and there was no difference between pre- vs post-course with $p > 0.05$

An ISS, which is consider as a potentially confounding factor in the study, could be calculated for 95.7 % of the 5690 participants. Overall, the median score was 4.0 (IQR 1.0, 5.0) pre-course and 4.0 (IQR 1.0, 5.0) post-course but 22.4 % (648/2893) of the pre-course group and only 18.1 % (461/2550) of the post-course cohort had scores greater than 8 (indicating moderate, severe or critical injury). This excess of higher scores in the pre-course group produced a significant result for the rank-sum test ($p < 0.001$). The mean scores of these heavily right-skewed data were 5.2 ± 6.1 pre-course and 4.6 ± 5.2 post-course (Table 1).

Mortality

Mortality at 24 hours and its sub-group by ISS

There were 115 (87 pre- and 28 post-course) deaths at 24 hours post-attendance, including 92 *"dead at ED/home"* and 23 dying at other hospitals (Table 1). There was a significant reduction ($p < 0.001$) in the 24-hour mortality rate in the post-course period (1.0 % 95 % CI 0.6, 1.4) compared with the pre-course period (2.9 % 95 % CI 2.3–3.5 %). The risk differences of 24 hours pre-vs post before and after adjusted for ISS are shown in Table 2.

Fig. 2 shows 24-hour mortality by ISS score severity categories. As can be seen in Fig. 2, 76.2% (4334/5690) of participants belong to a minor severity group (ISS <8), and the PTC course was successful in

Table 1
Baseline participant characteristics.

	All (n = 5690)	Pre-course (n = 2965)	Post-course (n = 2725)	P
Age (X ± SD) years	38.6 ± 17.3	37.9 ± 17.2	39.3 ± 17.5	< 0.05
Male (n, %)	3878 (68.2 %)	2034 (68.6 %)	1844 (67.7 %)	> 0.05
ISS (X ± SD)	4.9 ± 5.7	5.2 ± 6.1	4.6 ± 5.2	< 0.01
RTS (X ± SD)	7.63 ± 0.6	7.65 ± 0.6	7.62 ± 0.6	> 0.05
Site of trauma (n, %)				
1. Brain	2138 (37.6 %)	1189 (40.1 %)	949 (34.8 %)	< 0.05
2. Limb	1664 (29.2 %)	895 (30.2 %)	769 (28.2 %)	> 0.05
3. Face	1299 (22.8 %)	707 (23.9 %)	592 (21.7 %)	> 0.05
4. Skin & tissue	939 (16.5 %)	555 (18.8 %)	384 (14.1 %)	< 0.05
5. Abdominal	290 (5.1 %)	154 (5.2 %)	136 (5.0 %)	> 0.05
6. Thoracic	185 (3.2 %)	100 (3.3 %)	85 (3.1 %)	> 0.05
ED discharge				
1. Operating theatre	191 (3.4 %)	153 (5.2 %)	38 (1.4 %)	< 0.01
2. ICU	25 (0.5 %)	14 (0.5 %)	11 (0.4 %)	> 0.05
3. General ward	4790 (84.1 %)	2443 (82.4 %)	2347 (86.1 %)	< 0.05
4. Hospital discharged	414 (7.3 %)	211 (7.1 %)	203 (7.5 %)	> 0.05
5. Transferred	178 (3.1 %)	69 (2.3 %)	109 (4 %)	< 0.05
6. Dead in ED/ discharged to die at home	92 (1.6 %)	75 (2.5 %)	17 (0.6 %)	< 0.05

Table 2
The risk difference of 24 hours proportion pre- vs post-course.

	Risk difference % (95 % CI)	Relative risk difference % (95 % CI)	P
Unadjusted	−1.9 % (−2.6 to −1.2)	−65 % (−79.8–50.2 %)	< 0.05
Adjusted	−0.9 % (−1.6 to −1.2)	−71.9 % (−99.8 % to −43.9 %)	< 0.05

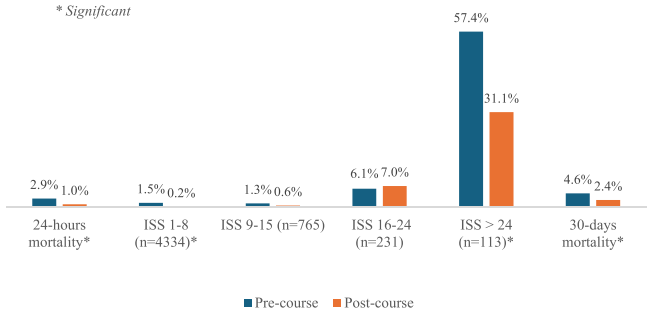

Fig. 2. 24-hour mortality with its subgroup by injury severity score.

reducing mortality in the minor group (ISS 1–8) and critical group (ISS > 24) with $p < 0.05$.

Mortality at 30 days

There were 1945 (34.2 %) uncontactable participants at 30 days post-attendance. This group had a significantly lower ISS than those retained at 30 days (4.3 ± 4.6 vs 5.2 ± 6.2, $p < 0.01$). Of the 3630 participants assessed at 30 days, there were 2031 (68.5 %) in pre-course period and 1599 (58.7 %) in the post-course period. There was a total of 136 deaths at 30 days, an overall mortality of 3.5 %. Which pre-course period (n = 97, 4.6 %) was significantly higher than the post-course period (n = 39, 2.4 %) with $p < 0.01$. The risk differences at 30 days pre- vs post-course unadjusted and adjusted for ISS are shown in Table 3.

Length of hospital stay

Information on length of hospital stay was available for 95.1 % (3452/3630) of those (n = 3630) remaining in follow-up. Overall, the mean length of stay was 6.5 (95 % CI 6.3–6.7) days. It was 6.7 (95 % CI 6.5–6.9) days pre-course and 6.2 (95 % CI 5.8–6.7) days post-course, a difference ($p = 0.027$) of −0.4 (95 % CI −0.8 to −0.1) days.

Length of stay was moderately correlated with ISS ($r = 0.40$). Adjusted for ISS, the pre-post difference of −0.1 (95 % CI −0.4, 0.2) days was smaller in absolute terms and no longer statistically significant ($p = 0.458$).

Discussion

Our study demonstrated that the PTC course conducted in a LMIC was associated with an improvement in road trauma survival at 24 hours and 30 days post-ED attendance. Despite the study design limitations, this is reliable evidence for its effectiveness as this is the period where effective acute trauma care is expected to work, and this benefit was predominantly seen in those with the severest injuries. That is, a patient attending with a minor injury is unlikely to die, and therefore, the course would not address or influence their care. The lack of any significant difference in in-hospital death rates also suggests that the improved 30-day survival was solely due to ED patient care and not general health system improvements or existing public health policies [2]. There were no new public health measures or legislated road safety measures in the study period and statistical methods to account for extant possible confounders still showed benefit. Given the 6-month time periods and the short interval between observational periods, this is also unlikely to be at play.

Patient clinical outcomes should be considered as the ultimate assessment of the effectiveness of any trauma training course or program. However, it is rarely done, even in widely conducted courses like Advanced trauma life support (ATLS) or HICs. PISTACHIO was successful in its aims. Our finding was similar to Shi XP et al. who found that mortality rates dropped from 31.9 % to 23.1 % ($p < 0.01$) within 10 years of the provision of the PTC course in China.[16] However, this was a retrospective observational study, and the 10-year period raises the probability of confounding due to other variables, such as improvements in other aspects of clinical care and population health policy [17].

According to Livergant et al., less than 7 % of all reported trauma courses can evaluate the effect on a patient's outcome [11]. Van Olden et al. assessing the clinical impact of ATLS on trauma Netherland patients, found that this course reduced mortality at the first 60 minutes of admission but failed to show improvement at 1-day and 1-week mortality [18]. This difference in result may derived from disparity setting and social economy, while Van Olden et al.'s study conducted in HIC with a small number of patients recruited (63 in both phases), with an average higher of ISS (29 ± 11) and exclusion who received first aid before admission/transferred from another healthcare centre [18], our study included more patient in LMICs with lower severity of trauma and divergence of patient sources. In contrast, there were a number of studies showing that ATLS does not affect patient survival rate [19–23]. PISTACHIO did not show an effect on the length of the hospital stay of road trauma victims (in days) as the pre-post difference of −0.1 (95 % CI

Table 3
The risk difference of 30 days proportion pre- vs post-course.

	Risk difference % (95 % CI)	Relative risk difference % (95 % CI)	P
Unadjusted	−1.9 % (−2.6 to −1.2)	−65 % (−79.8–50.2 %)	< 0.05
Adjusted	−0.9 % (−1.6 to −1.2)	−71.9 % (−99.8 % to −43.9 %)	< 0.05

−0.4, 0.2) with p = 0.458. This finding aligns with the study of Noordin et al. for Basic Life Support (BLS) and Advanced Cardiac Life Support (ACLS) courses in a tertiary hospital in Pakistan [24]. Noordin et al. found that there was no difference in length of hospital stay (in days) post- vs pre-intervention (5.9 ± 5.8 vs 6.3 ± 6.7, p > 0.05). This similarly can be explained that those courses focusing on ED care did not affect the inpatient number (and length of hospital stay), because the more severe patients who would have died were saved and admitted to the hospital, while the admissions for more minor trauma patients were avoided.

Sixty-eight percent of road trauma victims in our study were male and their average age was 38.6 (year). This finding is consistent with the Vietnamese Ministry of Health's annual report [2,25] and WHO summary regarding the characteristics of road trauma victims [26,27]. Younger males are seen as financial providers in Vietnam, extending the burden of road trauma to their dependents. It is arguable that the significant difference in average age between pre- vs post-course (37.9 ± 17.2 vs 39.3 ± 17.5, p < 0.05) may affect to the mortality incidence and weaken our study's intervention. However, there is no evidence of effect modification or confounding by age and, if there was, the older age in post-course would mitigate against us showing benefit. The level of trauma severity pre-course was higher than post-course (5.2 ± 6.1 vs 4.6 ± 5.2 p < 0.01) and was considered as the main confounding factor in our study. Our ISS was similar to the result of Murad *et al.* in trauma patients in Iraq, with an average ISS of 6.1 [28]. However, it was smaller than the ISS of Tsang et al. which the ATLS was applied in trauma centres in Canada [29]. This difference comes from the reason that our study conducted in a 'frontline hospital', which is first received trauma patients, while Tsang researched the Level I trauma centre. However, RTS, another trauma scale used in our study, showed no significant difference between the 2 phases (7.65 ± 0.6 pre-course vs 7.62 ± 0.6 post-course, p > 0.05). The disagreement between RTS and ISS was investigated in the study of Galvagno et al. [30] with the explanation is that while ISS is only based on anatomy injuries and discards physiological abnormality, RTS stress is on physiology symptoms and heavily weighted on brain trauma [31], which accounted for only around 37 % of our study population. Like many LMICs, the motorcycle was the ubiquitous form of transportation in Vietnam [25]. Not surprisingly, head and facial trauma were the most common type of injury in our study (see Table 1).

In the ED disposition sub-group, with fewer acute trauma patients, the post-course phase had a lower proportion of emergency surgery (1.4 % vs. 5.2 %, p < 0.01) and a lower rate of "die or discharge to die at home." The term "discharge to die at home" is a preference in Vietnamese culture practice that, if patient injuries are thought to be inevitably fatal, death be at home is preferred rather than in a hospital. The vital status of this subgroup was confirmed by a family member by telephone. Contrarily, the proportion of patients transferred to the general ward in the post-course outnumbered that in the pre-course (82.4 % vs 86.1 %, p < 0.05).

Limitations

This study has several limitations, including the possibility of residual confounding. Firstly, though clinically important, the outcomes reported here are secondary and, therefore, should be considered exploratory. With limited resources, we were not confident that sufficient participants would be attained for 'hard' patient outcomes. Secondly, the study design being before and after with each hospital as its own control would have been more robust as a randomized parallel intervention to prevent co-intervention. Still, financial and time constraints would not allow this. Thirdly, conducting the study during the COVID pandemic also caused concern due to public health measures reducing road trauma [32]. Fourthly, the 30-day loss to follow-up of 34.2 % may include a disproportionate number of deaths. However, the ISS correlates well with mortality [33] and was significantly lower in those lost to follow-up at 30 days compared with those not lost to follow-up, suggesting that this was unlikely the case. Actually, according to Kristman et al., 34.2 % loss of follow-up was not high, and this proportion is in the range of acceptable from 5 % to 60 % [34]. Lastly, although death is an important outcome it should be considered in the setting of quality of life. It is possible that those who did not die were shifted to a poor clinical state, with a low quality of life and a burden on their careers and the state. We will address the economic and quality of life aspects in further papers.

Conclusion

The PTC course organized in two provincial hospitals in Vietnam was associated with the reduction of road trauma mortality at 24 hours and 30 days but did not shorten hospital stay. Further investigation of other patient and healthcare system outcomes of the course, such as quality of life and cost-benefit, are required to fully evaluate the full impact of the PTC course in this setting.

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CRediT authorship contribution statement

Ba Tuan Nguyen and Mark R. Nelson conceived the idea for the study. Ba Tuan Nguyen, Toi Lam Phung, Quyet Thang Cong, and Huu Tu Nguyen collected the data. Ba Tuan Nguyen and Viet Tran drafted the manuscript. Ba Tuan Nguyen, Toi Lam Phung, and C. Leigh Blizzard are responsible for the statistical analyses. Andrew Palmer, C. Leigh Blizzard, Quyet Thang Cong, Toi Lam Phung, Marcus Skinner, Haydn Perndt, and Huu Tu Nguyen revised the manuscript. All authors have read and approved the final manuscript.

Declaration of Competing Interest

None declared.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.auec.2025.05.003.

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