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ORIGINAL RESEARCH

Effective Teaching Methods for the Assessment and Treatment of Exertional Heat Illness in Athletic Training Education

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Context: Athletic training education should focus on evidence-based teaching through providing authentic learning opportunities.

Objective: To examine the effectiveness of 2 different instructional methods' impact on pre–athletic training students' assessment and treatment of a patient with exertional heat stroke (EHS).

Design: A pretest, posttest randomized control trial study design was used.

Setting: Five undergraduate athletic training programs.

Patients or Other Participants: Thirty-six pre–athletic training students volunteered to participate. Thirty-two participants completed the research interventions (19 = hybrid simulation [HS], 13 = case-based learning [CLB]).

Intervention(s): All participants received educational material and classroom presentation regarding EHS. Participants completed the preintervention Knowledge, Preferences, and Practices of Certified Athletic Trainers Regarding Recognition and Treatment of Exertional Heat Stroke (KPP-EHS) survey. Approximately 2 to 3 weeks after receiving the educational material, the participants completed HS or CBL intervention protocol and completed the postintervention KPP-EHS survey. The HS intervention consisted of a clinical scenario using a standardized patient and rectal thermometer task trainer. The CBL intervention involved completing a case-study worksheet regarding a clinical scenario. At the 6-week follow-up time point participants completed the KPP-EHS survey.

Main Outcome Measure(s): Composite and subscale scores from the KPP-EHS survey.

Results: A factorial repeated measure 2 $\times$ 3 (Group $\times$ Time) analysis of variance revealed a statistically significant main effect for time of the total composite score of both groups ($F = 28.005$, $P = .000$, partial $\eta^2 = 0.659$). Bonferroni post hoc testing revealed a statistically significant difference between time points 1 and 2 (mean difference = –25.176, $P = .000$, 95% confidence interval –34.036, –16.317) and time points 1 and 3 (mean difference = –32.842, $P = .000$, 95% confidence interval –44.917, –20.767).

Conclusions: Athletic training educators should consider the use of HS and CBL in conjunction with didactic course work to prepare students to appropriately manage EHS.

Key Words: Hybrid simulation, case-based learning, education

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KEY POINTS

- Implementation of scenario-based learning methods is an effective way to increase knowledge in novice students.
- Hybrid simulation and case-based learning provide a transitional learning experience from didactic knowledge-based learning to clinical skill application.
- Providing a realistic learning opportunity in a safe, low-risk environment can promote critical thinking and clinical decision-making.

INTRODUCTION

Students entering professional practice must be prepared to handle roles and responsibilities of an athletic trainer (AT).[1] One of those responsibilities is the management of acute care of injury, illness, and emergencies.[2,3] Emergency management includes the effective prevention, treatment, and management of exertional heat stroke (EHS).[4] Adverse effects and deaths associated with EHS can be prevented with early recognition and treatment[5] through proper assessment of core temperature and cold-water immersion.[4,6] Despite the recommendations for appropriate EHS care, many ATs use invalid methods of assessment and treatment.[7,8] Mazerolle et al.[7,9] found ATs are not following the standard of care regarding EHS and have limited or no training on how to properly implement rectal thermometry.[7] Practicing ATs cited a lack of educational preparation and formal training as reasons for not using rectal thermometry.[7,9] To improve athletic training practice, educational activities during professional education need to provide opportunities for clinicians to integrate the most current evidence and clinical skills.[5]

In health care education, clinical skills are best taught with a semblance of realism to achieve the highest level of skill competence.[10] Providing real-time opportunities for athletic training students is essential for the transfer of knowledge learned in the didactic setting to clinical practice.[11,12] These real-time opportunities, such as patients with EHS, do not always occur during clinical education, which creates a need for athletic training educators to create authentic learning opportunities.[11] Athletic training faculty are encouraged to use innovative, student-centered teaching and learning methodologies[3] to enhance professional preparation. Case-based learning (CBL)[13,14] and simulations[15] are 2 pedagogical strategies that support the utilization of real-life scenarios.

Case-based learning, as defined by Thistlethwaite et al,[13] is the use of authentic, real-life scenarios to prepare students for clinical practice. Students report that CBL strategies enhance learning[13,16,17] and allow them to focus on specific learning outcomes such as cultural competence, critical-thinking skills, clinical reasoning, skill acquisition, and decision-making.[13,14,16–18] Simulations have also been shown to be effective in both teaching and evaluating students' clinical skills.[19] A simulation involves placing a student in a mock clinical scenario created within a physical space that replicates the actual environment with enough realism to allow the student to believe the clinical scenario is real.[15] Simulations can range from task trainers (eg, airway trainer), patient simulators (eg, computer-operated, life-sized mannequins),[20] or standardized patients (SPs).[11] Hybrid simulation (HS) uses the combination of multiple simulation modalities such as SPs simultaneously with a task trainer or patient simulator.[21,22] Research has supported the use of CBL and simulations as a means to provide authentic learning opportunities through realistic environments that allow students to learn and practice clinical skills before treating patients[23–25] while specifically increasing patient safety,[26–28] student responsibility,[29,30] communication, critical thinking, and decision-making.[27,31] To effectively educate and prepare students for clinical practice, it is imperative to determine sound pedagogical strategies to create realistic learning opportunities and equip entry-level professionals with knowledge and skills necessary to be successful ATs.

No research exists in athletic training education comparing the pedagogical strategy of CBL with HS. Researchers in athletic training have examined the effectiveness of either SPs or high-fidelity simulations on educational outcomes such as confidence, clinical skills, and knowledge.[11,20,28,31–34] Therefore, the purpose of this study was to compare 2 learning strategies, CBL using a case study and HS using a SP and a rectal mannequin task trainer, to evaluate the pedagogic effectiveness.

METHODS

Participants

A total of 36 participants from 5 Commission on Accreditation of Athletic Training Education–accredited athletic training programs within District 4 of the National Athletic Trainers' Association volunteered for this study. Participants were recruited from pre–athletic training courses to control the foundational knowledge base regarding EHS. Participants had declared athletic training as their major but were not yet accepted into the professional phase of an athletic training education program. The participants had not received any formal education regarding EHS within their pre–athletic training–specific courses. The researcher did not control for any other education, training, or experiences with EHS outside of the pre–athletic training coursework. No other demographic information was collected. This study was approved by the university's institutional review board as expedited. Participant consent was obtained during the educational session within the pre–athletic training class.

Design

A randomized control study design was used to determine the change in knowledge, preferences, and practices of pre–athletic training students regarding recognition and treatment of EHS. The research design used a preintervention survey, postintervention survey, and a 6-week retention survey using a modified version of the Knowledge, Preferences, and Practices of Certified Athletic Trainers Regarding Recognition and Treatment of Exertional Heat Stroke (KPP-EHS) survey at all time points. The KPP-EHS survey was developed and validated by Burton and Mazerolle[35] to evaluate ATs' knowledge and practice beliefs regarding EHS. The KPP-EHS survey was modified with permission from Burton and Mazzerolle[35] for use with pre–athletic training students. The survey was administered via Qualtrics (Provo, UT) at all survey time points.

All participants received a standardized educational packet about EHS. The educational material consisted of the 2015 National Athletic Trainers' Association (NATA) Position Statement on Exertional Heat Illnesses,[6] the NATA "Beat the Heat" handout,[36] Korey Stringer Institute handouts on rectal thermometry and cold water immersion,[37] and a paper copy of the voice-over PowerPoint presentation developed by faculty at the University of Wisconsin–Milwaukee.[38] All educational materials, which focused on the prevention, recognition, and treatment of EHS, were reviewed by content experts for content validity. To supplement the provided materials, participants watched the voice-over PowerPoint during the educational session in the pre–athletic training course.

After completing the education session, study participants were randomly assigned to an intervention group: HS or CBL. Study participants were e-mailed their assigned intervention group and asked to take the baseline KPP-EHS survey. The baseline survey was given after the educational session to capture their knowledge, preference, and practices regarding EHS after they received the standardized educational information. Approximately 2 weeks after the initial educational session within the pre–athletic training course, each participant scheduled an individual 30-minute HS or CBL intervention session with the principal investigator (PI). Following the intervention, each participant completed a short oral debriefing with the PI and then repeated the KPP-EHS survey. Participants were e-mailed the survey 6 weeks after the HS or CBL intervention to complete the survey for the final time. The total composite score and subscale (Knowledge, Practice, Assessment, Treatment, and Prevention) scores were calculated from the KPP-EHS survey score at each time point.

Hybrid Simulation Procedures

During the HS intervention, each participant interacted in a "real-time" encounter with a trained SP experiencing EHS. The HS encounter used a SP template and was adapted with permission. The SPs were trained during 3 separate training sessions including a complete practice scenario with a mock participant. The SPs were instructed to give appropriate responses and used a time-in/time-out method allowing for correction and feedback to facilitate an accurate assessment of EHS. The time-in/time-out method was included to provide a safe learning environment for both the student and the SP. The participants were informed they could call a time-out if they were unsure of how to proceed or needed any clarification. The SP was trained to call a time-out if the student was performing a skill incorrectly to provide a positive learning experience, give immediate feedback, and eliminate risk associated with improper skill performance. Additionally, cue cards were used when the SP could not mimic the signs and symptoms exhibited by a patient, such as rectal temperature.

Before the HS intervention, the PI provided the participant with verbal and written instructions regarding the pedagogical strategy. Instructions included explaining the role of the SP and the task-trainer model, how to implement the time-in/time-out method for any questions, and instructions to assess and treat the SP according to the clinical scenario. Participants all received the same clinical scenario. Moreover, all participants were informed there was no grading associated with the intervention. During the HS, a task trainer was available for the participant to obtain a rectal temperature. The task trainer was positioned to allow for continued verbal interaction with the SP while assessing core temperature on the task trainer. Written cue cards provided the temperature readings at each time point to allow for temperature readings true to a patient with EHS.

Once the assessment of EHS was determined via rectal temperature, each participant treated the SP with cold-water immersion using the provided cold-water tub. After 5 to 10 minutes of immersion, the participant reassessed core temperature on the task trainer to determine whether cold water immersion should be continued. The written cue cards were set to present a core temperature to allow for the discontinuation of cold-water immersion after 15 minutes. To ensure students were learning the correct assessment and treatment methods for EHS, only the correct modalities (rectal thermistor and cold-water immersion tub) were provided for the participants. The time-in/time-out method was used throughout the scenario to ensure the intervention provided a meaningful learning opportunity using best practices.

Case Study Procedures

The participants in the CBL group met one-on-one with the PI and were presented with a written copy of the identical clinical scenario as the HS group. In addition, the PI read the clinical scenario aloud to the participant and provided any clarification regarding the scenario. Following the presentation of the clinical scenario, the CBL participants were asked to complete a worksheet addressing the proper assessment and treatment of EHS. The worksheet posed questions guiding students to identify pertinent case information to recognize the signs and symptoms of EHS and to identify their assessment and treatment plan. After the completion of the worksheet, the PI engaged in verbal discourse discussing the steps participants identified within the case study and provided correction, clarification, and feedback as needed. All participants were informed before beginning the CBL that there would be no grading associated with the intervention.

Data Analysis

Composite and subscale scores were calculated for each participant on the basis of the 67-question Likert scale KPP-EHS survey for all 3 study time points: preintervention, immediately postintervention, and 6 weeks postintervention. Subscales included knowledge, practice, assessment, treatment, prevention, and confidence. Moreover, descriptive statistics were computed for the composite scores and all

Table 1. Descriptive Statistics of Survey Scores

		Hybrid Simulation Group		Case Study Group	
Subscale	Time Point	Mean ± SD	95% Confidence Interval	Mean ± SD	95% Confidence Interval
Composite	Preintervention	351.89 ± 37.6	333.77, 370.02	334.54 ± 29.1	316.98, 352.09
	Postintervention	379.63 ± 39.27	360.71, 398.56	357.15 ± 33.8	336.72, 377.59
	6-wk follow-up	388.58 ± 37.91	370.3, 406.85	363.54 ± 42.6	337.8, 389.28
Knowledge	Preintervention	238.37 ± 22.03	227.75, 248.99	229.38 ± 17.7	218.71, 240.05
	Postintervention	253.84 ± 25.55	241.53, 266.16	242.85 ± 21.6	229.8, 255.89
	6-wk follow-up	259.58 ± 21.97	248.99, 270.17	242.38 ± 27.7	225.64, 259.13
Practice	Preintervention	98.47 ± 15.69	90.91, 106.04	90.31 ± 14.6	81.46, 99.16
	Postintervention	108.11 ± 15.11	100.82, 115.39	97.54 ± 15.1	88.39, 106.69
	6-wk follow-up	110.58 ± 17.01	102.38, 118.78	104.15 ± 17.2	93.76, 114.55
Assessment	Preintervention	102.74 ± 13.98	96, 109.47	98.54 ± 12.3	91.11, 105.97
	Postintervention	110.37 ± 13.9	103.67, 117.07	105.46 ± 12.1	98.17, 112.75
	6-wk follow-up	111.42 ± 14.4	104.48, 118.36	105 ± 15.1	95.87, 114.13
Treatment	Preintervention	92.37 ± 15.2	85.04, 99.7	84.08 ± 13.5	75.92, 92.23
	Postintervention	104.11 ± 17.94	95.46, 112.75	91.62 ± 16.2	81.8, 101.43
	6-wk follow-up	107.05 ± 18.34	98.21, 115.89	98.31 ± 20.3	86.03, 110.59
Prevention	Preintervention	137.58 ± 13.23	131.2, 143.96	132.62 ± 11.7	125.54, 139.7
	Postintervention	142.89 ± 13.74	136.27, 149.52	138.62 ± 13.5	130.45, 146.78
	6-wk follow-up	146.63 ± 11.82	140.93, 152.33	138.92 ± 14.3	130.27, 147.58
Confidence	Preintervention	15.05 ± 3.566	13.33, 16.77	14.85 ± 4.04	12.41, 17.29
	Postintervention	17.63 ± 2.266	16.54, 18.72	16.77 ± 2.62	15.19, 18.35
	6-wk follow-up	18.47 ± 2.318	17.36, 19.59	17 ± 3.08	15.14, 18.86

subscale scores. A factorial repeated-measures 2 × 3 (Group × Time) analysis of variance (ANOVA) was used to measure a change between and within the intervention groups (HS and CBL) and the 3 time points (preintervention, postintervention, 6 weeks postintervention) for the overall composite score and the score of each of the 6 subscales. A P value of .05 was used to determine statistical significance. Data analysis was completed with IBM SPSS (version 22.0; IBM Corporation, Armonk, NY).

RESULTS

Of the 36 participants, 32 (88.9%) completed the KPP-EHS survey at all 3 time points (preintervention, postintervention, 6 weeks postintervention). Four participants did not complete the 6-week postintervention survey and were not included in the statistical analysis of the data. Of the 32 participants, 19 (59.4%) completed the HS intervention and 13 (40.6%) completed the CBL intervention. Missing variable analysis revealed 6 missing data points. Further analysis revealed the data points were not missing randomly; therefore, a multiple regression imputation method was used to fill in the missing data points ($P = .024$, Little MCAR test). Statistical analysis revealed the main outcome scores, and 5 of 6 subscales met the criteria for normal data distribution (Table 1).

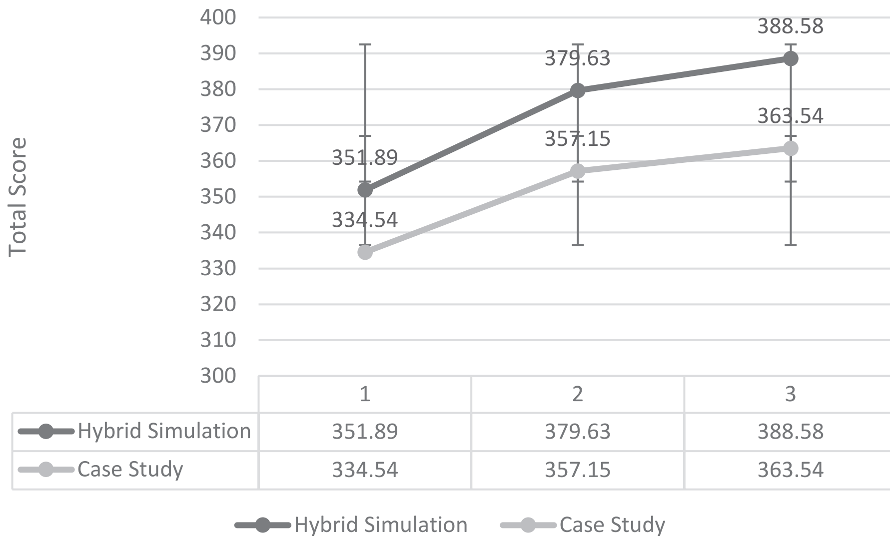
A factorial ANOVA with repeated measures 2 × 3 (Group × Time) revealed a statistically significant main effect for time of the total composite score regardless of group ($F = 28.005$, P =.000, partial $\eta^2 = .659$; Figure). Bonferroni post hoc testing revealed a statistically significant difference between time points 1 and 2 (mean difference = –25.176, p = .000, 95% confidence interval = –34.036, –16.317) and time points 1 and 3 (mean difference = –32.842, P = .000, 95% confidence interval = –44.917, –20.767). In addition, all subscale items revealed a significant difference over time. See Table 2 for the complete ANOVA table. The between-subjects effect of intervention type was not statistically significant ($F = 2.93$, P = .097), indicating there was no interaction between intervention type and total score. Also, the between-subjects effect of HS and CBL intervention found no significant differences between groups for any subscale.

DISCUSSION

The purpose of our study was to examine 2 pedagogical methods, HS compared with CBL, to determine which method positively affected pre–athletic training students' knowledge related to the assessment and treatment of EHS. We found both methods of education to increase pre–athletic training students' knowledge related to EHS over time; however, we did not find one pedagogical strategy to be more effective than the other. Both intervention groups demonstrated an increase in knowledge, practices, and preferences related to assessment and treatment of EHS from baseline to postintervention and from baseline to 6 weeks postintervention. These findings demonstrate both teaching methods are effective strategies for increasing novice pre–athletic training students' knowledge related to EHS.

Effective teaching methods are needed in athletic training education. Specifically, research has demonstrated the need for realistic learning opportunities in a safe, low-risk environment that engage critical thinking and clinical decision-making.[14,39–41] Through the creation of a realistic clinical scenario used in both the CBL and the HS, we found the ability to provide realistic, low-risk teaching opportunities. The HS method provided hands-on opportunities and allowed for real-time clinical decision-making. The CBL allowed students to make clinical decisions in a low-risk environment without the need for additional outside resources. Although these two teaching methods differed by approach, both

Figure. Composite scores change over time. Results with 95% confidence interval error bars are shown.



increased knowledge related to the recognition and management EHS.

Previous research[5] has supported the need to ensure pre–athletic training students and ATs are better educated and prepared to handle emergency care skills including the assessment and treatment of EHS. Research has revealed AT educators are not providing hands-on practice time or simulations when teaching rectal thermometry and cold-water immersion.[5] As students graduate from athletic training programs and enter professional practice, it is important they feel prepared to assess and treat all life-threatening conditions. Through the utilization of HS, we demonstrated an authentic learning opportunity for students to increase their preparedness to handle a medical emergency such as EHS.

Within the interventions, we intentionally informed students that the simulation was a nongraded learning activity and the SP would call a time-out to provide correction and feedback if any skill was performed incorrectly. These factors were included to decrease the participants' fear of failure. By allowing the participants to make clinical decisions in a low-risk environment while incorporating active-learning strategies, we hoped to promote a stress-free learning environment. According to Bledsoe and Baskin,[42] providing nongraded opportunities allows students to engage in a scenario and make clinical decisions without the fear of failure.

Table 2. Change Over Time Within Survey Subscales

	Change Over Time		
Subscale	*F* Value	*P* Value	Partial η^{2a}
Knowledge	14.76	.00	0.50
Practice	23.41	.00	0.62
Assessment	9.24	.00	0.39
Treatment	14.27	.00	0.50
Prevention	6.21	.01	0.36
Confidence	9.65	.00	0.40

[a] Partial $\eta^2 > 0.25$ = large effect size.

Exertional heat stroke is a high-risk situation and the wrong decision could mean the difference between life and death. Providing a low-risk opportunity for students to learn a skill allows students to learn from mistakes through immediate feedback. Having these opportunities and providing a safe zone of learning before being placed in a situation, where the wrong decision could have a deadly consequence, protects both the students and the patient. Through the utilization of HS and CBL, students were able to make clinical decisions, receive real-time feedback, and correct any mistakes without potential negative consequences.

As the profession transitions to graduate-level education, athletic training educators will continue to work with novice learners, requiring the continued use of authentic learning opportunities focused on clinical skills before patient interaction. In athletic training education, clinical skills are best taught with a semblance of realism to achieve the highest level of skill competence.[10] For graduate students there needs to be stronger focus on helping them gain experience and confidence in clinical skills before interacting with real-time patients. Utilization of HS can help to provide such opportunities. In addition, the 2020 Commission on Accreditation of Athletic Training Education Standards for Accreditation of Professional Athletic Training Programs, indicate simulations can be used as means to meet portions of the standards related to clinical practice.[43] The use of both CBL and HS as teaching methodologies will provide students with a transitional learning experience from didactic knowledge-based learning to clinical skill application.

Limitations/Future Research

Failing to find significant differences between intervention groups demonstrates that both teaching methods are effective strategies for increasing novice pre–athletic training students' knowledge related to EHS. The lack of a difference between groups may have been because both groups were novice learners, with this intervention providing the first encounter with exertional heat illness education. With novice learners, both methods of teaching showed a positive knowledge outcome. Future research should examine the effects of HS on students at different levels in athletic training programs specifically examining the impact of scenario-based teaching strategies in graduate education. Therefore, participants were allowed to take the baseline and follow-up KPP-EHS surveys on their own, which did not control for any utilization of outside resources when completing the surveys. Future designs should provide a structured environment for surveys for consistency in results.

Within our study we compared 2 teaching methods that used real-life scenarios. Whereas this helped us see the advantages to scenario-based methods, we lacked a control group to allow for comparison to non-scenario-based teaching methods such as classroom lecture. Future research should consider the use of a true control group to determine the effectiveness of real-life scenario versus non–scenario-based teaching methods.

An area identified as lacking in entry-level ATs is confidence, specifically confidence in emergency care–related clinical skills.[7,44,45] Future research should examine the impact of HS and CBL on increasing the confidence of entry-level ATs specifically related to high-risk, low-incidence clinical skills. In addition, as the profession transitions to graduate-level education, future research should examine the effects of CBL and HS as they relate to confidence and transition to professional practice.

Conclusions

There is documentation[12,14,33] that both simulations and case studies have positive outcomes on learning in athletic training education, which was also supported by the current study. The current study found participants in both HS and CBL groups experienced an increase in knowledge, preference, and practice related to EHS that was also retained at the 6-week follow-up period. Moving forward, athletic training education needs to continue to focus on effective teaching methods to ensure best practices are used with high-risk clinical events such as EHS. Athletic training educators should consider the use of HS or CBL in conjunction with didactic course work to prepare students to appropriately manage EHS.

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