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Athletic Training Students Demonstrate Supplemental Oxygen Administration Skill Decay, but Retain Knowledge Over Six Months

Purpose: Research suggests skill decay occurs with emergency skills, such as supplemental oxygen administration (OA), since the frequency of medical emergencies in clinical settings is low. Identifying the presence and timeline for skill decay allows educators to employ strategies to prevent this occurrence. Therefore, this study evaluated retention of knowledge and clinical skills associated with supplemental oxygen administration, specifically nasal cannula (NC) and non-rebreather mask (NrM) usage in professional athletic training students.

Methods: Cross-sectional study. Twenty-nine athletic training students (males=11, females=18; age=21.03+1.38) enrolled in a Commission on Accreditation of Athletic Training Education (CAATE)-accredited professional athletic training programs. Participants' supplemental oxygen administration knowledge and skills was assessed five times (baseline-T4). The baseline assessment was followed by an educational review session. Participants' knowledge and skills were re-assessed (T1) and then randomly assigned to two groups. The experimental group's supplemental oxygen administration knowledge and skills were re-evaluated at 1-month (T2), 3-months (T3), and 6-months (T4). The control at 6-months (T4).

Results: Analysis revealed no significant differences between the groups on knowledge ($F_{2,54}=.15, P=.86$) and overall clinical skills ($F_{2,54}=1.52, P=.23$). A significant main effect for time on knowledge ($F_{2,54}=65.30, P1.89, 50.98=112.55, P1.55, 41.88=108.03, P$

Conclusions: Both groups retained supplemental oxygen administration knowledge over 6-months. Conversely, nasal cannula and non-rebreather mask skills decayed from review session to 6-month follow-up. Regular rehearsal and practice of acute care clinical skills should be integrated into educational programs to avoid decay of skills. Since these skills are not frequently utilized in the clinical education environment, integrating opportunities to practice these skills to maintain the competence level of students and prepare them for clinical practice is warranted.

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Athletic Training Students Demonstrate Supplemental Oxygen Administration Skill Decay but Retain Knowledge over 6 Months

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ABSTRACT

Purpose: Research has shown skill decay occurs with emergency skills, such as supplemental oxygen administration (OA), because the frequency of medical emergencies in clinical settings is low. By identifying the presence and timeline for skill decay, educators are able to employ strategies to prevent this occurrence. Therefore, the retention of knowledge and clinical skills associated with supplemental oxygen administration, specifically nasal cannula (NC) and non-rebreather mask (NRM) usage in professional athletic training students was evaluated in our study. **Methods:** The study design was cross-sectional. Twenty-nine athletic training students (males = 11 and females = 18, age = 21.03 ± 1.38) enrolled in a Commission on Accreditation of Athletic Training Education (CAATE)-accredited professional athletic training program. Participants' supplemental oxygen administration knowledge and skills were assessed five times (baseline-T4). The baseline assessment was followed by an educational review session. Participants' knowledge and skills were re-assessed (T1) and then randomly assigned to two groups. The experimental group's supplemental oxygen administration knowledge and skills were re-evaluated at 1 month (T2), 3 months (T3), and 6 months (T4). The control was at 6 months (T4). **Results:** Our analysis showed no significant differences between the groups for knowledge ($F_{2,54} = .15, P = .86$) and overall clinical skills ($F_{2,54} = 1.52, P = .23$). A significant main effect for time on knowledge ($F_{2,54} = 65.30, P < .001$) that was found at baseline was significantly different than T1 and 6 months. A significant main effect for time, specifically on nasal cannula clinical skills ($F_{1,89,50,98} = 112.55, P < .001$) and non-rebreather mask skills ($F_{1,55,41,88} = 108.03, P < .001$) that was found at baseline was different than T1 and 6 months, and T1 was different than 6 months. **Conclusions:** Both groups retained supplemental oxygen administration knowledge over 6 months. Conversely, nasal cannula and non-rebreather mask skills decayed from review session to the six-month follow-up. Regular rehearsal and practice of acute care clinical skills should be integrated into educational programs to avoid decay of skills. Because these skills are not frequently utilized in the clinical education environment, integrating opportunities to practice these skills to maintain the competence level of students and prepare them for clinical practice is warranted.

Key Words: Emergency management, acute care, skill retention

INTRODUCTION

In emergency situations when the patient demonstrates signs of difficulty breathing (e.g., respiratory distress, cardiac arrest), the use of supplemental oxygen administration (OA) is a potentially lifesaving procedure.¹ The National Athletic Trainers' Association Education Competencies includes a multitude of acute care competencies, including the knowledge and skills associated with the use of supplemental OA.² Supplemental oxygen must be delivered utilizing one of many delivery devices, including the nasal cannula (NC) and non-rebreather mask (NRM).^{2,3,4} The skills associated with supplemental OA are often instructed as a course component, but exposure beyond the classroom is minimal because this skill is not one that would be regularly utilized in the clinical education setting. To emphasize this fact, over a 10-year period, there were a total of 182 National Collegiate Athletic Association student-athlete sudden deaths with 64 of those likely attributable to cardiovascular causes and other causes that included sickle cell trait and pulmonary conditions.⁵ Of these causes of student-athlete death, the use of supplemental OA would

have been indicated for use on the patient during the emergency. In fact, “when supplementary oxygen is available, it may be reasonable to use the maximal feasible inspired oxygen concentration during cardiopulmonary resuscitation (CPR).”⁶ There has been evidence to support the use of oxygen to correct hypoxia, but the use of oxygen could be harmful, increasing morbidity and mortality rates in some medical conditions.^{4,7} Whether or not to administer oxygen and/or failure to competently administer oxygen utilizing an appropriate delivery device (eg, NC, NrM) may result in poor patient outcomes.⁴ While the occurrence of emergency situations requiring this therapy in the athletic training clinical setting are relatively low, when the need arises, the use of supplemental oxygen is important to avoid the potentially harmful consequences of hypoxia.^{3,4,6}

There has been evidence to suggest that there is a rise in the degree of skill decay of a variety of acute care skills the longer an individual goes without practicing the skill and that newly attained knowledge associated with acute care may not be sustained over time.^{8-6,17} Skill decay is defined as the loss or lack of retention of acquired skills after periods of nonuse.⁸ Researchers have shown that retention of life-saving skills in health care professionals is short, despite having received appropriate initial training.⁹⁻¹⁴ While possessing competency in acute care skills is critical, it is also imperative that health care providers possess the foundational knowledge related to the intervention that they are performing, which in this case is supplemental OA. Research in which the presence of knowledge decay in addition to skill decay is very limited about health care professionals, especially pre-hospital providers. The identification of knowledge decay is vital because utilizing skills without having proper knowledge causes difficulty in applying said skills during an emergency situation.

At present, there is no research reported on acute care skill knowledge and skill decay in supplemental OA related to athletic training students (ATS). Evidence in this area can be especially useful for educators to reduce the effects of decay and support the retention of knowledge and skills over time, particularly because previous research in athletic training and other health care professions indicates a decline in psychomotor skills over a period of limited use or nonuse. Therefore, the purpose of this study was to evaluate the retention of cognitive knowledge and clinical skills associated with supplemental OA, particularly the utilization of the NC and NrM delivery devices in ATS.

Methods

Participants

After reading and signing informed consent forms, 29 athletic training students (11 male and 18 female, age = 21.03 ± 1.38 years) enrolled in the professional phase of undergraduate athletic training programs during the 2014-2015 academic year participated in the study. Participants were recruited from 2 separate undergraduate programs from 2 separate states in the same NATA district and represented all levels of the athletic training program (8 sophomores, 15 juniors, and 6 seniors). All participants were required to have successfully completed an emergency responder or an equivalent course in which supplemental OA knowledge and skills were formally taught and evaluated by a qualified instructor. Demographic data are provided in Table 1.

Table 1. Participant Demographics

	Experimental group		Control group	
	<i>n</i>	%	<i>n</i>	%
	Sex			
Men	7	46.7	4	28.57
Women	8	53.33	10	71.43
Total	15	100	14	100
	Academic Status			
Sophomore	3	20.00	5	35.17
Junior	7	46.67	8	57.14
Senior	5	33.33	1	7.14
Total	15	100	14	100

Procedures

The Institutional Review Boards at both sponsoring institutions approved this study. All participants engaged in baseline assessment procedures, including evaluation in the form of a knowledge assessment (written examination) and psychomotor

(clinical) skills evaluation. In the week following, all participants attended a review session, which included an overview of the knowledge and concepts related to supplemental OA as well as an overview and rehearsal of the associated clinical skills. During the week following the review session, participants were assessed once again about the knowledge and skills associated with the use of supplemental OA devices using the NC and NrM delivery devices, both of which are used on conscious patients.

Following the post-review session assessment (T1), participants were counter-balanced by the university before being randomly assigned to either a control ($n = 14$) or experimental group ($n = 15$). To identify a time frame for when knowledge or skill decay may occur related to the use of both the NC and NrM, the experimental group was re-evaluated after the review session at the following intervals: 1 month (T2), 3 months (T3), and 6 months (T4). The control group was only re-evaluated at the six-month (T4) mark. Figure 1 highlights the study methods and timeline.

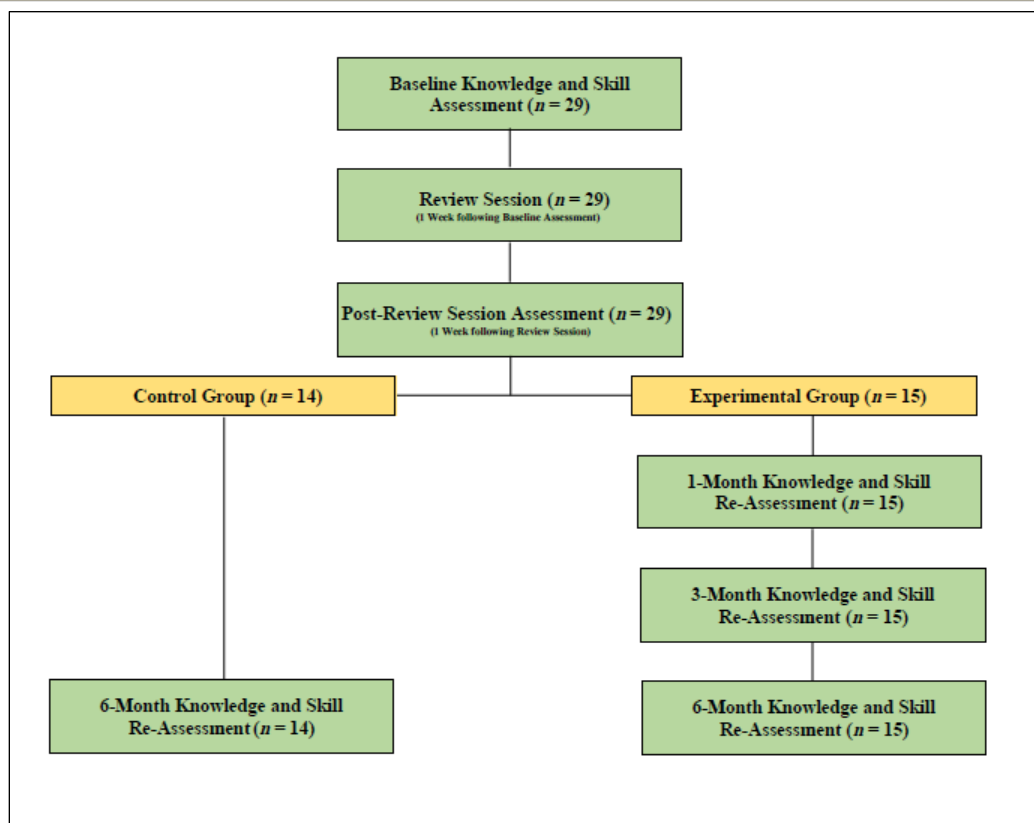


Figure 1. Study Design (Pretest-Posttest Repeated Measures)

Assessment Procedures

Participants underwent both knowledge and skill assessment procedures at various periods throughout the study. A baseline assessment was conducted in the week prior to the review session and included a knowledge assessment in the form of a 16-item, multiple-choice written examination, including five distractors and a clinical skills assessment in the form of a practical examination. The purpose of the written examination was to assess cognitive knowledge related to the use of supplemental OA, which included indications, contraindications, NC and NrM selection, and application strategies. Participants' clinical skills were assessed by participating in a practical examination related to the use of the NC and NrM delivery devices to administer supplemental oxygen and included patient and equipment preparation, fitting, and proper application of the delivery device. The NC and NrM clinical skills were assessed separately. The clinical skills were performed on an airway-training manikin. The practical examination, which contained 16 items for the NC skills and 19 items for the NrM skills, was scored utilizing a checklist that included yes/no items. All items on the skills checklist were weighted equally, and scores included the percentage of correct responses. Both the written and practical examinations were developed from professional standards related to the use of supplemental OA.³ Both assessment instruments were sent to 3 individuals with expertise related to emergency management and pedagogy to determine content validity.

After participants attended the review session, they were subsequently assessed (T1) for the knowledge and skills associated with the use of the NC and NrM delivery devices to supplemental oxygen. The purpose of this assessment was to compare results with the baseline assessments to ensure that the review session had the intended purpose of increasing knowledge and skill.

Following the post-review session assessment (T1) procedures, participants were randomly assigned to either a control ($n = 14$) or an experimental group ($n = 15$). The experimental group repeated the assessment procedures (written and practical examinations) previously described at the following intervals after attending the review session: 1 month (T2), 3 months (T3), and 6 months (T4). The frequency of this assessment was to establish a possible timeline for knowledge and skill decay. The control group was re-assessed 6 months (T4) after attending the review session. The post-review session assessment (T1) was the marker used to track knowledge and skill decay for both groups at each subsequent assessment interval. The timelines used in this study were consistent with previous studies in which knowledge and skill decay in the health care profession were evaluated.^{9-11,13-16} The same instruments were used to evaluate knowledge and skills in all assessment procedures throughout the study. The items on the multiple-choice written examination were randomized with each administration to avoid memorization. The two skills (NC and NrM) that were assessed on the practical examination were also randomized with every assessment. Furthermore, the order in which each task (written or practical examination) was conducted was randomized with every assessment.

Review Session

Once baseline assessment procedures were completed, participants attended a review session led by the investigators at his/her respective institution. The review session included the use of a standardized lecture (PowerPoint presentation with recorded voice-over) addressing the cognitive knowledge associated with the use of supplemental OA. The standardized video demonstrated the proper clinical skills associated with the use of the NC and NrM delivery devices to administer supplemental oxygen. The same lecture and video demonstration were used at each research site to ensure identical information was being conveyed to the participants. Participants were provided a hard copy of the PowerPoint lecture as well as a clinical skills review sheet that presented the skills associated with the use of the NC and NrM delivery devices to administer supplemental oxygen using established professional standards.³ After participants viewed the lecture and both videos, they practiced and observed the clinical skills associated with supplemental OA on an airway-trainer manikin. While the participants practiced their skills, the investigator provided corrective feedback and assistance as necessary. Supplemental OA skills utilizing the NC and NrM were practiced until participants felt confident in their level of proficiency based on investigator feedback.

The review sessions were conducted in an athletic training classroom/laboratory setting. Participants were requested to refrain from studying the material or practicing their skills outside of the review session. The participants were reminded about these expectations on a regular basis.

Data Analysis

Descriptive statistics were used to calculate demographic data, supplemental OA knowledge, and clinical skills scores. Repeated measures analysis of variance (ANOVA) with between-subjects (group) and within-subjects (time) effects were used to assess pre-post changes in knowledge/clinical skills scores. Data from the combined groups were analyzed at baseline, T1, and T4 to identify overall changes in knowledge and skills over time. Cronbach's alpha was used to determine internal consistency for the knowledge assessment. IBM SPSS Statistics for Windows (version 21; IBM Corp., Armonk, NY) was used to analyze the data. Alpha level was set a priori at $P < .05$.

RESULTS

Knowledge

The analysis showed no differences in supplemental OA knowledge between the experimental and the control groups ($F_{2,54} = .152$, $P = .86$) at any of the assessment intervals (Figure 2). The experimental group demonstrated a significant difference in knowledge scores over time ($F_{4,56} = 23.02$, $P < .001$, $\beta = 1.0$) in which baseline knowledge scores (67.08 ± 11.44) were significantly lower than T1 (88.75 ± 6.76 , $d = 2.3$), T2 (85.42 ± 8.07 , $d = 1.8$), T3 (83.75 ± 9.34 , $d = 1.5$), and T4 (86.25 ± 9.51 , $d = 1.8$) knowledge scores (Table 2).

There were no differences in posttest (T2) knowledge and all other assessment time frames in the experimental group. A significant difference ($F_{2,54} = 65.30$, $P < .001$, $\beta = 1.0$) was observed in the percentage of correct responses between the baseline and posttest for the combined groups in which baseline knowledge scores (66.38 ± 11.38) were significantly lower than T2 (87.50 ± 7.83 , $d = 2.1$) and T4 (84.48 ± 12.23 , $d = 1.5$) knowledge scores (Table 2). While there was a trend toward knowledge decay at T4 for the combined groups, the mean differences were not significant between T1 and T4 knowledge scores (Figure 5). The knowledge assessment demonstrated internal consistency with an alpha coefficient of .153 (minimal) at baseline and .564 (minimal) at 6 months (T4).

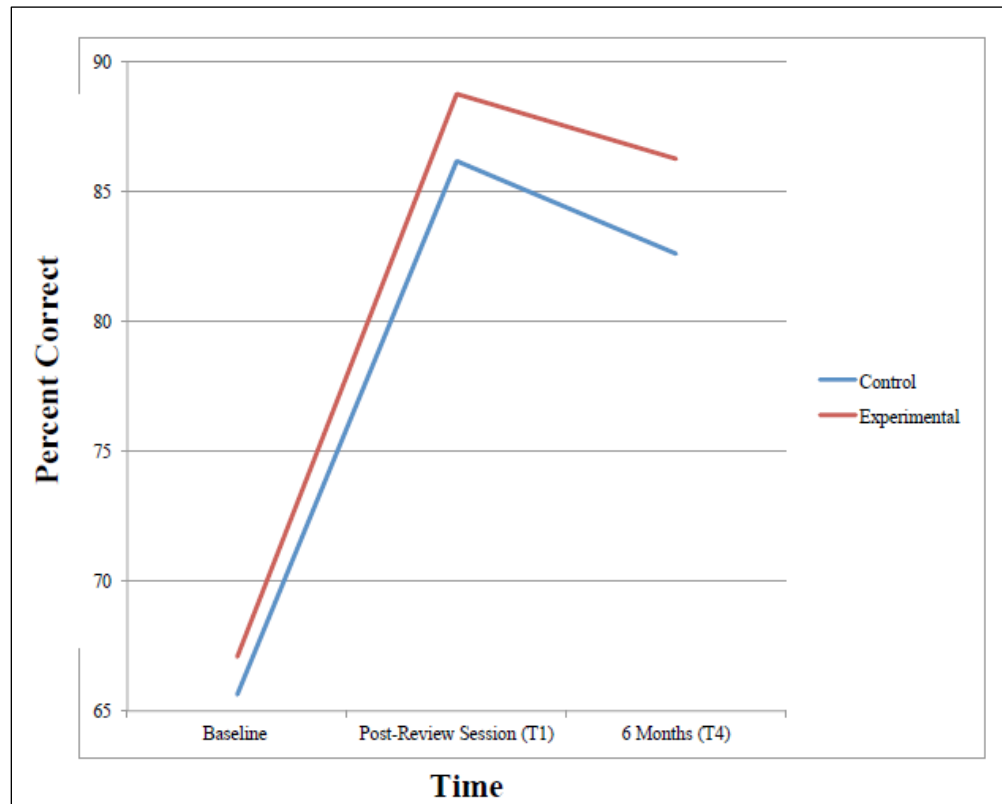


Figure 2. Between-Groups Comparison of Knowledge

Table 2. Knowledge and Clinical Skill Assessment Descriptive Data^a

Group	Baseline	Post-Review session (T1)	1 month (T2)	3 months (T3)	6 months (T4)
<u>Knowledge</u>					
Experimental (n = 15)	67.08 ± 11.44	88.75 ± 6.76	85.42 ± 8.07	83.75 ± 9.34	86.25 ± 9.51
Control (n = 14)	65.63 ± 11.69	86.16 ± 8.90	n/a	n/a	82.59 ± 14.75
Combined (n = 29)	66.38 ± 11.38	87.50 ± 7.83	n/a	n/a	84.48 ± 12.23
<u>NC Skill</u>					
Experimental (n = 15)	34.58 ± 23.84	91.25 ± 9.68	90.83 ± 9.11	83.75 ± 12.46	84.17 ± 14.15
Control (n = 14)	44.19 ± 19.68	90.18 ± 9.40	n/a	n/a	79.46 ± 18.42
Combined (n = 29)	39.22 ± 22.09	90.73 ± 9.39	n/a	n/a	81.90 ± 16.22
<u>NrM Skill</u>					
Experimental (n = 15)	47.37 ± 19.18	93.68 ± 5.70	90.53 ± 8.01	87.72 ± 10.46	90.53 ± 10.56
Control (n = 14)	51.13 ± 20.99	93.99 ± 6.14	n/a	n/a	85.71 ± 12.11
Combined (n = 29)	49.18 ± 19.81	93.83 ± 5.81	n/a	n/a	88.20 ± 11.40

^aMean scores represent the percentage of correct responses.

Clinical Skills

NC. There were no significant differences in NC skills scores between the experimental and the control groups ($F_{1.89, 50.98} = 2.07$, $P = .14$) at any of the assessment intervals (Figure 3). The experimental group showed a significant difference in NC skills over time ($F_{2.27, 31.74} = 56.89$, $P < .001$, $\beta = 1.0$) in which baseline skill scores (34.58 ± 23.84) were significantly lower than T1 (91.25 ± 9.68 , $d = 3.1$), T2 (90.83 ± 9.11 , $d = 3.1$), T3 (83.75 ± 12.46 , $d = 1.5$), and T4 (84.17 ± 14.15 , $d = 2.5$) skills scores (Table 2). More importantly, there was a difference in NC skills noted between T2 (90.83 ± 9.11) and T3 (83.75 ± 12.46), indicating a decay in that skill between 1 month and 3 months following the post-review session assessment, but no differences in NC skills between any other interval. A significant main effect for time on NC clinical skills for the combined groups ($F_{1.89, 50.98} = 112.55$, $P < .001$, $\beta = 1.0$) was that baseline skill scores (39.22 ± 22.09) were significantly lower than T1 (90.73 ± 9.39 , $d = 3.0$) and T4 (81.90 ± 16.22 , $d = 2.2$) scores, and T1 was significantly higher than T4 (Figure 5). The NC clinical skills assessment demonstrated internal consistency with an alpha coefficient .792 (extensive) at baseline and .718 (extensive) at 6 months (T4).

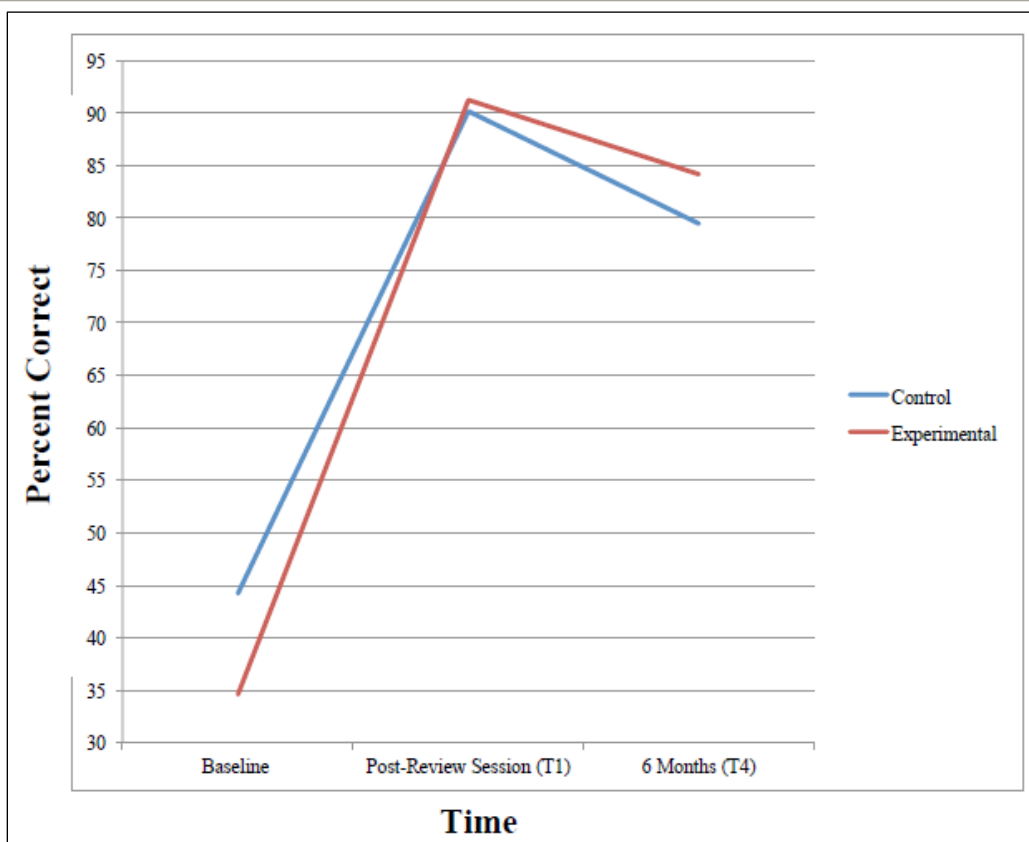


Figure 3. Between-Group Comparison of Nasal Cannula Clinical Skills

NrM. Analysis indicated no differences in NrM skills between the groups ($F_{1.55, 41.88} = .853$, $P = .41$) at any assessment interval (Figure 4). There was a significant difference in NrM skills scores ($F_{1.94, 27.17} = 71.83$, $P < .001$, $\beta = 1.0$) in the experimental group over time. Specifically, baseline skill scores (47.37 ± 19.18) were significantly lower from T1 (93.68 ± 5.70 , $d = 3.2$), T2 (90.53 ± 8.01 , $d = 2.9$), T3 (87.72 ± 10.46 , $d = 2.6$), and T4 (90.53 ± 10.56 , $d = 2.7$) skill scores (Table 2). Unlike NC clinical skills, there was a significant difference noted between T1 and T3 with T3 scores significantly lower than T1 scores. A significant main effect for time on NrM clinical skills for the combined groups ($F_{1.55, 41.88} = 108.03$, $P < .001$, $\beta = 1.0$) indicated that baseline skill scores (49.18 ± 19.81) were significantly lower than T1 (93.83 ± 5.81 , $d = 3.0$) and T4 (88.20 ± 11.40 , $d = 2.4$) scores but that T1 was also significantly higher than T4 (Figure 5). The NrM clinical skills assessment demonstrated internal consistency with an alpha coefficient .822 (exemplary) at baseline and .670 (moderate) at 6 months (T4).

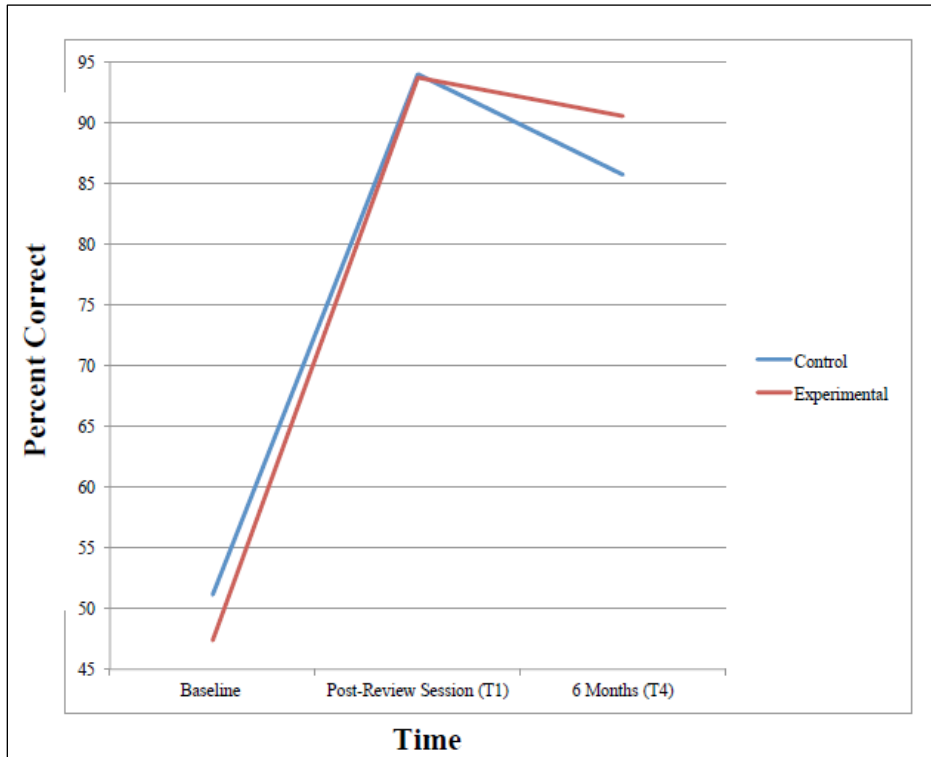


Figure 4. Between-Group Comparison of Non-Rebreather Mask Clinical Skills

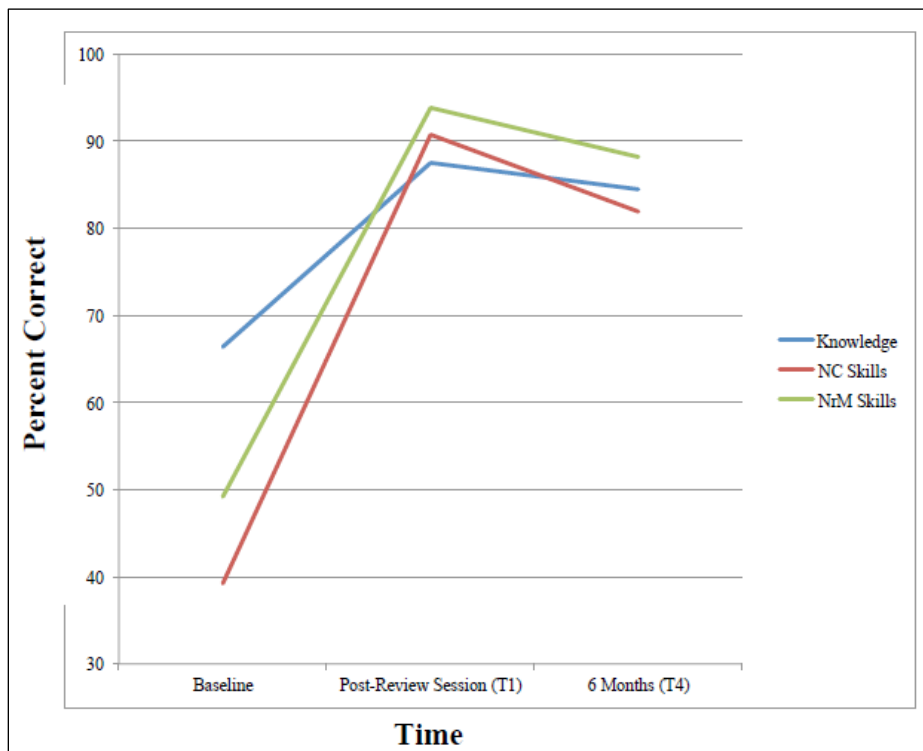


Figure 5. Combined Groups Changes in Assessments Over Time

DISCUSSION

Knowledge Retention

The results indicated that supplemental OA knowledge is retained over a six-month period of time (Figure 5). All participants in this study demonstrated improvements in their cognitive knowledge from baseline assessment to the post-review session assessment, and knowledge was retained in both groups over 6 months. However, there was a noted decline in scores that would suggest a trend of knowledge decay in the combined groups at 6 months, but this decline in knowledge was not statistically significant, and the average scores of all participants was greater than 80%. The experimental group did not perform statistically better on the knowledge assessment at the six-month interval, despite having multiple assessments. Important to note is that the combined group assessment scores were reflective of subpar performance on the baseline assessment, indicating a need for review for all students on a regular basis.

Research related to knowledge retention of acute care skills is limited and results are mixed. The results of our study are consistent with a previous study in which ATS retained cognitive knowledge related to airway management over 6 months.⁹ In addition, Smith and colleagues reported that nurses retained knowledge in both basic life support (BLS) and advanced cardiac life support (ACLS), which included supplemental OA.¹⁰ Interestingly, the nurses who signified increased confidence performed better on knowledge assessment and their ability to perform BLS or ACLS.¹⁰ Likewise, a variety of health care providers (e.g., pediatric residents, emergency medicine attending physicians, and nurses) retained cognitive knowledge in defibrillator pad choices and placement on children following 6 months of training.¹⁸ Interestingly, Fraser et al indicated that participants who spent less than 25% of their time managing pediatric patients were not as accurate in defibrillator pad choices and placement, suggesting that continual training for content not often clinically applied is crucial to maintaining proficiency.¹⁸

Conversely, Curry and Gass found that after 6 months of CPR training, physician knowledge deteriorated to a pre-training level while nurses maintained their knowledge over 12 months.¹⁹ Madden reported that 72% of nursing students achieved a pass standard immediately following CPR training, but only 44% achieved a pass standard 10 weeks later.²⁰ Similarly, nurses failed to retain cognitive knowledge related to trauma 3 months after taking the course.²¹ Clearly, the evaluation of knowledge retention associated with acute care skills is conflicted. Regardless of the fact that the present study did not indicate a significant decay in knowledge over 6 months but trended towards decay is noteworthy, given the fact that participants were formally instructed in the content on 2 separate occasions (emergency responder or equivalent course required within the respective athletic training programs and the review session as a component of this study). Additionally, the fact that the experimental group had repeated exposure to the knowledge assessment and still trended towards decay is concerning. This finding is consistent with research by Su et al who reported that paramedics improved knowledge scores following a pediatric resuscitation course but still had significant cognitive knowledge decay at 12 months, despite the fact that 75% of study participants were exposed to an educational intervention at 6 months.¹⁷

Skill Retention

The clinical skills associated with supplemental OA using a NC and NrM decayed in the combined groups over a six-month period (Figure 5). The purpose of having an experimental group who endured more frequent assessments was to identify a timeline for skill decay, should one exist. We found that NC skills decayed significantly between the one-month and three-month assessment, but there were no other significant differences amongst any of the NC assessments following the review session. The NrM skills also decayed significantly between the post-review session assessment and the three-month assessment interval with no other significant differences among any of the other assessments following the review session. Because both the NC and NrM had a significant decline in skills at the three-month assessment interval may indicate that 3 months is the point when skills decline substantially. However, it is worth noting that both NC and NrM skills declined steadily at the one-month and three-month assessment intervals. The improvement in NC and NrM skill scores by the experimental group at the six-month assessment interval is unexpected. However, when the groups were combined, it was found that both NC and NrM skills demonstrated significant skill decay between the post-review session assessment and 6 months. The experimental group did not perform NC or NrM skills significantly better than the control group, despite having multiple trials.

Our study demonstrated findings related to skill decay of acute care skills that is consistent with those in other health care professions. Popp and Berry found that airway management clinical skills decreased significantly in ATS at 6 months following an instructional review session.⁹ In another study, clinical skills associated with BLS skills in nurses dropped from a 100% pass rate to a 66.7% pass rate just 3 months after the initial training.¹⁰ Additionally, after 9 months following initial training, the pass rate declined from 92.9% to 35.7%.¹⁰ In novice paramedics, Ruetzler et al reported a decline in endotracheal intubation skills from 78% success rate to a 58% success rate after 3 months.¹⁴ In a different study, endotracheal intubation skills in paramedics dropped significantly in 6 months from initial training while self-efficacy did not decay at the same rate.¹¹ Youngquist et al suggested that

while health care professionals feel capable of performing a clinical skill, they may not perform the skill at a level of proficiency due to skill decay.¹¹

In similar research, Anderson et al evaluated lay persons' ability to provide acute care and found that CPR skills of workplace first responders also demonstrated a notable pattern of skill decay as early as 30 days after initial training.¹² After initial training, 100% of first responders demonstrated competence in the application of extrication cervical collars, but only 61% maintained this competence after 12 months.¹⁵ Kovacs et al evaluated supplemental OA skills in health science students and found that skills decreased by 25% over a 10-month period with the sharpest decrease occurring in the first 16 weeks.¹³ Additionally, McKenna and Glendon showed a 50% decline in CPR skills over a two-month period, and they found that only 2.4% of participants trained in CPR were deemed competent after 3 years.²²

The lack of adequate and timely practice of a psychomotor skill results in the decay of that skill over time.⁸⁻¹⁶ Skill decay is markedly problematic in cases in which individuals receive initial training for knowledge and skills that may not be required for use for a long period of time as was the case with the students participating in this study.⁸ We support previous findings in athletic training that skill decay occurs in the athletic training education acute care competencies.⁹ However, the decline in NC and NrM clinical skills should not be associated with a total loss of skills. At the six-month assessment interval, the combined groups mean scores averaged over 80%. Therefore, some components of the skills were maintained even though the overall skills decayed over time. Smith and colleagues identified factors that negatively affect skill retention, including (1) insufficient hands-on practice, (2) inconsistent teaching, (3) unrelated course content, (4) complex instruction, (5) delays between instruction and skills practice, (6) lack of supervision, (7) low instructor feedback, and (8) instructor incompetence.¹⁰ Therefore, educators should be cognizant of these factors and make strides to improve potential problem areas in the curriculum in order to retain acute care skills in ATS.

Our findings are consistent with findings in athletic training and other health care professions that decay occurs in acute care skills. The decline in NC and NrM clinical skills should not be associated with a total loss of skills. Mean skills scores were over 80% for the combined groups 6 months following instruction. Therefore, even though there was a decay of skills, some components of the skills were maintained.

Studies in which there was a deliberate practice of skills on a regular basis showed less decay of skills.^{11,13,16} Hein et al engaged paramedic students in a simulation experience at 6 months following initial instruction for an airway insertion skill and found that participants retained skill better than those who did not participate in the simulation.²³ In similar research, it was found that independent skill practice plus instructor feedback at regular intervals was effective in maintaining clinical skills associated with supplemental OA.¹³ Additionally, advanced cardiac life support skills were retained over 14 months by medical residents who engaged in deliberate practice and small group simulation-based educational interventions.¹⁶ Broomfield reported that a CPR "refresher" course showed initial improvement in CPR skills, but those skills again deteriorated 10 weeks later.²⁴

In order to combat the occurrence of skill decay in acute care skills, athletic training educators (and practicing athletic trainers) should consider the implementation of regular educational interventions. We are aware of many programs that engage in annual training and programming prior to the start of the academic year. Because there is sufficient evidence to suggest that acute care skills decay, these skills should be included in annual training with a skill refresher mandated 6 months later. Another mechanism to combat skill decay is to require students to attend supervised laboratory activities in regular intervals (e.g., every 6 months), which focus on acute care skills. The use of simulations is another means of incorporating the rehearsal of acute care skills. Finally, both students and preceptors would benefit from regularly planned clinical integration proficiencies or activities that emphasize the acute care skills in the clinical education setting, which would serve to thwart the effects of skill decay that occur with nonuse of that skill.

Limitations and Suggestions for Further Research

The knowledge and clinical skills assessed in our study only included the use of supplemental OA, specifically the use of the NC and NrM. The incorporation of other acute care competencies and a larger sample size could strengthen the confidence in the conclusions of this study. Even though we found that there was a trend towards skill decay at each assessment interval following the posttest, we noted a significant decline in both NC and NrM skills of the experimental group at 3 months following the review session. When both groups were combined, we noted significant decreases in both NC and NrM skills at the six-month assessment period. Utilizing a larger number of participants and incorporating other acute care competencies may find a difference in the timeline for knowledge and/or skill decay. Despite the fact that participants were continually reminded to refrain from studying the material or practicing their skills outside of the review session, this action is contrary to the activities instructors would normally expect of students in preparation for a skills assessment, which may have affected the results. Additionally, there was no formal inquiry conducted to ensure it was the case. This explanation could be the reason for the experimental group's increase in scores

for the knowledge assessment and both skills assessments at the six-month interval. However, it should be noted that in an emergency, time will not be allocated to “review” the necessary procedure. A convenience sample was used of participants who were recruited due to their enrollment in our programs and would be available for participation in a long-term study, and the sample was not counter-balanced by academic status. The type and level of initial training may have affected the cognitive and psychomotor skills. The 2 lead investigators scored practical exams at their respective institutions, resulting in a level of subjectivity even though a standardized checklist was used. The majority of participants scored very poorly on the baseline knowledge assessment, resulting in low internal consistency of the instrument, which was somewhat improved at the six-month assessment interval when participants performed better. To better examine knowledge retention and retention, it might be beneficial to add more items and increase the sample size and rigor of the knowledge assessment instrument in future research. For this study, a cutoff score for an acceptable level of proficiency or criticality of items on the written and/or practical examinations were not developed and should be furthered researched. Finally, it would be worthwhile to determine how various educational interventions affect supplemental OA knowledge and skills retention.

CONCLUSIONS

Our study presented evidence to suggest that skill decay occurs in athletic training clinical skills associated with the acute care competencies. It was found that supplemental OA clinical skills decayed significantly over 6 months. Conversely, our study demonstrated that knowledge might not decay as rapidly as skill. In order for students to maintain their skills in these critical areas, regular rehearsal of acute care clinical skills is necessary. Because these skills are not frequently utilized in the clinical education environment, athletic training programs should integrate opportunities to practice these skills to maintain the competence level of students and prepare them for clinical practice.

REFERENCES

1. Branson RD. Pre-hospital oxygen therapy. *Resp Care*. 2013;58(1):86-97.
2. National Athletic Trainers' Association. *Athletic Training Education Competencies*, 5e. Dallas, TX: National Athletic Trainers' Association; 2011.
3. Miller MG, Berry DC. *Emergency Response Management for Athletic Trainers*. Baltimore, MD: Lipponcott Williams & Wilkins; 2011.
4. O'Driscoll R. Emergency oxygen use. *BMJ*. 2012;345(7886):39-43. [PMID: 23078806]
5. Maron BJ, Hass TS, Murphy CJ, Ahluwalia A, Rutten-Ramos S. Incidence and causes of sudden death in U.S. college athletes. *J Am Coll Cardiol*. 2014;63(16):1636-43. [PMID: 24583295]
6. Link MS, Berkow LC, Kudenchuk PJ, Halperin HE, Hess EP, et al. Part 7: Adult advanced cardiovascular life support: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation*. 2015;132(18suppl 2):S444-64. [PMID: 26472995]
7. Rodrigo GJ, Rodriguez Verde M, Peregalli V, Rodrigo C. Effects of short-term 28% and 100% oxygen on PaCO₂ and peak expiratory flow rate in acute asthma. *Chest*. 2003;124(4):1312-7. [PMID: 14555560]
8. Arthur W, Bennett W, Stanush PL, McNelly TL. Factors that influence skill decay and retention: A quantitative review and analysis. *Human Perf*. 1998;11(1):57-101.
9. Popp JK, Berry DC. Athletic training students demonstrate airway management skill decay, but retain knowledge over six months. *Athl Train Ed J*. 2016;11(4):173-80.
10. Smith KK, Gilcrease D, Pierce K. Evaluation of staff's retention of ACLS and BLS skills. *Resuscitation*. 2008;78(1):59-65. [PMID: 18406037]
11. Youngquist ST, Henderson DP, Gausche-Hill M, Goodrich SM, Poore PD, Lewis RJ. Paramedical self-efficacy and skill retention in pediatric airway management. *Acad Emerg Med*. 2008;15(2):1295-303.
12. Anderson GS, Gaetz M, Masse J. First aid skill retention of first responders within the workplace. *Scan J Trauma Resusc Emerg Med*. 2011;19:11. [PMID: 21303536]
13. Kovacs G, Bullock G, Ackroyd-Stolarz S, Cain E, Petrie D. A randomized controlled trial on the effect of educational interventions in promoting airway management skill maintenance. *Ann Emerg Med*. 2000;36(4):301-9. [PMID: 11020676]
14. Ruetzler K, Roessler B, Potura L, Priemayr A, Robak O, et al. Performance and skill retention of intubation by paramedic using seven different airway devices—a manikin study. *Resuscitation*. 2011;82(5):593-7. [PMID: 21353364]
15. Ireland CJ, Zietz KM, Bridgewater FH. Acquiring and maintaining competence in the application of extrication cervical collars by a group of first responders. *Prehosp Disaster Med*. 2008;23(6):530-6. [PMID: 19557970]
16. Wayne DB, Siddall VJ, Butter J, Fudala MJ, Wade LD, et al. A longitudinal study of internal medicine residents' retention

- of advanced cardiac life support skills. *Acad Med.* 2006;81(10 Suppl):S9-12. [PMID: 17001145]
17. Su E, Schmidt TA, Mann NC, Zechnich AD. A randomized controlled trial to assess decay in acquired knowledge among paramedics completing a pediatric resuscitation course. *Acad Emerg Med.* 2000;7(7):779-86.
 18. Fraser KN, Kou MM, Howell JM, Fullerton KT, Sturek C. Improper defibrillator pad usage by emergency medical care providers for children: an opportunity for reeducation. *Am J Emerg Med.* 2014;32(9):953-7. [PMID: 25059884]
 19. Curry L, Gass D. Effects of training in cardiopulmonary resuscitation on competence and patient outcome. *CMAJ.* 1987;137(6):491-6. [PMID: 3651910]
 20. Madden C. Undergraduate nursing students' acquisition and retention of CPR knowledge and skills. *Nurse Educ Today.* 2006;26(3):218-27. [PMID: 16314002]
 21. Tippet J. Nurses' acquisition and retention of knowledge after trauma training. *Accid Emerg Nurs.* 2004;12(1):39-46. [PMID: 14700571]
 22. McKenna SP, Glendon IA. Occupational first aid training: decay in cardiopulmonary resuscitation (CPR) skills. *J Occup Psychol.* 1985;58:109-17.
 23. Hein C, Owen H, Plummer J. A training program for novice paramedics provides initial laryngeal mask airway insertion skill and improves skill retention at 6 months. *Simul Healthc.* 2010;5(1):33-9. [PMID: 20383089]
 24. Broomfield R. A quasi-experimental research to investigate the retention of basic cardiopulmonary resuscitation skills and knowledge by qualified nurses following a course in professional development. *J Adv Nurs.* 1996;23(5):1016-23. [PMID: 8732531]