ATHLETIC TRAINERS' ABILITY TO ESTABLISH PERIPHERAL INTRAVENOUS ACCESS

A Thesis
Submitted to the Graduate Faculty
of the
North Dakota State University
of Agriculture and Applied Science

By

Elizabeth Debra McCormack

In Partial Fulfillment of the Requirements
for the Degree of
MASTER OF SCIENCE

Major Program:
Advanced Athletic Training

April 2022

Fargo, North Dakota

North Dakota State University
Graduate School

Title

Athletic Trainers' Ability to Establish Peripheral Intravenous Access

By

Elizabeth Debra McCormack, LAT, ATC, NREMT

The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

MASTER OF SCIENCE

SUPERVISORY COMMITTEE:

Dr. Katie Lyman
Chair

Dr. Kara Gange

Dr. Jennifer Longo

Dr. Jay Albrecht

Approved:

April 14, 2022
Date

Dr. Yeong Rhee
Department Chair

ABSTRACT

Certified athletic trainers (AT) are usually the first to respond to an athletic emergency heat illness (EHI) and are expected to provide prehospital care. The goal of this study was to investigate the percentage of athletic trainers who could successfully place an intravenous (IV) line and retain the skill for 30 days. Fifteen ATs received an educational training on how to place an IV from a nationally registered paramedic (NR-P) Those ATs who were successful in administering an IV were asked to report 30 days later for follow-up. Data were analyzed to compare IV placement success rates, confidence levels before and after each attempt, and ATs perceived value in the newly learned skill. The concept of ATs' success in IV placement will need additional study to help develop athletic training educational curricula and modify any prehospital care standards if necessary.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ABBREVIATIONS

AEMT	Advanced Emergency Medical Technician
ALS	Advanced Life Support
ATP	Athletic Training Program
AT	Certified Athletic Trainer
BOC®	Board of Certification
BMI	Body Mass Index
CAATE	Commission on Accreditation of Athletic Training Education
CDC	Center for Disease Control and Prevention
CEU	Continuing Education Unit
CNS	Central Nervous System
CVC	Central Venous Catheter
EAP	Emergency Action Plan
EAMC	Exercise Associated Muscle Cramps
ECE	Executive Committee for Education
EHI	Exertional Heat Illness
EHS	Exertional Heat Stroke
EMS	Emergency Medical Services
EMT	Emergency Medical Technician
EMR	Emergency Medical Responder
IRB	Institutional Review Board
IV	Intravenous
NATA	National Athletic Training Association
NCAA	National College Athletics Association

NREMT.....National Registry of Emergency Medical Technician

NR-P .....Nationally Registered Paramedic

PIV .....Peripheral IV

PIVC .....PIV cannulation

SCT .....Sickle Cell Trait

SORT .....Strength of Recommendation Taxonomy

WBGT.....Wet Bulb Globe Temperature

1. INTRODUCTION

1.1. Overview of the Problem

The Commission on Accreditation of Athletic Training Education (CAATE) 2020 educational standards have deemed it appropriate to include intravenous (IV) placement in the curriculum as a standard for entry-level, professional athletic training students.[1] Students completing an athletic training program are required to graduate with the following skills based on the corresponding CAATE standards: manage patients with life threatening or emergent conditions (Standard 70), administer medications (Standard 75), manage fluid intake during activity (Standard 83), evaluate environmental conditions to prevent environmental illnesses (Standard 85), and develop and implement emergency action policies (Standard 92).[1] Standards 70 and 75 indicate athletic trainers (AT) can initiate life-saving measures and administer medications to patients in emergent conditions, implying that under a physician's orders they can establish and place an IV. Standards 83, 85, and 92 give direction that ATs can manage environmental illnesses, including heat illnesses that may warrant intravenous therapy. These published standards suggest that IV placement is a skill that ATs are qualified to implement in the event of an emergent condition.

Starting an IV is within the athletic trainer's scope of practice and is a skill that can improve patient care in an emergency heat illness (EHI).[2] Currently, the gold standard of care for an EHI is to identify a patient in distress, take a core temperature reading via a rectal thermometer, initiate cooling methods and monitor the patient, and transport once the body temperature has decreased.[2] ATs can further enhance their care for a patient exhibiting signs and symptoms of EHI by establishing prehospital IV access and expediting prehospital fluid

therapy.[3] The published position statements by the National Athletic Trainers' Association (NATA) provide guidelines, resources, and direction for ATs to manage heat illness.[2,4,5]

However, many ATs do not routinely practice IV placement in traditional settings or have never received formal education specific to the medical intervention Additionally, each state has their own practice act that dictates an AT's actions, and ATs are legally obliged to follow their physician's standing orders.[6] For example, while the practice acts for both Minnesota and North Dakota clearly define the role of ATs in providing emergency care, they lack specific guidelines or explicit wording regarding the expectation for ATs to place IVs.[7,8]

1.2. Statement of Purpose

The purpose of this study was to determine the proficiency of the AT in placing peripheral IVs. This study also tested their retention of the newly learned psychomotor skill. Published research that specifically evaluates an AT's ability to place IVs or retain the skill of placing IVs is lacking. Furthermore, this research was designed to examine the relationship between ATs and their perceived value of learning the skill. The research also measured ATs' confidence in learning the skill. Finally, this study included demographic covariates to determine whether education or job setting determines IV placement success.

1.3. Research Questions

Q1: What percentage of participants successfully place an IV on the day of the educational intervention?

Q2: What percentage of participants successfully place an IV 25-45 days after the educational intervention?

Q3: What is the change in self-confidence of ATs between day one and day 25-45?

Q4: What is the AT's perceived value of learning IV placement?

Q5: What is the relationship between the participant's education level and job setting and their IV performance?

1.4. Definitions

Athletic Trainer (AT): "highly qualified, multi-skilled health care professionals who render service or treatment, under the direction of or in collaboration with a physician, in accordance with their education, training and the state's statutes, rules and regulations. As a part of the health care team, services provided by athletic trainers include primary care, injury and illness prevention, wellness promotion and education, emergent care, examination and clinical diagnosis, therapeutic intervention and rehabilitation of injuries and medical conditions."[9]

Intravenous Therapy (IV): "therapy that delivers fluid into veins in the body by using an injection with a syringe or via infusion."[10]

Emergency Heat Illness (EHI): "Heat emergencies are health crises caused by exposure to hot weather and sun."[11]

Exertional Heat Stroke (EHS): "a core body temperature greater than 104° to 105°F (40.0° to 40.5°C) with associated central nervous system dysfunction."[12]

Confidence: "a feeling or belief that you can do something well or succeed at something"[13]

1.5. Limitations

Several limitations were present in this study and may affect the generalizability of findings. Participants in this study learned and performed venipunctures in a controlled laboratory setting after first receiving training on how to perform the skill. Athletic trainers who must perform a venipuncture in a true emergency or job setting may experience environmental challenges, which could lead to changes in accuracy or confidence. A second limitation is the

local population from which subjects were recruited. A convenience sample consisting of certified athletic trainers from the Fargo-Moorhead region of the United States were recruited for the study. Athletic trainers in other regions across the country might receive different education or have different experiences with emergency heat illnesses. Additionally, since this research used human arms for IV placements instead of manikins or simulation devices, the exclusion criteria automatically excluded any person with a fear of needles (Trypanophobia), any medical condition that prevents repeat IV placements, or any blood clotting disorders.

1.6. Delimitations

Published research about IV placement skill retention for ATs is limited compared to other allied health care providers, such as Paramedics (NR-P) and nurses. Being unable to locate additional research, ATs were chosen as the study population because they are the first responders for many athletic events and must treat EHI appropriately. Therefore, the results of this study cannot be generalized to other health care professions. In addition, the study population was limited to athletic trainers in the Fargo-Moorhead area who do not routinely place IVs at their jobsite. Data was taken on day 1 and in the 25-45 day follow up window. The duration of the study helped to measure short-term skill acquisition and retention among ATs.

1.7. Assumptions

Assumptions in this study include that participants were honest with their demographic information and previous work history. Also, since confidence was measured by questionnaire, the researchers must assume each subject answered each item truthfully and accurately. The researchers must also assume that each participant gave maximal effort while learning IV placement and venipuncture, and completed each data collection session to the best of his/her

ability. Lastly, the assumption is that the participants were not practicing this skill beyond the two research dates and only attempted at the testing site within the two sessions.

1.8. Variables

The first and second research questions' dependent variable was IV placement proficiency; or determining the percentage of ATs who were successful in their attempts according to the National Registry of Emergency Medical Technicians (NREMT) Intravenous Therapy Psychomotor score sheet. The second research question investigated the dependent variable of skill retention or doing the same skill 25-45 days later in addition to skill proficiency. The researchers controlled time as the independent variable in both the first and second research question. The third research question investigated self-confidence as the dependent variable and controlling time of the study as the independent variable. The fourth research question examined perceived value of IV placement to the AT as the dependent variable and controlling time as the independent variable. The fifth research question measured the participant's IV performance as the dependent variable, and controlled the participant's demographic information as independent variable.

1.9. Significance of Study

Therefore, it is essential for athletic trainers to provide the high-quality care in accordance with published NATA Position Statements. It is within an AT's scope of practice to utilize IV therapy to treat environmental illnesses and dehydration.[3,14] However, it is currently unknown what percentage of practicing ATs perform IV administration or what percentage are performing the skill correctly. There is currently no curriculum for teaching athletic training students how to place an IV. However, by determining the proficiency of ATs in placing IVs, there may be an increased advocacy for ATs to learn how to start an IV to expedite prehospital

fluid therapy in EHI situations and enhance patient outcomes. This study assessed ATs' ability to learn the IV administration skill, as well as determined their ability to retain the skill and feelings of confidence.

2. LITERATURE REVIEW

2.1. Heat Illness

2.1.1. Definition

It is within the athletic trainer's (AT) scope of care to diagnose, treat, and educate patients on heat illness.[15] The three main classifications of heat illness are heat cramps, heat exhaustion, and heat stroke.[2] The least severe of the classifications, exercise associated muscle cramps (EAMC), often known as heat cramps, is a condition that presents during or after strenuous exercise as painful, involuntary muscle contractions.[2] There is not always a pattern as to which muscles are involved; one muscle can contract and relax, which sets off a spasm in an adjacent muscle.[2] The occurrence of heat cramps in an athlete can indicate more serious issues that affect athletic performance, such as a fluid deficiency or neuromuscular fatigue.[2]

Heat exhaustion is defined as the inability to continue exercise, combined with factors such as sodium loss or dehydration.[16] Heat exhaustion signs and symptoms vary and can include low blood pressure, elevated pulse rate, pale and sweaty skin, nausea, vomiting, irritability, chills, and more.[17] However, heat exhaustion is usually characterized by a core temperature of up to 104°F and cardiovascular hypoperfusion without central nervous dysfunction involvement.[16] To correctly evaluate and distinguish heat exhaustion from other emergency heat illnesses (EHIs), it is necessary to utilize a rectal thermometer to accurately determine core temperature.[2] Heat exhaustion impacts the body differently than heat cramps, but is not as severe as a heat stroke.[2]

Sweating is the primary mechanism for heat dissipation at increased ambient temperatures and high metabolic demands.[4] During exercise, cardiac output escalates to meet the increased metabolic demands of the skeletal system.[16] Circulation is diverted from visceral

organs to the peripheral vessels to enhance cooling through the skin, which causes sweating.[16] Sweating also decreases the volume of plasma circulation, which can result in hypovolemia and can further impair the body's ability to dissipate heat.[16] When the rate of heat loss is exceeded by heat production, the core temperature will steadily rise, which elevates the risk of an EHI.[16] On the EHI spectrum, heat exhaustion is a precursor to exertional heat stroke.[16]

Exertional heat stroke (EHS) has the most severe impact on the human body and the central nervous system (CNS) out of the three classifications.[2] EHS is associated with CNS disruption and multiple organ failure.[2] Another term for EHS is hyperthermia, which specifically describes when metabolic heat is produced too quickly by the muscle during exercise to allow heat transfer to the surrounding environment, thus causing the core temperature to rise and overheat the internal organs.[17] Signs of EHS can include altered mental status, seizures, hyperventilation, tachycardia, sweating, irrational behavior, nausea, disorientation, headaches, and diarrhea.[2] Recognizing each classification of EHI is important for providing the correct treatment. The main criteria for differentiating between EHS and heat exhaustion are elevated core temperature and signs of CNS dysfunction.[2] EHS occurs when the body's core temperature is greater than 104ºF and can lead to system failure if not treated quickly.[2]

Rhabdomyolysis is another nontraumatic, medical emergency that is related to EHI. Rhabdomyolysis is the systemic breakdown of skeletal muscle tissue that can be caused by overexertion, which results in the release of myoglobin, creatine kinase, and other intracellular muscular components into the extracellular space and bloodstream.[18] Myoglobin is a protein that causes kidney damage.[18] This overexertion can lead to muscles being starved of blood and breaking down rapidly, which is also called ischemic rhabdomyolysis.[19]

2.1.2. Rates of Incidence

The sports with the most heat-related deaths among U.S. children and adolescents are football, wrestling, and cross country.[20] It is estimated that 9,000 or more high school athletes suffer from an EHI each year, usually at the start of the fall sports season when athletes are not yet acclimated to their environment.[20] For high school sports, the incidence rate of nonfatal EHI is 1.6 per 100,000 athletes as of 2013.[20] The highest rates of EHI occur in preseason football.[20] From 2005-2009, more EHS-related deaths occurred in organized sports than in any other five-year period over the last 35 years.[20] Between the years of 1995-2010, 35 high school football players died from EHS. In the summer of 2011, there were six EHS-related deaths in high school football.[20] Preventable heat illnesses have been happening in organized sports at the high school level in the United States for decades, and continue to occur.

EHI-related death rates at the collegiate level closely resemble those at the high school level. From 2000 to 2017, a total of 21 National Collegiate Athletic Association (NCAA) football student athletes died during preseason conditioning workouts from nontraumatic mechanisms (cardiac conditions, exertional sickling episodes, rhabdomyolysis, and EHI).[12] In fact, 11 of the 21 NCAA football deaths from 2000-2017 occurred during the first or second day of preseason workouts.[12] Excessive strength training and conditioning sessions that occur too quickly in the acclimatization process can lead musculoskeletal injury or death.[12] NCAA Division I football is responsible for the most fatalities out of all collegiate sports and division levels in the United States in both traumatic and nontraumatic deaths.[21] The nontraumatic deaths in Division I football amount to eight deaths in winter workouts, 16 in summer conditioning, two in September conditioning, and one in a November practice. This equals five deaths from EHS, nine from sudden cardiac death, one from asthma, and 12 from exertional sickling collapses.[21] It

could be argued that the deaths from exertional sickling are often as a result of increased core temperature.[22] These numbers are high and will continue to rise if coaches and ATs alike do not take proper precautions to prevent and treat EHIs.

EHI-related deaths are not confined to high school or collegiate athletics. For example, between 2008 and 2018 in the United States, there were 4,188 cases of EHS in the United States Armed Forces.[23] From 1999 to 2010, 8,081 heat-related deaths were reported within the United States general population.[24] In 72% of these deaths, the underlying cause was exposure to excessive heat.[24] A total of 69% of heat-related deaths were males, and 36% were people aged 65 and older.[24] Almost all of the aforementioned heat-related deaths occurred between May and September with the highest numbers reported during July and August.[24] Arizona, Texas, and California accounted for 43% of the 8,081 heat-related deaths.[24]

In an analysis of occupational heat-related mortality rates completed by the Bureau of Labor Statistics from 2000-2010, it was revealed the median age of a deceased worker in this 10 year range was 41 years old.[25] It was noted that higher percentages of EHI and heat-related deaths were correlated with race and ethnicity. Black and Hispanic Americans were more at risk than white and non-Hispanic people.[25] When ethnicity was compared to incidence of EHI in the agriculture and construction industries, the same pattern was found.[25] Hispanic people in agriculture and construction had a higher rate of incidence than non-Hispanic Americans.[25] Deaths from heat-related illness are often preventable, but on average, deaths attributed to occupational heat-related illness among US crop workers average 28 per year; 20 times the rate for all US civilian workers.[26] Any occupation that is subject to perform exertional work tasks while exposed to high ambient temperatures have an increased vulnerability to heat-related health problems.

2.1.3. Contributing Factors

The direct cause of EHS is elevated core temperature, which can result from a variety of factors.[2] It has been found that the equation to calculate a person's core body temperature is a product of the sum of external heat load, plus the internal metabolic heat load, minus evaporative heat loss due to sweating.[26] Dehydration is one of the main causes of EHS and can be caused by adaptations of bodily systems; like sweating, vomiting, or diarrhea.[2] Additional causes of dehydration can include taking certain medications, drinking alcohol, or using caffeine.[2] The signs and symptoms of dehydration can include but are not limited to cramps, excessive thirst, general discomfort, flushed skin, dizziness, apathy, headache, nausea, chills, dyspnea, or decreased athletic performance.[2]

Another potential cause of EHS is electrolyte or sodium imbalance.[2] These imbalances do not usually occur in trained athletes who consume a normal diet but do occur in athletes who sweat heavily or who have not acclimatized to heat properly.[2] Dietary sodium is important to the body for maintenance of fluid balance and can help prevent muscle cramping and heat exhaustion.[5] Including sodium in fluid replacement beverages or sports drinks should be considered when physical activity exceeds two hours or when a person is becoming acclimated to environmental heat. Adding 0.3 to 0.7 g/L of salt can offset losses in sweat and minimize associated medial issues.[5] Dehydration, coupled with electrolyte or sodium imbalances, can cause EHS.

It is possible to confuse EHS with exertional sickling episodes, as they have similar presenting signs.[19] People who are born with sickle cell trait (SCT) are predisposed to exertional sickling.[19] The sickle hemoglobin (inherited from a parent) can change the shape of normal red blood cells during intensive exercise to a sickle shape. These sickle blood cells can cause

blockages in blood vessels and in turn slow down cardiovascular flow in the body.[19] This leads to muscles being starved of blood and breaking down rapidly, also called ischemic rhabdomyolysis.[19] Sickle cell trait limits blood flow distribution in the body and can decrease the oxygen carrying capacity of blood.[19] Both EHS and exertional sickling are more likely when exercise occurs at a higher altitude.[2] About 300 million people in the world who carry the sickle cell trait.[22] In the United States this condition is disproportionately diagnosed in African Americans and affects about three million people.[22] Unlike EHS, a sickling collapse usually happens early in a workout when a person's core temperature would not have had sufficient time to rise to that of hyperthermia.[22] Unlike heat cramping, where an athlete displays tonic muscles, a sickling collapse is described as a slump to the ground with weak, normal looking muscles. Those who carry SCT can be predisposed to EHI.[27] It is important to differentiate an EHI from a sickling episode to provide the best appropriate treatment possible. Overall, athletes with known SCT need to be monitored in both environmental and non-environmental conditions that can trigger a sickling episode.

2.1.4. Nonenvironmental Risk Factors

Athletic Trainers are responsible for preventing and monitoring harmful nonenvironmental conditions in their athletes that could lead to injury. Recent or current illnesses can predispose a person to suffer from a heat illness due to fever or dehydration.[2] An increased body mass index (BMI) puts an athlete at risk because the fat layer causes a greater metabolic heat production during exercise trapping the heat instead of letting it dissipate.[2] Similarly, athletes who are not in good cardiovascular condition are susceptible to EHI due to poor heat adaptation.[2] Athletes who are not acclimatized to the environmental conditions during strenuous exercise are at an increased risk.[2] The main adjustments the human body makes during heat

acclimatization include lower salt concentration in sweat, increased sweat output, expansion of plasma volume, improved cutaneous blood flow, and a lowered threshold for sweating to commence.[28] Furthermore, certain medications and substances, such as antihistamines, antidepressants, or alcohol, have dehydrating effects and increase risk for heat illness.[29] In addition, some predisposing medical conditions add to risk of heat illness including malignant hyperthermia, scleroderma, cystic fibrosis, sickle cell trait, neuroleptic malignant syndrome, diabetes, previous heat injuries, congenital disorders, cardiac disease, or skin abnormalities.[2,16] Nonenvironmental risk factors need to be monitored by ATs and coaches alike to environmental risk factors to prevent EHI.

2.1.5. Environmental Risk Factors

Environmental risk factors are conditions external to the body that can influence the risk of an EHI.[2] This can include something as simple as wearing dark clothing. Wearing dark clothing on a hot, sunny day can cause heat absorption from the sun and should be worn minimally.[2] Ambient air temperature, relative humidity, and air motion contribute to whether a person has to depend entirely on evaporation for heat loss.[17] Appropriate work-to-rest ratios based on the intensity of activity, environmental conditions, and individual factors should be implemented when planning athletic activity.[17] These breaks allow the body to cool and provide ample time for rehydration.[12]

The greatest risk for EHS exists when the wet bulb globe temperature (WBGT) exceeds 82°F during high-intensity or strenuous exercise that lasts longer than one hour.[28] The WBGT is found to be comprehensive and superior to other indices such as heat index.[17] A WBGT reading is used in athletic, military, and industrial settings to gauge heat risk because it encompasses both measurements of radiant heat and air water content. The wet bulb temperature is measured with a

dry bulb thermometer that is covered with a water-saturated cloth wick. A black globe temperature computes the ambient air temperature by inserting a dry bulb thermometer into a standard black metal globe, which absorbs radiant energy from the surroundings.[17] WGBT and black globe temperature are both measured in direct sunlight. Most of the time, these measurements are performed with a portable monitor that measures the WBGT. When the WBGT is not available, on-site ambient temperature and relative humidity data can be applied to algorithms to estimate heat risk and determine further participation. When the WBGT exceeds 82°F, continuous activity and competition should be canceled or rescheduled.[2]

To illustrate the associations between WBGT and the EHI rate of incidence, a four-year study conducted from 2004-2007 on NCAA football student athletes evaluated the association specifically among preseason practice days.[30] A descriptive epidemiology study compiled data from 60 colleges and universities. A total of 553 EHI cases and 365,810 exposures were reported for an overall EHI rate of 1.52/1,000 exposures.[30] The highest rate of EHI occurred during the first 14 days of the preseason period, and the greatest risk was during the first seven days. The risk of EHI increased substantially when the WBGT was 82.0°F or greater.[30] Approximately 74% of the reported EHI cases were exertional heat cramps, and about 26% were a combination of heat syncope and heat exhaustion.[30] In a 2020 survey sent to high school ATs, when asked through what methods do their schools modify activities in the heat, 33.9% of ATs reported using a device that measures WBGT.[31] When asked about the primary person who oversees the WBGT reading process to ensure that the standards are followed, the AT was the most common person 85% of the time.[31] Exertional heat illnesses occur at increased WGBT levels, and ATs should take all the necessary preventative measures to reduce the risk of injury.

2.1.6. Prevention

There are many steps that can be taken to prevent heat illnesses, and ATs are educated and equipped to handle these emergencies with evidence-based practice and current research at their disposal.[15] The National Athletic Trainers' Association (NATA) has published guidelines, recommendations, positions, and consensus statements on preventing heat illness and sudden death in athletic practice.[2] Among the most important recommendations for ATs are the education of coaches and athletes, implementing appropriate heat acclimatization guidelines, ensuring appropriate medical care is available for vulnerable environments, educating athletes on fluid intake, pre participation screening for athletic activity, and having emergency action plans (EAP) readily available.[2]

An EAP is an organized, reviewed, legal document that provides specific step-by-step instructions in the case of any emergency at a venue.[32] The NATA has published literature detailing the necessary components of an EAP.[32] The bare minimum components of an EAP include plan implementation, details on included personnel and any emergency equipment, modes of communication, modes of transportation, the venue location and address, the emergency care facilities, and instructions on documentation of the incident.[32] The EAP must be practiced, and all parties involved must understand their specific role and responsibilities in the event of an emergency situation.[32] The EAP should be disseminated to all administrators, staff, managers, local EMS groups, and then rehearsed. An EAP is not athletic training specific and should be present in all venues, institutions, and events where an emergency can potentially occur.

Utilizing an online questionnaire, researchers investigated high school AT's adoption of policies and procedures used for monitoring and modifying activity in the heat. A total of 741

ATs reported their adoption of environmental-related policies, facilitators, and barriers that influenced decisions in implementing these policies at their respective institutions.[31] Data were collected from fall 2018 to spring 2019. Descriptive statistics provided the proportions of responses for each of the questions.[31] A total of 30.4% of respondents reported they did not have a written policy and procedure for the prevention and management of exertional heat stroke. Overall the researchers found the policy component with the highest adoption rate was modifying the use of protective equipment, in which 77.5% currently maintained a policy, and 8.2% were in the process of creating a policy.[31] The most common facilitators identified in this survey included support from someone in an authoritative position (56%), state mandate from a high school athletics association (49.1%), and state legislation to mandate this policy (49.1%).[31] Conversely, the barrier most commonly reported was resistance or apprehension from head coaches to modify practices (33.6%). Athletic Trainers who did not report barriers were more likely to maintain a written policy for prevention and management of exertional heat stroke compared to those who reported barriers (73.2% vs. 53.7%).[31] Although only a small proportion of ATs in this study were not compliant with adopting environmental injury related policies, this was only a small sample of those in secondary school settings. The first step in preventing EHI is implementing prevention strategies with documented policies and practiced EAPs.

Heat illnesses are best treated when they are recognized quickly and treated efficiently. To do this, the education of athletes, coaches, and administrative staff on the recognition and treatment of heat-related illnesses is necessary.[17] When collegiate and secondary school ATs were surveyed, only 77.1% of ATs had read the current NATA position statement on heat illness.[33] In addition, it is the responsibility of the AT to educate patients and athletes about the importance of hydrating correctly, resting, and eating well. Finally, athletes should be made

aware of the heat acclimatization process.[17] Resources for ATs are readily available to render the best care possible to patients suffering from an EHI.[2,4,5]

Along with more severe environmental conditions, the incidence of EHI has increased, indicating the need for health care providers to intervene and prevent these fatal conditions.[31] In the high-school only AT survey, the self-reported number who adopted full compliance in preseason heat-acclimatization guidelines mentioned a state-level mandate as one of the key facilitators for a policy adaption. This supports the strength of systemic intervention as a facilitator for policy adoption and reflects that legislation will help protect athletes from the risk of EHI.[31]

2.1.7. Treatment of EHS

The NATA has recommendations and guidelines in their position statement addressing EHI that list the gold standard treatment of EHS.[2] Current recommendations dictate that ATs should immediately take the rectal temperature of the patient with a suspected EHI and facilitate immediate cold-water immersion. Rectal temperature is the most accurate on-field method possible to monitor core temperature.[2] In a previous 2010 study, ATs perceived rectal thermometers as the most valid temperature assessment device when compared with other assessment devices, but would use oral thermometers as the primary assessment tool (49.1%).[33] Reasons for invalid temperature assessment and inappropriate treatment methods of EHS could be from the lack of exposure (to both recognition and treatment) within the clinical setting or school districts and organizations prohibiting the use of rectal thermormators.[33] Existing research suggests ATs should not rely on oral, tympanic, or axillary temperatures for patients in EHI situations because these are inaccurate measures of core temperatures during and after exercise.[2,5,17,28] It is important to take a rectal temperature to differentiate between heat

exhaustion and heat stroke, as treatment will differ slightly. A person suffering from a heat stroke will have an elevated core temperature higher than 104°F.[2] It was found in a 2010 survey of ATs working in multiple settings, only 18.6% of the 456 respondents have used or planned on using a rectal thermometer in their emergency action plan for EHI. Respondents cited that invasiveness, lack of training, and lack of equipment availability were major reasons alternative temperature taking methods were being utilized.[33] Athletic Trainers who have the ability to take rectal temperature of a patient suffering from an EHI should do so to provide the best possible care.

Next, the priority is to lower the core temperature of the patient as quickly as possible.[2] The best way to do so is to remove the patient's clothes and equipment first. Then, immerse their whole body into a tub of cold water that ranges from 39-59°F.[2] The AT must monitor the patient and remove them when their core temperature reaches 101-102°F.[2] In the event that a cold tub is not readily available to utilize, other methods can be implemented to start rapid cooling, as this is a critical factor in determining patient mortality. The patient can be moved to a shaded or air-conditioned area and cooled with fans, ice bags, or ice towels. However, it has been shown that ice water or cold water immersion will decrease the core body temperature much more quickly than alternative methods.[34]

When collegiate and secondary school ATs were surveyed in 2010, 49.7% used cold-water immersion to treat EHS, although 50.3% of ATs identified using other means to cool core temperature the majority of time.[33] The most commonly practiced alternate cooling method was ice bags or towels (14.2%), then only cold towels (12.9%), and followed by only ice bags (10%).[33] A majority of the collegiate ATs reported using cold-water for primary cooling treatment more than high school ATs who used various alternate cooling methods.[33]

After cooling, the AT should begin fluid replacement while emergency medical services has been contacted and are en route.[2] It is key to monitor the temperature during the cooling therapy and recovery of the patient. Once the patient's rectal temperature reaches approximately 101°F to 102°F, only then should the patient be removed from the cool water immersion.[2] Following the guidelines provided by the NATA will ensure the patient has been provided the best treatment available.

2.2. Athletic Trainers

2.2.1. Scope of Practice

The previous section dedicated to Environmental Heat Illnesses incorporated aspects of the professional obligations of an AT specific to EHI. To further elaborate on the scope of practice and expectations of ATs, the purpose of this section is to highlight the relevant legal considerations pertaining to ATs performing specific medical interventions. In addition, this section includes descriptions of legal documents published by the professional organizations in the Athletic Training profession. Athletic Trainers are health care professionals who work with physicians to optimize patient physical capacity, health, and well-being. The practice of athletic training encompasses the prevention, examination and diagnosis, treatment, and rehabilitation of emergent, acute, subacute, and chronic neuromusculoskeletal conditions, and certain medical conditions to minimize subsequent impairments, functional limitations, disability, and societal limitations.[6]

To be a licensed and certified athletic trainer, an individual must graduate from an accredited academic program.[15] They then must pass their Board of Certification® (BOC®) exam as well as attain licensure in the state they will be practicing. Individuals must be legally recognized by the appropriate state regulatory agency prior to practice athletic training.[15] This is

the standard in all 50 states of the United States, with the exceptions of California, New York, Hawaii, and South Carolina. In New York and South Carolina, the only required legality is certification. Certification protects the title use of the term "Athletic Trainer" and is granted to those who meet predetermined standards. In these states, a non-certified individual may perform the duties of an AT, but they may not use the title of athletic trainer.[15] Hawaii does not require certification or licensure. Hawaii utilizes the registration method, which means that an individual would have to register their details with state officials. The state of California does not have any regulation at this point in time. Like any other health care profession, athletic training is subject to national and state laws to protect both health care providers and their patients.[35]

Table 1. BOC® Standards of Professional Practice

Direction	ATs must render service under the direction of a physician.
Prevention	ATs implement safety measures to prevent injury and illness.
Immediate Care	ATs provide care in acute or emergency situations.
Examination, Assessment, and Diagnosis of Injury	ATs use patient history and physical examination to patient's impairments, diagnosis, level of function and disposition.
Therapeutic Intervention	ATs determine appropriate treatment and rehabilitation strategies for patients.
Program Discontinuation	ATs discharge patients when they have received optimal benefit from their program.
Organization and Administration	ATs document all actions in accordance with local and state laws.

Adapted from Board of Certification[15]

Position statements are documents written by specific topic experts and published by the NATA, which produce a set of recommendations associated within the domains of athletic training.[36] The purpose of these writings is to provide clinical practice recommendations based on the best evidence available.[36] The oldest position statement was published in March 2002, titled "Emergency Planning in Athletics," and the most recent publication is "Immediate Management of Appendicular Joint Dislocations," which was published in December 2018. The

NATA also publishes consensus statements, official statements, and support statements. Consensus statements are the product of inter-association task forces organized by the NATA. Official statements are brief statements on timely topics, and support statements are documents that show the alliance between the NATA and outside organizations on different topics. The difference between official, consensus, support, and position statements are that position statements use a Strength of Recommendation Taxonomy (SORT) and level of evidence to provide context to readers of the evidence provided to help guide clinical decision making. The SORT is helpful to clinicians, researchers, and educators because it is efficient, evidence based, and addresses the outcomes that are important for clinicians within the strengths of recommendations.[36]

Additionally, position statements are legal documents that can be used as evidence in a civil or criminal court of law to uphold and prove the standard of care of NATA members. A recent example of this occurrence was the death of Jordan McNair, an NCAA football player at the University of Maryland who died from a mismanaged heat illness in May 2018. The "Walter's Report" was the independent review and evaluation of the events of May 29, 2018 by Walter's Inc., a consultant for sports medicine. At the commencement of the report, the NATA's position statement on Emergency Action Planning in Athletics and Exertional Heat Illnesses is specifically cited as the established best-practice guidelines.[37] Athletic Trainers are expected to practice accordingly within their scope of care and follow evidence-based and published guidelines.

Each state has their own specific practice act for certain occupations. A practice act is a law that governs an occupation, usually at a state level. Athletic Trainers follow state practice acts to provide parameters for their work and to protect patients from unprofessional or unsafe

athletic training services.[35] It is mandatory to comply with state regulatory requirements. The first BOC® Standard, Direction, references that ATs must provide care under the direction of a physician through standing orders or written, agreed upon protocols.[15] While the content of the government document varies from state to state, each practice act must contain definitions and regulations about the state board, records, license renewal and costs, the grounds for revoking licenses, and any associated penalties. Practice act documents can be found and easily accessed on the BOC® website.

2.2.2. Athletic Training Current Education

Athletic training students are educated in the skills expected of a professional in the five recognized domains of athletic training. Students are trained in injury and illness prevention strategies that focus on enhancing health to improve a patient's quality of life. They are also educated on how to evaluate patients who have acute or chronic musculoskeletal disorders or medical pathologies and to arrive at a diagnosis. Students learn how to provide emergency care to patients and to make correct referrals when appropriate. Additionally, students are taught to assess the status of musculoskeletal injuries or conditions to determine functional limitations or impairments. They are trained to modify treatment plans based on regular reassessment of their patient's condition and appropriately discharge them when preset goals have been met. Lastly, students learn the skills necessary to manage a health care facility.[6] Students are taught to document their treatments and interactions with patients properly and in a timely manner. Table 2 presents descriptions of the five domains of athletic training.

Table 2. Domains of Athletic Training

Injury and Illness Prevention and Wellness Promotion	Promoting healthy lifestyle behaviors with effective education and communication to enhance wellness and minimize the risk of injury and illness
Examination, Assessment, and Diagnosis	Implementing systematic, evidence-based examinations and assessments to formulate valid clinical diagnoses and determine patients' plan of care
Immediate and Emergency Care	Integrating best practices in immediate and emergency care for optimal outcomes
Therapeutic Intervention	Rehabilitating and reconditioning injuries, illnesses and general medical conditions with the goal of achieving optimal activity level based on core concepts (i.e., knowledge and skillsets fundamental to all aspects of therapeutic interventions) using the applications of therapeutic exercise, modality devices and manual techniques
Health Care Administration and Professional Responsibility	Integrating best practices in policy construction and implementation, documentation and basic business practices to promote optimal patient care and employee well-being

Adapted from Board of Certification[15]

Students are required to participate in a variety of patient encounters that are predetermined by their respective accredited athletic training education program (ATP). The clinical experience is critical to the holistic education, as the component allows the student to participate in experiential learning opportunities and apply skills learned in the classroom. In a 2013 mixed-methods study designed to better understand how clinical experiences affect student retention in undergraduate ATPs, it was found that authentic, clinical experiences were very meaningful to students. However, the time commitment was a barrier to retention.[38] Five research questions about how clinical instructors, settings, sport assignments, and peers affected student retention guided this study. Ninety-four, senior-level student participants in District 4 were separated into two groups. The first group consisted of 23 students who quit their athletic training program (ATP) early, and the second group (n=71) were the "persisters," or remaining students who continued their progression in the ATP.

Quantitatively, the follow-up ANOVA revealed that the persister and dropout groups' responses differed significantly for three of the five questions and respective scales. The persisters and dropouts were not statistically different with academic or social integration. The dropout group had more precollege athletic training experiences than the persister group did; however, the persisters proved to be more clinically integrated in the athletic training major than the dropouts. Subsequently, the persister group was more motivated to finish the athletic training major than was the dropout group.[38] In the questionnaire results, persisting students identified the authentic learning experiences as important to retention in the major. Conversely, the dropout students identified having a poor authentic learning experience as a barrier to retention, specifically citing not being allowed to interact with patients as a main reason for leaving their program.[38] Phrases such as "standing around" and "wasting time" were popular identifiers among the dropouts. A total of 78% of the participants also agreed that the sheer number of clinical hours was too demanding, and this influenced the dropouts' decision to pursue other college majors along with changing interests.[38] Despite the differences between the two groups, time commitment was a barrier to retention for the students in this study. The quality of the hours spent at a clinical experience should be valued more than the sheer quantity. In addition, athletic training educators may be providing students with accurate information regarding recommended practices for injury and pathology but undermining their application within the clinical setting by failing to offer students structured, hands-experience in the didactic portion of the curriculum so that the students gain proficiency.[33]

A 2015 exploratory study sought to investigate the role clinical education experiences had on students' development of passion for athletic training.[39] Participants included 17 senior and junior level students (eight males, nine females) who were phone interviewed. The

participants were led through an open-ended, semi-structured interview session where they were asked questions about their preceptors, career goals, and their own clinical experiences. To analyze qualitative results, the researchers focused on understanding abstract social phenomena from the interviews and converted them to the central themes of the study.

The researchers reported the development of the student commitment to the profession is directly related to a positive clinical education experience facilitated by a passionate preceptor.[39] It was found that strong mentorship, realism, and professional commitment of their preceptor had a significant positive influence on the student's clinical education.[39] Preceptors who facilitated environments that allowed questioning, open communication, and spoke freely of the realistic side of their roles and responsibilities were spoken highly of amongst the participants in the cohort.[39] Thus, a quality clinical education experience where students develop a thorough understanding of the intricacies of the profession is essential to their retention in an ATP.

Both of the aforementioned clinical education studies suggest that permitting a student to take responsibility for patient care and interaction has a positive influence on their clinical education.[38,39] Investigations focused on the clinical education experiences help to contribute to the athletic training literature by highlighting the impacts of authentic, clinical educational experiences on students. Additionally, they highlight the all-important influence that preceptors have on the overall skill training of students. The CAATE 2020 Standards include Standard 16, which mandates one athletic training clinical immersive experience.[1] This continuous four-week experience will improve clinical education outcomes by allowing the student to experience the totality of care provided by athletic trainers.[1]

Another important aspect of athletic training education is assessment. Competencies are a key aspect of the education that entail grading of the students' skills outside of the classroom. In

a 2008 study, researchers analyzed the modes that students were assessed through a survey regarding clinical proficiency evaluation methods and barriers, educational content areas, and clinical experience settings.[40] Based on the responses of the 201 accredited ATP directors who participated in the study, the three most commonly used evaluation methods for student performance of clinical proficiencies were real time (students evaluating a real patient), simulation (students evaluating a mock patient who has no real training in portraying injury/illness), and standardized patients (students evaluating a mock patient who is trained to portray injury/illness).[40] Out of the aforementioned methods, simulation was the most commonly utilized method in clinical settings due to lack of appropriate real-time patients and lack of the preceptors' time to coordinate a standardized patient.[40] Instructing with simulated scenarios and props creates a "safe-to-fail" environment, in which students can make mistakes without dire consequences.[41] Students received the most opportunities to participate in real-time evaluations in the realm of clinical examination and therapeutic modalities. More opportunities to complete real-time evaluations were present in collegiate or high school athletic training facilities (ATF) compared to other clinical settings, such as physical therapy clinics or doctor's offices. The two main hindrances to performing real-time evaluations for students stemmed from a low number of injuries/conditions, or the injuries/conditions not aligning correctly with the proficiency schedules. Lastly, the institutional data also revealed that ATPs who compensated preceptors had no significant advantages compared to ATPs who did not provide additional compensation to preceptors.[40] To determine athletic training students' clinical proficiency for entry-level employment, ATPs should incorporate standardized patients or take a disciplined approach to using simulation for instruction and evaluation.

Similar to other health care professions, ATs are required to stay current on all current research and facets related to the profession. Continuing education units (CEUs) are required by the BOC® for all ATs. Continuing education units prepare individuals to perform services or procedures beyond their entry-level education. They are to be reported to the BOC® biannually and include five categories. Continuing education units may result in the achievement of additional qualifications or enhanced skill sets.[6] The BOC® Code of Responsibility states in Code 2, Competency, that the "Athletic Trainer engages in lifelong, professional and continuing educational activities (pg27)."[6(pp27)] Biannually, ATs must complete 50 CEUs. All continuing education programs in each category must be intended for an audience of credentialed health care and/or wellness providers, such as ATs, physical therapists, registered nurses, physician's assistants, or medical doctors. The content must be at least entry-level and pertain to the domains identified in the most recent edition of the Practice Analysis.

2.2.3. CAATE 2020 Educational Standards

In 1996, the NATA Education Task Force compiled 17 recommendations to reform athletic training education. One recommendation was to establish an Executive Committee for Education (ECE). Later in June 2012, the ECE prescribed 14 new recommendations in a report to the NATA Board of Directors regarding future directions in athletic training education.[42] One of these recommendations was an initiative to examine athletic training education at its current degree level and investigate the potential need to elevate the degree to graduate level.[43] The investigation led to the presentation of the "Professional Education in Athletic Training – An Examination of the Professional Degree Level" to the NATA Board of Directors in December 2013, the official motion to transition the degree. Nicknamed the "Professional Degree White Paper," this document compiled key findings, evidence, and data from 333+ ATPs in the United

States on the current state of ATP education and their recommendations.[43] The official decision for the degree change was announced to the public in a statement from the Strategic Alliance in the fall of 2015.

Presently, the CAATE published the 2020 educational standards for professional program students in January 2018. These standards went into effect on July 1, 2020.[1] There are two specific standards that set these requirements apart from CAATE's 2016 revisions that are relevant to this research study. Standard 70 states that professional students will evaluate and manage patients with acute conditions, including triaging conditions that are life threatening or otherwise emergent. These include (but are not limited to) the following conditions: conditions related to the environment: lightning, cold, heat (including use of rectal thermometry), exertional sickling, rhabdomyolysis, and hyponatremia.[1] Standard 75 states that professional students will learn to administer medications or other therapeutic agents by the appropriate route of administration upon the order of a physician or other provider with legal prescribing authority.[1] Moving forward with these new educational standards, professional students will potentially be instructed how to perform IV therapy and introduce fluids to treat EHI as part an ATP curriculum.

Currently, there is no published literature regarding the relationship between ATs and their proficiency in establishing peripheral IV access, nor any studies conducted about AT's confidence or perceived value in learning and performing this skill. Presently, it is within the scope of practice for an AT to insert an IV and administer fluids under the direction of a physician.[2] With immediate care being a dominant aspect of the athletic training profession and BOC® Practice Standard Three,[15] ATs must be incorporated into future emergency care research.

2.3. Intravenous Access and Therapy

2.3.1. Peripheral Intravenous Access

Intravenous (IV) access is a core component of health care in a hospital setting, and a fast-acting, effective method for fluid administration and medication to the human body.[44] A peripheral IV (PIV) can be placed in the posterior hand, antecubital fossa, or the dorsal aspect of the foot, while a central venous catheter (CVC) is usually placed in the skin above the right collarbone.[45] The catheter outside of the needle is a thin, flexible tube that is inserted into a vein to administer chemotherapy, blood transfusions, intravenous fluids, and other drugs.[45] Peripheral IV placement is more common for short-term IV therapy and has the benefit of being easy to monitor and insert.[46] Peripheral IVs should be changed every 72-96 hours and need to be removed as soon as a patient is in a stable condition.[46] In comparison, a CVC can stay in place for weeks or months if necessary to avoid repeated needle insertions.[45] Central venous catheters differ from PIVs in that a CVC is placed strategically so the ending lays above the right atrium of the heart via the superior vena cava.[46] They can be placed through the jugular, subclavian, or femoral veins.[46] CVCs are used for patients who have poor vasculature, require long-term venous access, are seriously ill, or require total parenteral nutrition.[46]

Other components of an IV to consider include the line, needle, and hub. The IV line is a hollow, plastic, tube-shaped catheter that is attached to a large hub that remains above the skin.[47] The line is supplied over a beveled needle with a transparent flashback chamber at its opposite end, which allows the practitioner to identify when blood from the vein flows into the needle during insertion. There are different sized needles, referred to as a gauge, which reflects the internal diameter of the catheter and ranges in size from 14G to 24G. The higher the gauge number, the narrower the catheter is.[47] After the needle is inserted into the vein, removing the

needle from the external hub of the line reveals an attachment where an IV fluid administration set can be attached.[48] The hub can also have an additional port to allow drug administration without disconnecting other ongoing IV fluids or medications. Other equipment required for PIV access includes antiseptic swabs or wipes, gauze, sterile normal saline, and a sterile transparent moisture-permeable dressing.[48] Local anesthetic agents are sometimes used with larger gauged needles or to minimize distress in some patient populations such as young children.[47,48] Overall, there are many supplies needed to start IV access.

Intravenous catheters can be placed by nurses, paramedics, physicians, and other practitioners who have completed the necessary training. However, IV placement training in the United States differs from state to state, and various prehospital professions' regulatory boards require different training protocols. There are several concepts that need to be mastered to safely place IVs, including infection control, pharmacology, mathematical complications, disposal of blood and blood products, associated anatomy and physiology, and methods of drug administration.[49] Additional knowledge required for safe practice in IV therapy can include background in legal, professional, and ethical issues, fluid and electrolyte imbalance, and complications of treatment and their prevention.[49] Conditions that warrant PIV and CVC therapy include both routine and emergent fluid replacement, medication administration, blood transfusions, and nutrient delivery.[46] Relative contraindications to PIVs include infection, phlebitis, burns, traumatic injury (proximal to the insertion site), previous infiltration, or surgical procedures at the insertion sites.[50] An additional contraindication to placing a PIV would be severe dehydration or shock, in which case placing an IV in collapsed peripheral vein could be difficult or hazardous.[50] It is important that practitioners are aware of all indications and contraindications when establishing IV access.

There are different types of complications that can potentially result from PIV therapy, including local and systemic. Local complications can include but are not limited to phlebitis, infiltration, hemorrhaging, infection, and extravasation.[46] Phlebitis is inflammation of the vein.[51] It can be caused by excessively acidic or alkaline fluids, use of inappropriate size catheter for the target vein, or trauma during the insertion process.[52] Infiltration occurs when fluid or medications from the IV leak into tissues surrounding the insertion site caused by poor placement or excessive movement of the catheter.[52] Extravasation is when vesicant medications or fluids leak into the surrounding tissues at the insertion site.[52] More severe than infiltration, extravasation can lead to delayed healing, local tissue damage, necrosis, or loss of function of the tissue.[52] Systemic complications are more severe on the body and are observed in cardiac, renal, and pediatric or elderly populations.[46] Systemic complications can include pulmonary edema, embolisms, bloodstream infections, and more.[46] The practitioner establishing IV access needs to be wary of all potential complications.

Sometimes more severe than a systemic complication is a nosocomial infection. A nosocomial infection is an infection attained while receiving health care that was not present at the start.[53] Nosocomial infections are associated with an increase in days of hospital stay, mortality, and hospital costs.[54] A major risk for a nosocomial infection incidence is poor maintenance of the peripheral vascular access site by insufficiently trained staff. Nurses play a vital role in the prevention of nosocomial infections. Prevention strategies such as insertion, monitoring, and assessing PIV sites are a routine part of nursing care.[54] It is the responsibility of the health care professional who established the IV to maintain and monitor the IV for any potential life-threatening issues involved with this invasive procedure. More training is necessary for health care practitioners to reduce risk of infection stemming from IV insertion.

2.3.2. Peripheral IV Access in Nursing

Intravenous cannulation is a common procedure performed by nurses in the hospital setting.[54] Approximately 60% of hospital inpatients annually are given a peripheral intravenous catheter to receive fluids and medications.[54] Due to the large volume of PIVs placed, it is estimated that there are 250,000 incidences of blood stream infection annually in the United States.[55] It is the professional duty of a nurse to maintain competency in the standards of care.[56] One resource available is the Infusion Nurses Society, who have been a ruling entity amongst clinicians who specialize in infusion therapy since 1973.[57] The Infusion Nurses Society annually publishes and modifies standards that regulate framework for policies and procedures in regards to IV therapy.[57] The 2021 edition lists 66 standards that outline the clinical skill and practice, documentation, infection prevention, and more.[57] Additionally, in 2011 the Centers for Disease Control and Prevention (CDC) published Guidelines for the Prevention of Intravascular Catheter-Related Infections.[55] There are twenty recommendations that are regularly updated to reflect the most recent evidence-based practice in the field.[55] Some of these guidelines address basic concepts, such as the selection of catheters, patient cleansing, aseptic technique, and skin preparation. Additional guidelines address more complicated topics such as umbilical catheters, replacement of CVCs, systemic antibiotic prophylaxis, and performance improvement.[55] Guidelines provided by the Infusion Nurses Society and CDC provide direction for IV therapy in the field of nursing.

A 2019 cross-sectional study sought to examine the care and maintenance of PIV cannulation by determining current knowledge, current practices of nurses, and what obstacles are encountered in caring for and maintaining PIVs.[54] A census method of sampling was used among nurses in a medical college teaching hospital in Nepal. Two hundred nurses participated

in the study, which included junior and senior inpatient nurses from various departments. A validated, semi-structured, self-administered questionnaire assessed each of the participant's knowledge and practice towards care and maintenance of PIV cannulation. The questionnaire was comprised of four sections which included 19 "Yes" or "No" statements about demographic information, knowledge on care and maintenance of PIV catheter, nurses' practice towards care and maintenance of peripheral intravenous cannulation, and identifying barriers encountered for properly caring for and maintaining PIV cannulation.[54]

Among the 200 nurses, 57% of respondents had less than one year of work experience. A total of 86% of nurses were staff nurses, 14% were senior staff nurses, and 53.5% of respondents were in the critical care unit.[54] Based on an analysis of demographic information, the researchers determined that more work experience and education had a positive influence on understanding and knowledge of care and maintenance of a PIV.[54] The findings revealed that 84.72% of respondents were performing correct practices in the care and maintenance of a PIV.[54] The researchers deemed this as a potential risk factor for patient safety, as 14.22% of respondents self-reported not following proper practices, and 1.06% of participants were not confident if their practices were correct or incorrect.[54] A total of 82.5% of participants were correct about selecting an appropriate site to place a PIV cannulation, while the remaining 17.5% were incorrect when asked.[54] Additionally, 97% of respondents had knowledge that thrombophlebitis and infection are the common complications of IV cannulation. Similarly, 75.5% of respondents were aware of the influences of environmental cleanliness on IV site infection.[54] The authors of this study limited their research to a single hospital, and data were analyzed quantitatively. Thus, the findings cannot be generalized to all nurses, or any healthcare professional that practices IV therapy. Sanitation and cleanliness protocols can reduce complications, which improves the

quality of care, patient safety, patient satisfaction ratings, and reduces the length of hospital stay and the overall cost of health care.[58]

Nurses need to be able to identify complications associated with infiltration, infection, and phlebitis.[56] In a study published in 2013 at a facility that had no annual requirements for educating staff on identifying or monitoring incidences of infiltration or phlebitis, the researchers sought to determine the effectiveness of an educational intervention on incidence of PIV complications.[56] The authors collected data on reported incidents during a three-month period prior to the intervention. Thirty-five nurses completed a 19-item pretest, an intervention that consisted of online modules, and a 19-item post-test (had to be completed within 48 hours of completing online modules).[56] The authors then collected data for three months after the intervention and monitored rates of infection. The pretest scores averaged 12.77/19 and increased to 13.29/19 after the intervention with the post-test ($P = .21$).[56] The results three months after the intervention also showed a 50% decrease in reported incidents of phlebitis and infiltration.[56] This review illustrates the necessity for nursing staff to receive continuing education on assessing and caring for PIV cannulation complications to reduce infection and malpractice.[56]

Nursing education combines theory, practice, and clinical competency assessment.[59] It is necessary to assess clinical competence in all healthcare professions to be able to provide services.[59] The Nursing and Midwifery Council Code of Conduct 40 and 41 address necessary continuing education for nurses and the importance of keeping knowledge current.[59] An article published in 2013 in the British Journal of Nursing described IV therapy specialty nurses' views of clinical competency assessments.[60] The 29 randomly selected participants included in this study were post-registered nurses who had undergone PIV therapy training.[60] The researchers created an online questionnaire that consisted of thirteen statements relating to PIV therapy

skills, knowledge, and competency that participants graded on a one to five Likert-type scale. The results illustrated the participants strongly agreed that "set standards must be achieved,"(pp1010) and "nurses are accountable for their own practice."(pp1010)[60] The researchers found when compared with other methods (written assessment, multiple choice tests, and objective structured clinical examinations) of clinical skill assessment for PIV therapy, clinical competency assessment is the most appropriate.[60] Regarding competency assessments, participants of this study found that it was "difficult to maintain consistency between different assessors,"(pg1010) and that "once deemed clinically competent, there is no further assessment or audit of practice."(pg1010) [60] Participants believed that a combination of assessments would be appropriate to assess practical skills, and that positive learning experiences sparked confidence in participants.[60]

Starting an IV is a difficult and invasive procedure. Most health care practitioners who have not been trained as vascular access experts receive little peripheral vascular access education, training, or opportunities to practice skills.[58] Simulation has proved to increase critical thinking skills and reduce medical errors in the health care system.[41] A 2016 study aimed to compare which method of IV education would be the best for nurses: The Virtual I.V. Simulator, Advanced Venipuncture Training Aid, or Advanced Venipuncture Arm. The goal of this study was to determine the impact of a blended, comprehensive instructional program on nurses' PIV cannulation (PIVC) insertion knowledge, confidence, and skills in a simulated environment. In this randomized, wait-list control group with crossover, 63 registered nurses (n=63) were separated into two groups, A and B. Each group participated in a two-hour PIVC online course and an eight-hour live training course using a mix of the three different simulation tools. The Virtual I.V. Simulator was a computer-based, interactive, self-directed PIVC learning system.[58]

Participants were required to complete two successful PIVC insertions with 90% competency before proceeding to the second tool. The second simulation tool was the Advanced Venipuncture Training Aid. It was a task trainer that displayed four veins of various depths and visibility in simulated blood and tissue.[58] Each participant completed six, self-paced simulated PIVC insertion procedures of this simulation. The final tool was the Advanced Venipuncture Arm, a realistic task training arm with multiple access sites and a controllable blood flow.[58] The participants completed six simulated PIVC insertion procedures on the Advanced Venipuncture Arm.

To start the study, all participants completed baseline PIVC knowledge, confidence, and skills assessments (Period 1). Group A completed the two-hour PIVC online course, while Group B completed the eight-hour live training, which included the use of the three simulation tools. Both groups then were reassessed (Period 2). At the crossover, Group A attended the live training and Group B the online course. To complete the study, both groups were reassessed for a third and final time (Period 3). The researchers found that there were no statistically significant differences between the groups' knowledge ($p=.09$), confidence ($p=.23$), or skills ($p=.23$).[58] The table below displays the mean and range for the knowledge, confidence, and skills assessment at each period for Group A and Group B. First attempt success and procedural time are also shown.

Table 3. Knowledge, Confidence, and Skills Simulation Assessments Between Study Groups Across Periods

Assessment:	PERIOD 1		PERIOD 2		PERIOD 3	
	Group A (n=30)	Group B (n=32)	Group A (n=30)	Group B (n=29)	Group A (n=28)	Group B (n=29)
Knowledge						
Mean (SD)	13.3 (2.2)	14.0 (2.5)	17.4 (1.9)	13.9 (2.2)	16.1 (1.9)	17.5 (1.8)
Range	7.5-18	8-19	14-20	10-17.5	11-19.5	13.5-21
Confidence						
Mean (SD)	40.7 (8.0)	38.0 (9.1)	40.5 (11.1)	37.1 (9.2)	41.7 (8.6)	41.2 (6.8)
Range	15-50	10-50	10-50	10-50	15-50	17-50
Skills						
Mean	62.2 (18.1)	67.7 (16.4)	77.0 (21.0)	67.3 (16.4)	79.8 (13.9)	78.9 (15.5)
Range	27-89	35-89	35-100	33-93	40-96	40-100
First attempt success						
n (%)	14 (47)	19 (59)	18 (60)	15 (52)	24 (86)	22 (76)
Procedural time						
Mean (SD)	7.5 (3.2)	7.5 (4.5)	6.5 (3.0)	6.0 (2.7)	5.8 (2.2)	6.2 (2.5)
Range	2.6-14.9	2.6-25.1	3.6-14.2	2.8-13.8	3.6-11.3	3.0-13.4

Adapted from Keleekai et al.[58]

At Period 1, Group A had higher scores than Group B for knowledge, confidence, and skills.[58] At Period 2, Group A and Group B's results were similar for confidence, and skills; whereas, group B had higher knowledge scores compared with group A.[58] At Period, Group B had improvement in knowledge, confidence, and skills compared with Period 2.[58] Group A demonstrated significantly lower knowledge scores in the last assessment compared with the second (p=.003), whereas no differences in confidence or skills were observed between the same periods.[58] In conclusion, the researchers explained that a blended learning program, which included a combination of online and simulation-based instruction, significantly improved nurses' knowledge, confidence, and skills in the PIVC insertion process from the beginning of the study.[58]

The delivery of a didactic PIV education program in combination with hands-on training results in significant improvements in PIV therapy outcomes.[61] To investigate current nursing education practices, researchers sent nurses and other health care specialists in Canada and the United States a survey to narrow the exact problems with PIV education.[61] The researchers

suggested that many graduate nurses lack confidence, knowledge, and ability in placing PIV catheters and adequately maintaining PIV sites. This study sought to clarify the current standard practices.[61] The participants were recruited to complete a 12-item questionnaire assessing the level of PIV education provided in the US and Canadian health care institutions in this descriptive design study. Nurses were recruited through the Association for Vascular Access (n=611). Less than half (46%) of participants said their institution has a process to evaluate the PIV insertion and maintenance skills of new nurses.[61] Common methods used to evaluate PIV skills mentioned on the survey included observing successful PIV insertions (usually at least three), validation of skill by a preceptor, PIV class attendance, or skills assessment checklists.[61] Participants' responses suggested that PIV education normally occurred during nurse orientation (43%), nurse residency program (18%), during an annual competency validation (16%), when a nurse transfers to select units (e.g. ICU; 10%), or on an as-needed basis (6%). A total 6% of participants indicated their health care institution does not provide PIV education.[61] Methods used to deliver PIV education in these health care settings included primarily classroom instruction followed by preceptor supervision with fewer participants noting any use of simulation as a method of instruction. The final question asked participants to identify who, hospital or nursing school, had responsibility for educating nurses about intravenous therapy. A total of 58% suggested it was a shared responsibility between their nursing school and the health care institution, 28% felt it was the health care institution's responsibility, and 14% indicated it was the responsibility of their nursing school.[61] As noted earlier, several institutions indicated they did not cover PIV content as part of their nurse orientation or annual competency training.[61]

While there appears to be no standard process among North American health care institutions on the time spent and timing of PIV education, assessment, evaluation, and

maintenance by nurses; understanding the current PIV education practices used by health care institutions is necessary to design more comprehensive PIV curriculum. Results of existing research dictate the need for an evidence-based curriculum to increase health care providers' knowledge and skill in delivering PIV therapy. Athletic Trainers need to be included in this conversation, as they are employed in institutions where PIVs are regularly utilized to administer fluids, such as hospitals, athletic training facilities, and medical clinics. It is within the AT's scope of practice to place IVs, [3,15] and there are no guidelines from CAATE or the BOC® to teach this skill to students. ATs have the potential to improve clinical practice and patient care by successfully expediting prehospital IV fluid therapy with proper PIV insertion training programs that incorporate simulated practice.

2.3.3. Peripheral IV Access in Emergency Medical Services (EMS)

Emergency Medical Responders (EMR), EMTs, Advanced Emergency Medical Technicians (AEMT), and NR-Ps all must complete formal classroom education from a certified instructor to become credentialed.[41] National EMS Certification is a vital aspect of public protection in the United States.[62] The National EMS Scope of Practice Model assigns psychomotor skills to each specific level of licensure, defines practice, and suggests the minimal educational guidelines.[41] This document does not have any regulatory authority but provides guidance to the states in an effort to increase uniformity in EMS practice and facilitate reciprocity between the states.[41] Additionally, the NREMT provides National EMS Certification, which is currently required in 46 states as a basis for obtaining state licensure to practice, with the exception of Illinois, Montana, North Carolina, and New York.[62] When an individual obtains his/her certification, the general public, employers, and state licensing authorities are aware that the individual has proved competency in the classroom.[62] Licensure, on the other hand, is the

legal authority given by an individual state to practice a profession within a designated scope of practice.[62] Certification by the NREMT is a distinct process from state licensure and serves the purpose of identifying candidates who have successfully completed the NREMT educational requirements and have demonstrated their skills and abilities in examinations.[62]

An NREMT candidate's education is based off of the Model EMS Clinical Guidelines.[41] The Model EMS Clinical Guidelines are not mandatory for educators, nor are they meant to be all-inclusive or to determine local scope of practice. They are designed to provide a resource to clinical practice and maximize patient care and safety.[41] Emergency medical services (EMS) educators have the ability to develop their own instructional resources, as this ensures that each program can specifically address community needs.[41] Additionally, the National EMS Education and Practice Blueprint is a valuable component of the EMS education system. It is multidisciplinary panel, led by the National Highway Traffic Safety Administration, that identifies core educational content for each licensure level and revises it every five to seven years.[41] There is also a common opinion that EMT students should need a minimum of 150 hours to complete a course, encompassing the four phases of education (didactic, laboratory, clinical and field).[41] Similarly, an EMR student would need 48 hours, and an AEMT would require 200 hours.[41] However, NHTSA does not mandate specific hour requirements for NREMT candidates to become certified.

Emergency services instructors use a variety of formats to deliver content to their students, including simulation and standardized patients.[41] A substitution for infrequent or unattainable clinical scenarios, the use of simulated scenarios and tools have shown higher success rates on the NREMT psychomotor exams. Simulated scenarios and tools have also been shown to enhance understanding, increase robust communication, increase understanding and

demonstration of competencies, improve critical thinking skills, improve safety, and the effectiveness and efficiency of services.[41]

In 2020, a review sought to summarize the literature on the use of simulation in EMS education and skill assessment. Quality simulation experiences are beneficial when teaching and evaluating skills that infrequently occur in the field.[63] A survey of 389 paramedic programs found that 100% of survey respondents had some access to some type of simulation tool, suggesting that simulation is universally available in EMS education.[63] However, despite this availability, the authors of the review indicated that several barriers prevented the appropriate use of the resources. In approximately one third of the surveyed paramedic programs, some portion of the available simulation tools were found to sit without regular use due to a lack of educator familiarity and training in the use of tools.[63] In paramedic programs using advanced manikins for training, 19% of educators had no formal training with the equipment and cited this as a shortcoming to utilizing simulation.[63] Addressing this neglect may lead to improved efficacy of simulation training. Despite these barriers, simulation is still considered a valuable tool in EMS training programs.[63]

According to the 2021 National Emergency Medical Services Education Standards, paramedics (NR-Ps) are educated and expected to execute expert decision-making skills.[41] The National Model EMS Clinical Guidelines recognize the need for national EMS clinical guidelines to help individual state EMS systems ensure a more standardized approach to the current practice of patient care and adoption of future practices. Paramedics perform interventions, evaluate the effectiveness of interventions performed, and modify treatment plans accordingly.[41] An NR-P is taught to constantly evaluate their decision making strategy and encompass all aspects of health care when evaluating a situation.[41] One specific intervention NR-

Ps are taught to perform is peripheral IV cannulation for medication and fluid administration.[64] Paramedics are trained in deciding whether or not to place an IV cannula.[65] Intravenous cannulation and administration of indicated medications are considered advanced life support (ALS) tenets in the stabilization of trauma patients before hospital arrival.[66] There are a multitude of conditions that the clinical guidelines explicitly state warrant establishing IV access by a NR-P to best treat the patient.[64] The conditions are listed below.

- Acetylcholinesterase Inhibitors Exposure
- Adult and Pediatric Syncope and Presyncope
- Agitated or Violent Patient/Behavioral Emergency
- Airway Respiratory Irritants
- Altered Mental Status
- Altitude Illness
- Anaphylaxis and Allergic Reaction
- Beta Blocker Poisoning/Overdose
- Blast Injuries
- Bronchospasm, Pulmonary Edema
- Bradycardia
- Brief Resolved Unexplained Event (BRUE) & Acute Events in Infants
- Burns
- Calcium Channel Blocker Poisoning/Overdose
- Cardiac Arrest
- Chest Pain/Acute Coronary Syndrome (ACS)/ST-segment Elevation Myocardial Infarction (STEMI)

- Crush Injury/Crush Syndrome
- Cyanide Exposure
- Dive (SCUBA) Injury/Accidents
- Drowning
- Eclampsia/Pre-Eclampsia
- Electrical Injuries
- End-of-Life Care/Palliative Care
- Facial/Dental Trauma
- Hyperglycemia
- Hyperthermia/Heat Exposure
- Hypoglycemia
- Hypothermia/Cold Exposure
- Implantable Ventricular Assist Devices
- Lightning/Lightning Strike Injury
- Nausea
- Neonatal Resuscitation
- Obstetrical and Gynecological Conditions
- Opioid Poisoning/Overdose
- Pain Management
- Poisoning/Overdose
- Universal Care
- Pediatric Respiratory Distress (Croup)
- Resuscitation in Traumatic Cardiac Arrest

- Shock
- Sickle Cell pain management
- Stimulant Poisoning/Overdose
- Tachycardia with a Pulse
- Topical Chemical Burn

Little is known about what factors are associated with successful IV placement, which severely limits the ability to develop benchmarks for skill maintenance, such as requiring a specific number of IV placements per year.[44] Intravenous cannulation can provide clinically important vascular access but inappropriate use can cause unnecessary pain and distress to patients.[65] A study from 2009 sought to evaluate if paramedic's rates of inappropriate cannulation, defined as cannulation when no drugs or fluids were logged as having been administered via the IV, would decrease if they received an educational intervention.[65] In this non-randomized control group design, two counties in the United Kingdom were compared before and after an educational intervention using routine clinical data. The intervention group included 80 paramedics in Nottinghamshire. These participants received an educational intervention delivered via their paramedic team leaders.[65] The control group consisted of 243 paramedics in Lincolnshire, who received no educational intervention. Overall cannulation rates and inappropriate cannulation rates were assessed before and after the intervention.[65] The researchers measured these from two months before and two months after the intervention to allow time for paramedic team leaders to disseminate practices to all members in their county.[65] Each team leader was given their presentation of the educational intervention, which consisted of guidance and procedures for no-touch for IV cannulation, aseptic technique, hand hygiene, glove use, fluid replacement, medication administration, warranting conditions, and prevention of

infection.[65] An evaluation questionnaire was given to the participants after the training to evaluate the effectiveness of the intervention.

To compare the two groups, the paramedics were observed by education specialists establishing venous access in a model arm in an ambulance. A predesigned checklist was used to assess the cannulation and aseptic technique. The data were analyzed using logistic regression.[65] The results showed that there was a reduction in inappropriate cannulation rates in the intervention group compared with the control group.[65] There were higher overall cannulation rates after the intervention compared with the pre-intervention data.[65] Participants in both intervention and control groups were correctly able to identify indications for establishing venous access both before and after the intervention. However, researchers shared that participants in the control group cited "because the admitting staff expect it"[(pp833)] as an indication more often than the intervention group, who cited "on the way to hospital to save time."[(pp833)65] The researchers concluded that the educational intervention was effective in enhancing quality and safety of prehospital IV cannulation by paramedics.[65]

A study from 2013 aimed to identify whether first attempt IV success was associated with a NR-P's number of attempted or successful previous IV attempts within the last year. The researchers retrospectively studied charts (n=602) of full-time paramedics with an IV attempt from 11 suburban and rural EMS agencies over a one-month period (January 1-31, 2009).[44] The researchers chose to exclude venipuncture attempts on minors.[44] On each chart, the success or failure of the first IV attempt was identified, and potential predictor variables were collected and analyzed by univariate logistic regression. This included age, systolic blood pressure, history of IV drug abuse, any traumatic event, catheter size, location of the IV attempt, and the provider's numbers of total and successful IV attempts in the preceding year.[44]

The results of the analysis showed that the larger the IV catheter size was associated with successful IV placement in adult patients but was not related to the prehospital provider's past years' experience.[44] This could be counterintuitive, and the authors suggested that a paramedic is more likely to choose a larger IV catheter when they anticipate they will be successful and a smaller IV catheter when they anticipate difficulty with placement.[44] Of the 602 included cases, 469 had a successful first attempt IV placement. Of the 133 cases with an unsuccessful first attempt IV placement, 44 had documented IV access prior to the arrival at hospital.[44] Any prior successful attempts in the previous year were not associated with successful IV placement in this model. The authors concluded that this data does not support requirements for paramedics to place a specified number of PIV lines per year or for EMS agencies to use individual provider IV placement rates as benchmarks in an attempt to improve future success rates of IV placement.[44] Although this data failed to support any concept for requiring a minimum number of yearly IV placements by full-time paramedics to improve success rates, further research exploring the medical intervention is necessary for future educational purposes. Intravenous cannulation is a difficult skill,[54] and it could possibly be creating longer on-scene times in emergency situations.[66]

An article published in 2011 demonstrated how researchers prospectively evaluated the efficacy of en route IV insertion in the rural setting and assessed the effect en route IV insertion had on EMS scene time. Increased time from prehospital to definitive care has been shown to negatively affect trauma patient survival.[66] It has been clearly established that mortality rates for rural trauma are twice the rates of their urban counterparts, and the efficacy of ALS tenets has been questioned as to their impact on mortality reduction.[66] Advocates of the scoop-and-run approach to prehospital care claim that attempts at on-scene IV insertion need to be avoided to

reduce on-scene time, and studies that support the scoop-and run technique assert lower mortality risk overall.[66] The Committee on Trauma of the American College of Surgeons have previously suggested that on-scene resuscitative interventions should be limited to establishing an airway, ventilation, controlling hemorrhaging, stabilizing fractures, and immobilization of the entire spine.[66] Their suggestions imply that IV access should be established en route to the hospital, and scene time should not be extended to establish vascular access.[44] However, studies have previously been shown that on-scene IV insertions occur at significantly greater frequency in rural areas than urban areas, thereby increasing EMS on-scene time.[66]

A rural EMS system provided trauma patient EMS IV insertion data for a one-year period, January 2007-December 2007. During this period, IV cannulations were performed on-scene before transporting to hospital care. The following year, January 2008-December 2008, a prospective trauma patient study protocol was instituted in which all IV insertions were attempted while en route to the emergency room. A total of 306 trauma patients had IV attempts on-scene, and 341 trauma patients had IV insertion attempts en route to the emergency room in the ambulance. The average EMS on-scene time with IV insertions on-scene was 19.8 minutes. The success rate of the 2007 data was 79% among providers. The 2008 on-scene time averaged 13.9 minutes with establishing IV access en route with a first attempt success rate of 93%.[66]

The authors stated that conditions such as lighting, arm positioning, and the availability of supplies may be improved by establishing vascular access in an ambulance. A negative impact of an ambulance en route IV insertion is the actual motion of a moving ambulance, which probably has minimal impact on IV insertion success.[66] However, in certain scenarios and if warranted, another health care provider on scene could establish peripheral vascular access and this could shorten prehospital on-scene time and expedite patient care.

A previous prehospital trauma care study from Scotland concurred with the results of the 2011 article in that patients who received ALS trauma intervention spent longer on-scene than those who did not.[67] A six-year prospective study (July 1, 1996 to June 30, 2002) was conducted of adult trauma patients treated by the Scottish Ambulance Service. The study aimed to compare contributions made by paramedics with advanced prehospital trauma care skills and ambulance technicians (EMTs) with the processes of care and outcomes of patients after trauma. Prehospital times, interventions, and outcomes were compared between patients treated by paramedics and those treated by technicians. Despite the adoption of different levels of emergency medical providers in the prehospital settings in Scotland, the benefits of this additional training have been questioned as these interventions delay definitive care to the patient.[67]

The authors of this study included 21,417 patients who were admitted to a hospital for at least three days or who died as a result of trauma. They excluded patients aged over 65 years old and children under 13 years old. The results revealed than an average time of 23 minutes was spent by paramedics to cannulate patients and administer fluids compared to an average of 14 minutes with no interventions by ambulance technicians.[67] Paramedics treated patients who also tended to have more serious injuries, and a third of their patients were cannulated, intubated, or both.[67] These interventions are associated with longer on-scene times.[67] The authors stated that prehospital times were consistent with other studies from the UK.[67] In conclusion, this study suggests that advanced prehospital trauma care training improves identification of the seriously injured patients who need ALS interventions, and more research is necessary to decide if patients warrant a scoop and run policy of prehospital trauma care.[67]

2.3.4. Conclusion

As previously mentioned, ATs are employed in a multitude of workplace settings and are subject to work outdoors at increased temperatures. Every AT is taught and tested on how to manage an EHI efficiently with best evidence-based practice guidelines and techniques at their disposal. [2,5,15] However, not all ATs have the same level of resource, geographically or socioeconomically, and have to modify their policies to best fit their institution's needs. Increased response times of rural EMS units can leave ATs responding to an emergency situation providing more prehospital care compared to fellow ATs with shorter regional EMS response times. In the incidence of an emergency heat illness, ATs who are trained to establish PIV access may be put in a situation where it is indicated fluid therapy be started to shorten EMS on-scene time. However, there is no research on the ability of ATs to establish PIV access and start IV therapy. With emergency care being a dominant aspect of the athletic training profession, ATs must be incorporated into future emergency care research.

3. METHODOLOGY

3.1. Purpose of the Study

The 2020 Commission on Accreditation of Athletic Training Education (CAATE) Educational Standards have deemed it appropriate to include intravenous (IV) placement in the curriculum as a standard for master's-level, professional athletic training students.[1] Students completing a CAATE Athletic Training program are required to graduate with the following skills based on the corresponding CAATE standards: manage patients with life threatening or emergent conditions (Standard 70), administer medications (Standard 75), manage fluid intake during activity (Standard 83), evaluate environmental conditions to prevent environmental illnesses (Standard 85), and develop and implement emergency action policies (Standard 92).[1] Standard 70 and 75 indicate that ATs can take life saving measures and administer medications to patients in emergent conditions, implying that under a physician's orders they can establish and place an IV. Standard 83, 85, and 92 give direction that ATs can manage environmental illnesses, including heat illnesses that may warrant intravenous therapy. These published standards indicate that IV placement is a skill that ATs are qualified to implement in the event of an emergent condition.

Starting an IV is within the athletic trainer's scope of practice and is a skill that can improve patient care in an emergency heat illness (EHI).[2] Currently, the gold standard of care for an EHI is to identify a patient is in distress, take a core temperature reading via a rectal thermometer, initiate cooling methods and monitor the patient, and transport once the body temperature has decreased.[2] Athletic Trainers can further enhance their care for a patient exhibiting signs and symptoms of EHI by establishing prehospital IV access and expediting prehospital fluid therapy.[1,3] There are published position statements by the National Athletic

Trainers' Association (NATA) that provide guidelines, resources, and direction for ATs to manage heat illness.[2,4,5]

However, many ATs do not routinely practice IV placement in traditional settings or are not trained to administer an IV. Additionally, each state has their own practice act that dictates an AT's actions, and ATs are legally obliged to follow their physician's standing orders.[6] For example, while the practice acts for both Minnesota and North Dakota clearly define the role of ATs in providing emergency care, they lack specific guidelines and explicit wording regarding the expectation for ATs to place IVs.[7,8]

Therefore, the purpose of this study was to determine the proficiency of the AT in placing peripheral IVs and to test their retention of the learned psychomotor skill. Published research that specifically evaluates an AT's ability to place IVs or retain the skill of placing IVs is lacking. Furthermore, this research was designed to examine the relationship between ATs and their perceived value of learning IV placement. The research also measured the AT's confidence in learning and teaching the skill. Additionally, this study examined the relationship between the participant's education level, job setting, and IV placement performance. The study was constructed to answer the following questions:

Q1: What percentage of participants successfully place an IV on the day of the educational intervention?

Q2: What percentage of participants successfully place an IV 25-45 days after the educational intervention?

Q3: What is the change in self-confidence of ATs between day one and day 25-45?

Q4: What is the ATs perceived value of learning IV placement?

Q5: What is the relationship between the participant's education level and job setting and their IV performance?

3.2. Participants

Participants included a sample of approximately 20 ATs from the Fargo-Moorhead area of North Dakota and Minnesota. Participants were recruited by word-of-mouth and email. Inclusion criteria included current certification by the Board of Certification (BOC®), and a license to practice athletic training in North Dakota or Minnesota. Exclusion criteria included ATs with extensive experience with IV placement (extensive indicating that placing an IV is a routine part of daily job duties), and any fear of needles (Trypanophobia).

Pregnant individuals and individuals with bilateral lymph node resection or bilateral upper extremity lymphedema, and/or any known medical condition that would prevent individuals from safely receiving repeat IVs (e.g. blood clotting disorders) were not excluded; but were not subject to repeat IV attempts.

Informed written and verbal consent were obtained prior to initiation of any data collection. Baseline demographic information (including age, sex, years of experience as an AT, current job setting, past job settings, current degree level, any past IV experiences, any previous EMT/Paramedic experiences or credentials, and any existing medical conditions) were collected on a participant demographic form prior to the start of IV instruction.

3.3. Equipment and Instruments

3.3.1. IV Equipment

The instruments required for this study included a basic IV start kit, which contains the following: IV tubing, 20-gauge needles, saline fluid bags, antiseptic wipes, skin tape, Tegaderm, gauze, drip chambers, venipuncture stylettes, normal saline flushes and tubing, tourniquets,

labeling stickers and markers, gloves, face masks, sharps containers, and biohazard disposal containers. Educational devices were used for initial practice prior to practice and testing on human subjects. Precautionary COVID-19 safety measures were taken, including requiring mask usage from all participants and examiners, utilizing hand sanitizer before and after IV placement attempts, and social distancing when possible. Participant's arms were utilized for all graded IV start attempts.

3.3.2. Demographic Form

All participants completed a demographic form indicating age, sex, years of experience as an AT, current degree level, any IV placement experience, previous job settings, any history of EMT/Paramedic experience or credentials, and any existing medical conditions. This demographic form can be found in Appendix A.

3.3.3. Self Confidence Questionnaire

Participants completed the five-point, Likert-type scale of self-confidence at the first data collection session before the educational intervention and after their graded IV placement attempt. The participants that made it to the second data collection session completed the questionnaire both before and after their graded attempt. This questionnaire was used to gauge the participant's confidence in preparing the IV materials, performing the venipuncture, performing this skill in their clinical setting, and potentially teaching the skill. This questionnaire also asked if the AT deems this skill as "useful" for all ATs to know and practice. This form can be found in Appendix B.

3.3.4. NREMT Advanced Level Psychomotor Examination – Intravenous Therapy

The NREMT Intravenous Therapy Psychomotor Examination is the grading sheet the NREMT uses to assess Advanced EMTs and Paramedics learning IV therapy. The skill is scored

out of 22 possible points (within 16 categories), but one successful IV must be established within six minutes to constitute passing the skill. For this study, 20 out of 22 points (14 categories) were physically performed by the participants. The last 2 points "Runs IV for a brief period to assure patent line" and "Adjusts flow rate as appropriate", needed to be orally stated and were not physically performed. The grading sheet does contain critical criteria that if not met, constitutes an instant failing grade; such as failing to establish an IV within two attempts within the six-minute mark, failing to manage the patient as a competent EMT, or performing improper technique. Each attempt the AT performed was graded using this score sheet by one of three proficient examiners. This form can be found in Appendix C.

3.4. Procedures

Data was collected in two separate sessions separated by 25-45 days. The first event was on November 7, 2021from 10am-2pm at Casselton Area Ambulance in Casselton, North Dakota. Prior to initiation of data collection, this study was approved by the Institutional Review Board (IRB) at North Dakota State University. Each participant read and signed an informed consent form and was given the opportunity to have any questions answered by a researcher. Participants then completed a demographic information form, and a researcher was present to answer any questions. Next, each participant filled out a Self Confidence Questionnaire prior to the educational intervention.

A Nationally Registered Paramedic (NR-P) instructed the ATs on the basics of peripheral IV insertion for one hour and gave demonstrations with step-by-step instructions. Participants were then allotted 30 minutes of practice time with educational tools, and two hours of practice time with a partner's arm. All participants who were free from any of the aforementioned medical conditions (see exclusion criteria) were subject to receive repeat IV practice attempts

from their partners. Participants had up to four practice attempts. Consent from the partner was given before each practice attempt. There were three qualified examiners present to supervise ATs, answer any questions, and provide guidance. After the two-hour practice session, the ATs had two placement attempts to correctly perform the IV insertion procedure in front of an examiner in six minutes, and their accuracy was measured using the NREMT Intravenous Therapy Psychomotor score sheet. This included physically performing the steps and orally communicating the appropriate points. Lastly, following completion of the IV insertion skill in front of the examiner, the participants completed the Self Confidence Questionnaire before leaving Casselton Area Ambulance. The ATs who were successful in placing the IV were asked to attend a follow-up data session to measure short-term skill retention. The ATs who could not place the IV were not tested further.

For participant's scheduling convenience, follow-up data collection was conducted between 25 and 45 days following the initial data collection. Participants went to Essentia Health offices, (located at 314 33rd St S, Fargo) on December 3 (n=2), December 8 (n=1), and December 9 (n=8). The participants completed a Self Confidence Questionnaire and attempted one IV placement on a partner's arm in front of one of the examiners using the NREMT Intravenous Therapy Psychomotor score sheet. Afterwards they completed the Self Confidence Questionnaire for the final time.

3.5. Statistical Analysis

All statistical analyses were completed via IBM® SPSS statistics software version 25.0 (IBM®, Armonk, New York). The alpha value was set at 0.05. The first and second research questions were analyzed using basic descriptive statistics to determine the percentage of participants who successfully place an IV on the first day and at the follow-up testing session.

The third research question was assessed using a paired-samples test to determine significant changes in self-confidence between the two sessions. The fourth and fifth research questions were examined as a correlation analysis.

3.6. Conclusion

While published research on ATs and their ability to perform an IV venipuncture is lacking, there is literature studying nurses and paramedics and their proficiency and confidence with this skill. [49,68,69] This study assessed ATs ability to learn the IV administration skill, as well as determined their ability to retain the skill and feel confident in doing so. In the athletic training setting, the role of IV administration is limited. However, by determining the proficiency of ATs in placing IVs in this study, there may be an increased advocacy for more ATs to learn how to start an IV to expedite prehospital fluid therapy in EHI situations and enhance patient care.

4. MANUSCRIPT

4.1. Abstract

[Background] It is estimated that there are 9,000 incidences of exertional heat illnesses (EHI) every year in high school athletics.[20] Prehospital care for exertional heat stroke (EHS), a severe category of EHI, requires vascular access to be established to administer fluid therapy to assist in rehydration.[2,4,17] Though the 2020 CAATE Educational Standards imply that athletic training students may learn to establish peripheral intravenous access,[1] many ATs have not learned this skill or practice it regularly.[3]

[Objectives] The primary purpose of this study was to determine the proficiency of the AT in establishing peripheral intravenous access and retention of the psychomotor skill.

[Methods] Fifteen ATs (N=15) were recruited for this study. The participants completed a Self Confidence questionnaire and demographics form. After receiving an educational intervention, guidance, and supervised practice from a paramedic on the basics of establishing and maintaining peripheral IV access, the participant's proficiency was tested using the National Registry of Emergency Medical Technicians (NREMT) Advanced Level Psychomotor Examination score sheet. The participants then completed another Self Confidence questionnaire. The participants who were proficient in placing the IV (N=12) were invited to attend a follow-up session to measure short-term skill retention between 25 and 45 days after the initial data collection. At the start of the second data session, participants completed a Self Confidence questionnaire. Their peripheral IV placement skill was immediately tested utilizing the NREMT Intravenous Therapy Psychomotor score sheet. Before leaving the participants completed the final Self Confidence questionnaire.

[Results] A total of 80% of ATs successfully established PIV access on day one of the study. Out of the 11 ATs who qualified for follow up testing, 72.7% were able to establish PIV access within two attempts approximately 30 days later. It was found ATs' confidence levels while learning the skill increased significantly on day one of the study (t_{14}=-3.292, p=.005, d=-.850), but there was not a significant correlation between IV administration success and pre-educational intervention self-confidence (R=-2.55, p=.359). There was a statistically significant correlation between IV administration success and post-educational intervention self-confidence (B) (R=-.580, p=.024). Overall, a successful placement resulted in greater self-confidence reports. There was no significant relationship found between demographic variables and IV placement performance, nor any significant differences found between differences in perceived value of the skill over time.

[Conclusions] Overall, the majority of participants successfully learned the psychomotor skill, retained their knowledge of it approximately 30 days later, and were confident in doing so. Further research involving larger sample sizes and increased length of study should be performed to assist in determining the ATs' role in assisting NR-Ps in establishing PIV access to expedite prehospital care in EHI emergencies.

[Key Words] intravenous therapy, athletic trainers, education, skills, confidence

4.2. Introduction

It is estimated that there are approximately 9,000 incidences of exertional heat illnesses (EHI) every year in high school athletics.[20] Furthermore, 11 NCAA football players died from EHS between 1995 and 2016.[70] Additionally, between 2008 and 2018 in the United States, there were 4,188 cases of EHS in the United States Armed Forces,[23] and from 1999 to 2010, 8,081 heat-related deaths were reported within the United States general population.[24] A seemingly

minor EHI can quickly develop into an emergency in which hospital care is required. Prehospital care for an EHI requires vascular access to be established to administer fluid therapy and assist in rehydration.[2,4,17]

Intravenous cannulation can provide clinically important vascular access, and there are a multitude of conditions that clinical guidelines state warrant establishing IV access.[2,4,5,17,64,65] It has been suggested that on-scene resuscitative efforts by paramedics (NR-P) should be limited to critical care skills, such as establishing an airway, controlling ventilations, managing hemorrhaging, and immobilizing the spine.[66] This implies that IV access should be established en-route to the hospital, and scene time should not be extended to establish vascular access.[44] ATs can provide assistance to paramedics by establishing IV access prior to arrival of EMS to save critical time.

Emergency care is one of the five domains of athletic training.[3,15] Athletic Trainers (AT) diagnose, treat, and educate patients about EHI,[15] and are often the first responder to EHI incidents.[12] The gold standard for EHI treatment, as listed in multiple National Athletic Trainers' Association (NATA) position statements, is to correctly evaluate and distinguish which EHI is occurring, initiate cold water immersion, initiate fluid replacement, and transport the patient to the hospital.[2,4,5] It is within the scope of practice for the AT to establish PIV access to expedite prehospital care in EHI emergencies[1,3,4]

There is no publicly available research about an AT's confidence level associated with establishing peripheral IV access, nor the AT's perceived value of the psychomotor skill. It is unknown how many ATs regularly cannulate patients, or if ATs see value in establishing IV access for fluid therapy as an intervention. A parallel profession, graduate nurses and other practitioners, have expressed a lack of confidence in placing PIV cannulations.[58,61] Confidence in

this skill increases with practice, assessment, and positive learning experiences.[60,61,58,69] To achieve positive patient outcomes, further research needs to be conducted specific to the athletic training profession to understand ability, confidence, and perceived value as it relates to establishing peripheral vein access.

Based on published NATA position statements as well as the newly released 2020 CAATE educational standards, the purpose of this study was to determine the proficiency of the AT in placing peripheral IVs. Additionally, this research analyzed participants' retention of the learned psychomotor skill. Furthermore, a secondary aim of the study measured self-confidence of participants before and after each trial of the skill. Lastly, the perceived value of the newly acquired skill was scored by each participant.

4.3. Methods

4.3.1. Participants

Participants included a sample of 15 ATs (average of 6.07 ± 5.6 years of experience as a certified athletic trainer) from the Fargo-Moorhead area of North Dakota and Minnesota recruited via word of mouth. To be included in this research, participants needed to be currently certified by the Board of Certification (BOC®) and have a license to practice athletic training in North Dakota or Minnesota. Exclusion criteria consisted of ATs with extensive experience with IV placement and any fear of needles. Individuals who were pregnant, had bilateral lymph node resection, bilateral upper extremity lymphedema, or any known medical condition that would prevent individuals from safely receiving repeat IVs (e.g. blood clotting disorders) were not excluded from this research, but were not subject to repeat IV attempts. Informed written and verbal consent were obtained prior to initiation of any data collection.

4.3.2. Procedures

Data were collected in two separate sessions separated by 25-45 days. The first event was on November 7, 2021 at Casselton Area Ambulance in Casselton, North Dakota. Prior to initiation of data collection, this study was approved by the Institutional Review Board (IRB) at North Dakota State University. Each participant read and signed an informed consent form and completed demographic information. Next, each participant completed a Self Confidence Questionnaire prior to the educational intervention. A Nationally Registered Paramedic (NR-P) instructed the ATs on the basics of peripheral IV insertion for one hour. Participants were then allotted two and a half hours of practice time using a blend of educational tools and partner's arms. After practicing, ATs had two placement attempts to correctly perform the IV insertion procedure in front of an examiner in six minutes, and their accuracy was measured. Lastly, following completion of the PIV insertion attempts, participants completed the Self Confidence Questionnaire before leaving Casselton Area Ambulance. The ATs who were successful in placing the IV were asked to attend a follow-up data session to measure short-term skill retention. The ATs who could not place the IV were not tested further.

For participant's scheduling convenience and allow time for any rescheduling due to weather or travel concerns, follow-up data collection was conducted between 25 and 45 days following the initial data collection. Participants went to Essentia Health offices, (located at 314 33rd St S, Fargo) on December 3, 2021 (n=2, day 27 of study), December 8, 2021. (n=1, day 32 of study), and December 9, 2021 (n=8, day 33 of study). The participants completed a Self Confidence Questionnaire and attempted to establish PIV access on a partner's arm in front of the examiner without any discussion, practice, or guidance. Afterwards, they completed the Self Confidence Questionnaire for the final time.

4.3.3. Statistical Analysis

All statistical analyses were completed via IBM® SPSS statistics software version 25.0 (IBM®, Armonk, New York). The alpha value was set at 0.05. The independent variables in this research were the educational intervention and time. Dependent variables of this research included IV placement skill proficiency, IV placement skill retention, and confidence. The first and second research questions were analyzed using basic descriptive statistics to determine the percentage of participants who successfully place an IV on the first day and at the follow-up testing session. The third and fourth research questions were assessed using a paired-samples test over time to determine changes in self-confidence and perceived value between the two sessions A correlation analysis was ran to investigate the relationships between demographic variables and IV placement performance. Statistical significance for all statistical analyses was set at a *P* value of < 0.05.

4.3.4. Results

4.3.4.1. Demographic Information

A total of 15 certified athletic trainers participated in this study. Participants had an average of 6.07 ± 5.6 years of experience as a certified athletic trainer. The independent variables included the educational intervention and time. Dependent variables included IV placement skill proficiency, IV placement skill retention, and confidence. Descriptive statistics and frequency data for demographic information are presented in Table 4.

Table 4. Demographic Information

Variable	Levels of Variable	Percentage
Employment Setting	College Athletics	78.6%
	College Educator	7.1%
	Middle School	7.1%
	Orthopedic Urgent Care	7.1%
Education Level	Bachelor's	33.3%
	Master's	53.3%
	PhD	13.3%

4.3.4.2. IV Skill Proficiency and Retention

Participants were assessed on IV placement skill proficiency two times, the first was immediately following the educational session, the second time was 25-45 days following the educational session. Only participants who successfully placed an IV within two attempts during the skill proficiency test on the day of the educational intervention completed the follow-up skill retention testing. Out of the 15 total participants, 12 (80%) successfully placed an IV on the first day, and 11 were able to participate in the follow-up session. Of those who participated in follow-up testing, 72.7% (8 participants) were able to successfully place an IV within two attempts and 27.3% (3 participants) were not. Correlation analysis was used to investigate relationships between demographic variables (education level, years of experience, and current employment setting) and IV placement performance, however no significant relationships were noted ($p>.05$ for all analyses).

4.3.4.3. IV Skill Self-Confidence

Participants' self confidence in IV administration was assessed at four different times throughout the study: A) day of the educational intervention before the educational session; B) day of the educational intervention after the skill proficiency test; C) at the follow-up session before the skill retention testing; and D) at the follow-up session after the skill retention testing. Descriptive statistics for self-confidence are presented in Table 5.

Table 5. Descriptive Statistics for IV Skill Self-Confidence*

Assessment Time	N	Mean	Standard Deviation	Range
A	15	12	5.41	4-20
B	15	16	5.36	5-23
C	11	17.18	4.47	9-22
D	11	18	4.82	8-24

*Highest possible score = 24; lowest possible score=4

Results of paired samples t-tests assessing changes in self-confidence over time revealed significance increases in confidence from pre-educational intervention (A) to post-educational intervention (B) (t_{14}=-3.292, p=.005) with a large effect size (d=-.850). Additionally, while there was not a significant correlation between IV administration success and pre-educational intervention self-confidence (R=-2.55, p=.359), there was a statistically significant correlation between IV administration success and post-educational intervention self-confidence (B) (R=-.580, p=.024). In this case a negative correlation indicates that successful placement resulted in greater self-confidence reports.

4.3.4.4. Perceived Value of IV Placement Skill

Finally, athletic trainers' perceived value of learning IV placement was assessed at the same four time periods as self-confidence: A) day of the educational intervention before the educational session; B) day of the educational intervention after the skill proficiency test; C) at the follow-up session before the skill retention testing; and D) at the follow-up session after the skill retention testing. Paired samples t-tests were used to assess for differences in perceived value of the skill over time; however, no significant differences were found (p>.05). Frequency data related to perceived value are presented in Table 6.

Table 6. Athletic Trainers Response to: "I believe it is valuable for an AT to know how to establish an IV" at Different Time Periods

Time of Assessment	N	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
A	15	0%	0%	6.7%	26.7%	6.7%	60%
B	15	0%	6.7%	0%	20%	13.3%	60%
C	11	0%	9.1%	0%	27.3%	9.1%	54.5%
D	11	0%	9.1%	0%	9.1%	27.3%	54.5%

4.4. Discussion

The NATA position statements for fluid replacement, exertional heat stroke, and preventing sudden death dictate that ATs should initiate fluid therapy in the event of an EHI.[2,4,5] Position statements are legal documents that are based on published literature to reflect the standard of care Athletic Trainers should provide.[36,37] It is within the scope of practice for an AT to establish peripheral IV access to expedite prehospital fluid therapy in EHI situations.[1,3,4] Currently, there is no way of identifying how many ATs routinely practice this psychomotor skill, nor is there any research available on the topic specific to this health care profession.

Athletic training students completing an athletic training program (ATP) are required to graduate with skills based on the 2020 Commission on Accreditation of Athletic Training Education (CAATE) educational standards. The related CAATE Educational Standards to this research (70, 75, 83, 85, and 92) imply that athletic training students may learn to establish peripheral intravenous access (PIV) in the event of an EHI.[1] These published standards suggest that IV placement is a skill that ATs are qualified to implement in the event of an emergent condition.[1,2,3,4,5,14]

The primary aim of this study was to determine what percentage of participants could successfully place an IV on the day of an educational intervention. In addition, we wanted to investigate how many participants could retain this skill with no additional practice over the course of approximately 30 days. The secondary aim of the study included measuring levels of self-confidence and perceived value of the skill before and after each trial. Lastly, an additional aim was to examine if a relationship existed between the participant's education level, job setting, and IV placement performance.

This study is the first publicly available to examine skill retention of this psychomotor skill amongst ATs. We found that out of the 15 total participants, 80% were successfully able to establish peripheral IV access on the first day. Subsequently, 72.7% of participants were able to successfully place the IV within two attempts approximately 30 days later with no practice between testing days or on the day of testing. Likewise, one of the secondary aims was determining if a relationship existed between any of the participant's demographic variables (education level, job setting, years of experience) and IV placement performance. We found no significant relationship between these variables. The participants of this study had an average of 6.07 ± 5.6 years of experience as a certified AT. While no relationship was found between the demographic variables, it is both interesting and hopeful to understand the implication that the majority of ATs with any degree, experience, and within any job setting can learn this skill.

Some previous research conducted on IVs and nurses evaluated knowledge of both graduate and student nurses. Keleekai et al. found that nurses with an average of 10.5-11.7 years of experience scored between 13.3-14 (out of 22) points on a baseline knowledge assessment. While 'knowledge' being measured in this study is not necessarily the same as 'accuracy' measured in our study, this research demonstrated that nurse's knowledge of IV cannulation

improved with increased simulated practice of the skill.[58] Osti et al studied nursing students in one teaching hospital in Nepal and found that 82.47% of respondents self-reported having proper knowledge of starting and maintaining a PIV via a 19-item survey. A total of 14.22% of the nurses self-reported not following proper practices, and only 75% of respondents were aware of the influences of environmental cleanliness on IV site infection.[54] This data speaks to the need for student practitioners to have more assessment, practice, and guidance with this medical intervention.

There is no research available at this time investigating the relationship between ATs' self-confidence and establishing peripheral IV access. Several research studies involving nurses describe the lack of confidence many nurses experience in placing and maintaining PIVs.[58,59,60,61,71] Keleekai et al discovered that amongst a cohort of nurses in a mixed methods simulation study, their wait list group's confidence increased by 16% after a two-month wait period that followed an educational intervention.[58] This was attributed to IV insertion practice with guidance from instructors and utilization of a variety of simulation tools. In another publication, Vandenhouten et al specifically explored intravenous nursing education in Northern America. A 12-item survey provided to nursing programs revealed that shared intravenous therapy curricula between professional development staff at health care institutions and nursing education programs had the potential to increase confidence of both registered and student nurses due to familiarity of instruction.[61]

We identified after measuring changes in self-confidence over time that there were significant increases in our participants' self-confidence from pre-educational intervention to post-educational intervention. However, while we did not detect a significant correlation between the IV administration success and pre-educational intervention self-confidence, there

was a correlation between IV administration success and post-educational intervention self-confidence *(p*=.005). This is consistent with the findings from Keleekai et al's study that over time higher confidence scores were sustained in those participants who were successful in placing the IV. In our research, the ATs who did not perform well scored their self-confidence questionnaires lower than those who were more accurate. Vandenhouten et al continued to describe that resources provided by professional vascular access societies, such as the Infusion Nurses' Society, could help increase confidence levels if more widely distributed to those practitioners who place IVs.[61] While there is no NATA position statement solely dedicated to PIVs and initiating fluid therapy in the event of an EHI, this concept is explained in the NATA position statement for Preventing Sudden Death, Exertional Heat Illness, and Fluid Replacement for the Physically Active.[2,4,5] Further literature published by the NATA could assist in awareness and advocacy of ATs in starting IVs more frequently, and subsequently increase confidence of those performing the skill.

There is no past research on the perceived value of starting an IV by ATs. In our research, after assessing for differences in the perceived value of the skill over time by participants, no significant differences were found. It was interesting to observe that the questionnaires completed at the pre-educational and immediate post-educational interventions had no participants that "Strongly Disagreed" with the last statement on the on questionnaire "I believe it is valuable for an AT to know how to establish an IV." Contrastingly, after the 25-45 day skill retention window there was an increase in the "Disagree" options to the statement. This could be attributed to a variety of factors. Perhaps the participants who were unable to place the IV successfully did not believe that any AT should undertake this skill if it is not practiced consistently, or a failed start attempt could lead to a decrease in confidence and a diminished

view on the skill as a whole. Hulse[59,60] demonstrated in her research through a questionnaire completed by nurses that nurses were reluctant to become 'signed off' and held accountable to complete IV therapy on their own because supervision offered a degree of perceived "security." Establishing a PIV is not an easy medical intervention, and practitioners who undertake this task are responsible for starting and maintaining the IV line and site and associated prevention of infection.

Our study was not without limitations. Due to the nature of using participant's own arms for other participants to practice, our participant size was admittedly smaller than anticipated. Future research could utilize manikins or simulations to assist with participant's apprehensiveness to needle sticks. Additionally, future research in this area should focus on recruiting more ATs and from a variety of regions from the United States. Another limitation we encountered was the 25-45 day skill retention window. The timing of the research was in the winter, so we had a window to accommodate for poor weather and travel issues. Other researchers investigating this topic should attempt to have the same skill retention window for all participants. Lastly, per Institutional Review Board (IRB) protocol and the BOC®, ATs cannot prescribe medications to patients. Saline is used in fluid therapy in the IV bag and is classified as a drug. As we used the National Registry of Emergency Medical Technicians (NREMT) Intravenous Therapy Psychomotor score sheet for standardization of scoring, participants verbalized the last two points "Runs IV for a brief period to assure patent line", and "Adjusts flow rate as appropriate." These steps were not physically performed. Future research done under the direction and guidance of a physician could assist in ATs being able to complete the entire task.

Despite the fact that there are legal documents providing guidelines stating the 'gold standard' of treatment for an EHI, establishing peripheral IV access to expedite prehospital fluid therapy is not a skill most ATs routinely practice. Additionally, while it is clear this medical intervention is within the scope of an AT and that there are specific CAATE educational standards implying that AT students may learn how to initiate fluid therapy in the event of an EHI, it is unclear if ATs believe it is a valuable psychomotor skill to practice. While the results from our research suggest that ATs are proficient in learning how to start a PIV, retain the skill, and are confident in doing so, not all perceived the value of this medical intervention for the profession. More research must be conducted incorporating fluid administration and with larger groups of participants to understand if ATs are proficient in expediting prehospital fluid therapy.

REFERENCES

1. Commission on Accreditation of Athletic Training Education. *2020 Standards for Accreditation of Professional Athletic Training Programs*.; 2020.
2. Casa DJ, DeMartini JK, Bergeron MF, et al. National Athletic Trainers' Association Position Statement: Exertional Heat Illnesses. *J Athl Train*. 2002;37(3):329-343. doi:10.4085/1062-6050-50.9.07
3. Velasquez BJ. IV Utilization or Access by Licensed Athletic Trainer in the Clinical Setting. *Sport Exerc Med - Open J*. 2018;4(1):e1-e3. doi:10.17140/semoj-4-e004
4. McDermott BP, Anderson SA, Armstrong LE, et al. National Athletic Trainers' Association Position Statement: Fluid Replacement for the Physically Active. *J Athl Train*. 2017;52(9):877-895. doi:10.4085/1062-6050-52.9.02
5. Casa DJ, Guskiewicz KM, Anderson SA, et al. National Athletic Trainers' Association Position Statement: Preventing Sudden Death in Sports. *J Athl Train*. 2012;47(1):96-118. doi:10.4085/1062-6050-47.1.96
6. Fincher L, Boyle-Walker K, Brown S. Athletic Training Services An Overview of Skills and Services Performed by Certified Athletic Trainers. *Natl Athl Trainers' Assoc*. Published online 2010. http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.178.8458
7. North Dakota Legislative Branch. ARTICLE 106-03 PRACTICE OF ATHLETIC TRAINING. Published 2021. Accessed March 1, 2022. https://www.ndlegis.gov/information/acdata/pdf/106-03-01.pdf
8. Revisors of Statutes. 2020 Minnesota Statutes 148.7806 Athletic Training. Published 2020. Accessed September 10, 2021. https://www.revisor.mn.gov/statutes/cite/148.7806

9. Arkansas Athletic Trainers' ASSOCIA. About Athletic Trainers. Accessed July 1, 2022. https://www.aataonline.com/what-is-an-athletic-trainer

10. Cambridge College of Healthcare & Technology. IV Therapy Common Questions. Published 2022. Accessed July 1, 2022. https://www.cambridgehealth.edu/iv-therapy-infusion-program/common-questions/

11. Elea Carey. Heat Emergencies. Published 2017. Accessed July 1, 2022. https://www.healthline.com/health/heat-emergencies

12. Casa DJ, Anderson SA, Baker L, et al. The Inter-Association Task Force for Preventing Sudden Death in Collegiate Conditioning Sessions: Best Practices Recommendations. *J Athl Train*. 2012;47(4):477-480. doi:10.4085/1062-6050-47.4.08

13. Merriam-Webster Dictionary. Definition of Confidence. Published 2022. Accessed July 1, 2022. https://www.merriam-webster.com/dictionary/confidence

14. Dr. Eric J Fuchs. Introduction to AT Utilization & Clinical Establishment of IV Access & IV Fluid Improve Patient Care. Published 2019. https://vimeo.com/338947334

15. Board of Certification. *BOC Standards of Professional Practice*.; 2018. http://www.bocatc.org/resources/standards-of-professional-practice

16. Gauer R, Meyers B. Heat-Related Illnesses. *Am Fam Physician*. 2019;99(8):482-489. doi:10.1007/s10049-020-00716-5

17. Armstrong LE, Casa DJ, Millard-Stafford M, Moran DS, Pyne SW, Roberts WO. Exertional Heat Illness during Training and Competition. *Med Sci Sports Exerc*. 2007;39(3):556-572. doi:10.1249/MSS.0b013e31802fa199

18. Torres PA, Helmstetter JA, Kaye AM, Kaye AD. Rhabdomyolysis: Pathogenesis, Diagnosis, and Treatment. *Ochsner J*. 2015;15(1):58-69.

19. National Athletic Trainers' Association. Consensus Statement: Sickle Cell Trait and the Athlete. *Annu Meet Natl Athl ...*. 2007;(1):1-5. http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Consensus+Statement+:+Sickle+Cell+Trait+and+the+Athlete#0

20. Kerr ZY, Casa DJ, Marshall SW, Comstock RD. Epidemiology of Exertional Heat Illness Among U.S. High School Athletes. *Am J Prev Med*. 2013;44(1):8-14. doi:10.1016/j.amepre.2012.09.058

21. Anderson S. NCAA Football Off-Season Training: Unanswered Prayers. . . A Prayer Answered. *J Athl Train*. 2017;52(2):145-148. doi:10.4085/1062-6050-52.3.02

22. Asplund CA, O'Connor FG. Challenging Return to Play Decisions: Heat Stroke, Exertional Rhabdomyolysis, and Exertional Collapse Associated With Sickle Cell Trait. *Sports Health*. 2016;8(2):117-125. doi:10.1177/1941738115617453

23. Filep EM, Murata Y, Endres BD, Kim G, Stearns RL, Casa DJ. Exertional Heat Stroke, Modality Cooling Rate, and Survival Outcomes: A Systematic Review. *Med*. 2020;56(11):1-24. doi:10.3390/medicina56110589

24. Centers for Disease Control. *Heat-Related Illness*.; 2016. https://www.cdc.gov/pictureofamerica/pdfs/picture_of_america_heat-related_illness.pdf

25. Gubernot DM, Anderson GB, Hunting KL. Characterizing Occupational Heat-Related Mortality in the United States, 2000-2010: An Analysis Using the Census of Fatal Occupational Injuries Database. *Am J Ind Med*. 2015;58(2):203-211. doi:10.1002/ajim.22381

26. Mitchell DiC, Castro J, Armitage TL, et al. Recruitment, Methods, and Descriptive Results of a Physiologic Assessment of Latino Farmworkers: The California Heat Illness Prevention Study. *J Occup Environ Med*. 2017;59(7):649-658. doi:10.1097/JOM.0000000000000988

27. Singer DE, Byrne C, Chen L, Shao S, Goldsmith J, Niebuhr DW. Risk of Exertional Heat Illnesses Associated with Sickle Cell Trait in U.S. Military. *Mil Med*. 2018;183(7-8):e310-e317. doi:10.1093/milmed/usx085

28. O'Connor FG, Casa DJ. Exertional heat illness in adolescents and adults: Epidemiology, thermoregulation, risk factors, and diagnosis. *UpToDate*. Published online 2016:1-15. https://www.uptodate.com/contents/exertional-heat-illness-in-adolescents-and-adults-epidemiology-thermoregulation-risk-factors-and-diagnosis

29. Brechue WF, Stager JM. Acetazolamide alters temperature regulation during submaximal exercise. *J Appl Physiol*. 1990;69(4):1402-1407. doi:10.1152/jappl.1990.69.4.1402

30. Cooper ER, Ferrara MS, Casa DJ, et al. Exertional heat illness in American football players: When is the risk greatest? *J Athl Train*. 2016;51(8):593-600. doi:10.4085/1062-6050-51.8.08

31. Kerr ZY, Register-Mihalik JK, Pryor RR, et al. Exertional Heat Illness Preparedness Strategies: Environmental Monitoring Policies in United States High Schools. *Environ Health Perspect*. 2019;127(4). doi:10.1289/EHP4163

32. Andersen JC, Courson RW, Kleiner DM, Mcloda TA. Emergency Planning in Athletics. *J Athl Train*. 2002;37(1):99-104. www.journalofathletictraining.org

33. Mazerolle SM, Scruggs IC, Casa DJ, et al. Current knowledge, attitudes, and practices of certified athletic trainers regarding recognition and treatment of exertional heat stroke. *J Athl Train*. 2010;45(2):170-180. doi:10.4085/1062-6050-45.2.170

34. McDermott BP, Casa DJ, Ganio M, et al. Acute Whole-Body Cooling for Exercise-Induced Hyperthermia: A Systematic Review. *J Athl Train*. 2009;44(1):84-93. doi:10.4085/1062-6050-44.1.84

35. Porters M V. *COMPLYING WITH YOUR STATE'S LAWS AND PRACTICE ACT*.; 2018.

36. Yeargin S, Lopez RM, Snyder Valier AR, DiStefano LJ, McKeon PO, Medina McKeon JM. Navigating Athletic Training Position Statements: The Strength of Recommendation Taxonomy System. *J Athl Train*. 2020;55(8):863-868. doi:10.4085/1062-6050-240-19

37. Walters Inc. - Consultant in Sports Medicine. *An Independent Evaluation of Procedures and Protocols Related to the June 2018 Death of a University of Maryland Football Student-Athlete*.; 2018. https://assets.documentcloud.org/documents/4918313/Investigation-in-death-of-Maryland-football.pdf

38. Young A, Klossner J, Docherty CL, Dodge TM, Mensch JM. Clinical Integration and How It Affects Student Retention in Undergraduate Athletic Training Programs. *J Athl Train*. 2013;48(1):68-78. doi:10.4085/1062-6050-48.1.22

39. Mazerolle SM, Dodge T. Role of Clinical Education Experiences on Athletic Training Students' Development of Professional Commitment. *Athl Train Educ J*. 2015;10(2):138-145. doi:10.4085/1002138

40. Walker SE, Weidner TG, Armstrong KJ. Evaluation of athletic training students' clinical proficiencies. *J Athl Train*. 2008;43(4):386-395. doi:10.4085/1062-6050-43.4.386

41. National Highway Traffic Safety Administration. *2021 National Emergency Medical Services Education Standards*.; 2021. https://www.ems.gov/pdf/EMS_Education Standards_2021_FNL.pdf

42. National Athletic Trainers' Association Executive Committee for Education. *Future Directions in Athletic Training Education*.; 2012.

43. Richardson R, Herzog V, Merrick M, et al. *Professional Education in Athletic Training: An Examination of the Professional Degree Level*.; 2013. http://www.nata.org/sites/default/files/The_Professional_Degree_in_Athletic_Training.pdf

44. Frisch A, Cammarata S, Mosesso V, Martin-Gill C. Multivariate Analysis of Successful Intravenous Line Placement in the Prehospital Setting. *Prehospital Emerg Care Off J Natl Assoc EMS Physicians Natl Assoc State EMS Dir*. 2013;17(1):46-50.

45. National Cancer Institute at National Institute of Health. Peripheral Venous Catheter. Published 2021. Accessed October 3, 2022. https://www.cancer.gov/publications/dictionaries/cancer-terms/def/peripheral-venous-catheter

46. Doyle GR, McCutcheon JA. Intravenous Fluid Therapy. In: *Clinical Procedures for Safer Patient Care*. BCcampus Open Education; 2012. https://opentextbc.ca/clinicalskills/chapter/intravenous-therapy-peripheral-and-central-venous-catheters/

47. Beecham GB, Tackling G. Peripheral Line Placement. *StatPearls Publ LLC*. Published online 2021. http://www.ncbi.nlm.nih.gov/pubmed/30969617

48. BCCH Child & Youth Health Policy and Procedure Manual. *INITIATING A PERIPHERAL INTRAVENOUS (PIV)*.

49. Campbell T, Lunn D. Intravenous therapy: current practice and nursing concerns. *Br J Nurs*. 1997;6(21):1218-1228. doi:10.12968/bjon.1997.6.21.1218

50. Ortega R, Sekhar P, Song M, Hansen C, Peterson L. Peripheral Intravenous Cannulation. *N Engl J Med*. 2008;359(26). doi:10.1056/nejmvcm0706789

51. National Health Service. Phlebitis (superficial thrombophlebitis). National Health Service. Published 2019. Accessed October 3, 2022. https://www.nhs.uk/conditions/phlebitis/

52. Bonsall L. Complications of Peripheral I.V. Therapy. NursingCenter. Published 2015. Accessed October 3, 2022. https://www.nursingcenter.com/ncblog/february-2015-(1)/complications-of-peripheral-i-v-therapy

53. Sikora A, Zahra F. Nosocomial Infections. *StatPearls Publ LLC*. Published online 2021.

54. Osti C, Khadka M, Wosti D, Gurung G, Zhao Q. Knowledge and practice towards care and maintenance of peripheral intravenous cannula among nurses in Chitwan Medical College Teaching Hospital, Nepal. *Nurs Open*. 2019;6(3):1006-1012. doi:10.1002/nop2.288

55. Centers for Disease Control and Prevention. Infection Control: Summary of recommendations. Published 2017. Accessed February 22, 2022. https://www.cdc.gov/infectioncontrol/guidelines/bsi/recommendations.html

56. Woody G, Davis BA. Increasing Nurse Competence in Peripheral Intravenous Therapy. *J Infus Nurs*. 2013;36(6):413-419. doi:10.1097/NAN.0000000000000013

57. Gorski L, Hadaway L, Meyer BM, Nickel B. *The 2021 Infusion Therapy Standards of Practice*. Vol 35.; 2021. doi:10.1097/nhh.0000000000000504

58. Keleekai NL, Schuster CA, Murray CL, et al. Improving Nurses' Peripheral Intravenous Catheter Insertion Knowledge, Confidence, and Skills Using a Simulation-Based Blended Learning Program: A Randomized Trial. *Simul Healthc*. 2016;11(6):376-384. doi:10.1097/SIH.0000000000000186

59. Hulse AL. Clinical competency assessment in intravenous therapy and vascular access: part 1. *Br J Nurs*. 2013;22(16).

60. Hulse AL. Clinical competency assessment in intravenous therapy and vascular access: part 2. *Br J Nurs*. 2013;22(17).

61. Vandenhouten CL, Owens AK, Hunter MR, Raynak A. Peripheral Intravenous Education in North American Nursing Schools: A Call to Action. *J Nurs Educ*. 2020;59(9):493-500. doi:10.3928/01484834-20200817-03

62. National Registry Emergency Medical Technicians. NREMT About Us. Published 2021. Accessed December 22, 2021. https://www.nremt.org/about/about-us

63. Green A, Hug M. Simulation Training and Skill Assessment in EMS. *StatPearls*. Published online 2020:20894. https://pubmed.ncbi.nlm.nih.gov/32809397/

64. National Association of State EMS. National Model EMS Clinical Guidelines (Version 3.0). Published online 2021:1-420. http://nasemso.org/Projects/ModelEMSClinicalGuidelines/documents/National-Model-EMS-Clinical-Guidelines-15Sept2014.pdf

65. Siriwardena AN, Iqbal M, Banerjee S, Spaight A, Stephenson J. An evaluation of an educational intervention to reduce inappropriate cannulation and improve cannulation technique by paramedics. *Emerg Med J*. 2009;26(11):831-836. doi:10.1136/emj.2008.071415

66. Gonzalez RP, Cummings GR, Rodning CB. Rural EMS en route IV insertion improves IV insertion success rates and EMS scene time. *Am J Surg*. 2011;201(3):344-347. doi:10.1016/j.amjsurg.2010.09.021

67. Sukumaran S, Henry JM, Beard D, et al. Prehospital trauma management: a national study of paramedic activities. *Emerg Med J*. 2005;22(1):60-63. doi:10.1136/emj.2004.016873

68. Nebocat CM. Phlebotomy-Related Self-Efficacy in Long Island Nursing Students: A Pilot Study. *Teach Learn Nurs*. 2017;12(4):281-285. doi:10.1016/j.teln.2017.07.003

69. Morgan PJ, Cleave-Hogg D. Comparison between medical students' experience, confidence and competence. *Med Educ*. 2002;36(6):534-539. doi:10.1046/j.1365-2923.2002.01228.x

70. Yeargin SW, Dompier TP, Casa DJ, Hirschhorn RM, Kerr ZY. Epidemiology of exertional heat illnesses in National collegiate athletic Association athletes during the 2009-2010 through 2014-2015 academic years. *J Athl Train*. 2019;54(1):55-63. doi:10.4085/1062-6050-504-17

71. Dougherty L. Peripheral cannulation. *Nurs Stand*. 2008;22(52):49-59. doi:10.7748/ns.25.35.59.s48

APPENDIX A. DEMOGRAPHIC FORM

Demographic Form

Name:

Number of years of experience as an Athletic Trainer:

Current Degree Level:

Current athletic training employment setting:

Previous athletic training employment settings:

Do you have any current medical conditions that would be affected by the insertion of a peripheral IV?

Have you previously held/currently hold any NRAEMT or Paramedic credentials? If so for how long?

APPENDIX B. SELF CONFIDENCE QUESTIONNAIRE

Self Confidence Questionnaire

Please respond to each question using the six-point scale listed below.

1: Strongly Disagree

2: Disagree

3: Somewhat Disagree

4: Somewhat Agree

5: Agree

6: Strongly Agree

1. I feel confident I can complete all necessary skills to provide peripheral intravenous therapy to an athlete/patient. ____

2. I feel confident I will be able to complete all necessary skills to provide peripheral intravenous therapy to an athlete/patient in the immediate future (~30 days). ____

3. I am confident I will be able to complete all necessary skills to provide peripheral intravenous therapy to an athlete/patient beyond 30 days. ___

4. I feel confident I can teach another Athletic Trainer or Athletic Training Student how to establish an IV. ___

5. I believe it is valuable for an Athletic Trainer to know how to establish an IV. ___

APPENDIX C. NREMT ADVANCED LEVEL PSYCHOMOTOR EXAMINATION – INTRAVENOUS THERAPY

National Registry of Emergency Medical Technicians
Advanced Level Psychomotor Examination

INTRAVENOUS THERAPY

Candidate: _____ Examiner: _____

Date: _____ Signature: _____

Actual Time Started: _____	**Possible Points**	**Points Awarded**
Checks selected IV fluid for: -Proper fluid (1 point) -Clarity (1 point) -Expiration date (1 point)	3	
Selects appropriate catheter	1	
Selects proper administration set	1	
Connects IV tubing to the IV bag	1	
Prepares administration set [fills drip chamber and flushes tubing]	1	
Cuts or tears tape [at any time before venipuncture]	1	
Takes or verbalizes appropriate PPE precautions [prior to venipuncture]	1	
Applies tourniquet	1	
Palpates suitable vein	1	
Cleanses site appropriately	1	
Performs venipuncture -Inserts stylette (1 point) -Notes or verbalizes flashback (1 point) -Occludes vein proximal to catheter (1 point) -Removes stylette (1 point) -Connects IV tubing to catheter (1 point)	5	
Disposes/verbalizes proper disposal of needle in proper container	1	
Releases tourniquet	1	
Runs IV for a brief period to assure patent line	1	
Secures catheter [tapes securely or verbalizes]	1	
Adjusts flow rate as appropriate	1	
Actual Time Ended: _____ **TOTAL**	**22**	

Critical Criteria

___ Failure to establish a patent and properly adjusted IV within 3 attempts during the 6 minute time limit
___ Failure to take or verbalize appropriate PPE precautions prior to performing venipuncture
___ Contaminates equipment or site without appropriately correcting the situation
___ Performs any improper technique resulting in the potential for uncontrolled hemorrhage, catheter shear, or air embolism
___ Failure to dispose/verbalize disposal of blood-contaminated sharps immediately in proper container at the point of use
___ Failure to manage the patient as a competent EMT
___ Exhibits unacceptable affect with patient or other personnel
___ Uses or orders a dangerous or inappropriate intervention

You must factually document your rationale for checking any of the above critical items on the reverse side of this form.