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**Jennings, Douglas S.** ***Human Patient Simulation in EMS***

## Abstract

The use of simulation for healthcare has evolved since the Civil War. Simulation was started long before the Emergency Medical Services were recognized. Throughout the years, simulation has developed and become a vital and useful tool for faculty and students in EMS. The findings of this study show that students completed more evolutions of intubations using mannequins and students had a reduction in class to practical time for hands on learning. The study also shows that instructors perceptions were that the simulators were good for students but really didn't save time for faculty.

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# Chapter I: Introduction

Simulation has been defined as “something that is made to look, feel, or behave like something else especially so that it can be studied or used to train people” (Merriam-Webster, n.d.-c). Long before mannequins were used, simulations used animals and people to train others in procedures and assessments. This practice is continued today but raises ethical concerns when sacrificing animals for science. Documentation regarding the use of simulations, can be traced back to the late 17$^{th}$ century as evidenced by the first obstetric mannequin, known as “The Machine,” that was made from cloth by a French midwife for the purpose of teaching birthing techniques to other midwives and surgeons (Rmk Aimes, n.d.). As technologies advanced through the 1980s clinical simulation had become relevant to many emergency medical services (EMS) programs. As more EMS programs recognize the impact simulations have in other educational programs, the more apt they are to try it.

The term simulation can be used in several contexts such as testing, training, education, and video games. A popular simulation training example would be flight simulation used to teach airline pilots critical skills in a controlled environment. The evolution of simulator uses in healthcare started with a 1967 study (Denson & Abrahamson, 1969), conducted by University of Southern California School of Medicine with anesthesiology residents. Faculty at University of Southern California thought that the aviation simulation training was so successful that there would also be benefits in healthcare training. The study results indicated that residents were able to reach accepted professional levels of competence in fewer days than residents who did not do simulations. This study paved the way for future simulations in healthcare (Denson & Abrahamson, 1969).

Prehospital emergency services were born out of our military conflicts (West Virginia Department of Education, n.d.). Soldiers wounded in battle needed to be transported to various places to receive care for their injuries. As time progressed, funding was made available through governments to start ambulance services; however, it wasn't until the late 1980s that educators started to look at simulation training for EMS.

Industry-wide efforts began after the release of the Institutes of Medicine 1999 report, *To Err is Human*. One recommendation from this report was "to move away from using live patients as 'trainers' and incorporate highly realistic, controlled training equipment and environments to allow new practitioners to develop and refine assessments, skills and procedures in a safe environment" (Hsieh, 2013).

Simulations provide a unique opportunity for students to view their own actions and improve upon them (EMS World, 2006). Hospitals and ambulances have patients that are unpredictable with a potential of anything happening to the staff and students, whereas simulation is a controlled environment (Gordon et al., 2001). High fidelity human patient simulators (HPS) allow students to perform invasive monitoring and investigate the effects of added stressors (Harris et al., 2011).

For the purposes of this study, the researcher assumes that pre-hospital healthcare, such as EMS, will primarily use mannequins for simulation. Simulations span a large spectrum of technology and can be defined by how complex or simple the simulations are. At one end of the spectrum is simple simulation such as a single body part or a mannequin that has one or two controls. These are great teaching tools for professionals to drill down a topic, and they are extremely easy to use. On the other end are high fidelity mannequins that can replicate human interactions as well as physiological changes. These mannequins can be used as a comprehensive approach to a capstone class, initial learnings, or refresher training. A plethora of mannequin companies are available to choose from, and studies show which ones perform the best (Bradley, 2006). Trainers must select the best mannequin for the appropriate level of instruction and skill (Cook et al., 2007). For example, if trainers are teaching intravenous (IV) placement in arms then why utilize an entire mannequin when you could use a simple arm simulator? It could be justified if the student was doing an entire scenario where the IV was a piece of the curriculum that could affect the patient outcome.

Some of the first simulation mannequins Wisconsin Technical Colleges used were cardiopulmonary resuscitation (CPR) half bodies. These were half bodied mannequins that were used for chest compressions and mouth to mouth breathing. They had no electrical or mechanical parts. Faculty communicated that EMS programs at Northcentral Technical College (NTC), students commonly use other students as patients for students to practice techniques. This practice is more peer to peer evaluating than instructor led evaluation. Through time, technology, and budgeting, NTC was able to procure technology for EMS mannequins. Faculty have observed, through limited use of mannequins, that learning has occurred during skill stations based on student testimonials through evaluations. Adult learners, according to Knowles (1980), have a desire to immediately apply the knowledge gained through cognitive lessons in a venue such as a psychomotor lab. For example, in a typical paramedic class, first students could learn about medications and the effect they have on a human body and then actually administer medications based on symptoms the high-fidelity mannequin is presenting. If the student administers the wrong dose or medication, then it becomes a “learning” experience, and the scenario is run again.

One skill that research indicates should be repeated more often is CPR. A substantial body of research has shown that CPR skills disappear within weeks of performing the skills in class (Alspach, 2005). These findings are another reason why repeated use of mannequins are important to the retention of life saving skills.

EMS paramedic students, at Wisconsin Technical Colleges, go through an intensive and rigorous program to practice as a licensed emergency medical technician paramedic (EMT-P). During this process, an EMS student must go through both field and clinical training. Field training can be described as training conducted with an ambulance service and clinical training can be described as training conducted in a facility such as an emergency room or another department in the hospital. Faculty have communicated several times at EMS Coordinators meetings, that clinical sites are becoming increasingly more difficult to place EMS students. The competency and hour requirements are very demanding on the students and the clinical sites. Paramedic students must complete 504 hours of field and clinical time through NTC’S paramedic program. These hour requirements are driven by the Wisconsin Technical College System office. Current paramedics generally have to complete competency requirements yearly in a field or clinical setting depending on the ambulance service protocols. These current paramedics would be in addition to new students competing for time in clinical.

Findings from EMS coordinators indicated that when simulators are used, a ratio of 3:1 can be used, meaning every three hours of clinical time can be done in one hour of simulation. The premise behind this is there normally will be down time in a hospital setting for things such as lack of patients or nurses and doctors who do not want the student to participate in certain cases. Whereas simulations are a more efficient use of time because most trainings can be created for every student, in a scheduled format, making use of valuable time.

**Statement of the Problem**

As a progressive education center, NTC has not collected enough evidence that indicates whether the use of simulators impacts student learning or skill attainment. NTC does not know what the effect would be on the learners if live patient clinical was replaced with simulation clinical. The purpose of this research is to gather and analyze evidence to determine if human patient simulator learning is as effective as or better than real patient experiences. This study will attempt to answer the following questions:

1. How does learning intubation, using a high-fidelity human patient simulator, compare to learning with real patients?
2. What effect does high fidelity human patient simulation intubation have on faculty's ability to teach competencies?
3. How can high fidelity human patient simulation improve use of student and instructor time?

**Purpose of the Study**

The purpose of this study is to show evidence, or lack thereof, that HPS learning for intubations is as effective as or better than real patient experiences in a clinical setting. This study fits well within the career and technical education research logic model. The study identifies with several categories such as delivery methods, program effectiveness, and program planning. The design for this study will use descriptive research methodology. A survey will be used to gather points of view and data from faculty. The independent variables will be the respondent's views of high-fidelity human patient simulation compared to going to a clinical site and using real patients. The dependent variable will be the competencies required. The population for this study will be new and existing paramedics and EMS faculty.

**Significance of the Problem**

The impacts of this study could have profound effects on how NTC and other training centers, conduct clinical such as having choices of sending students to some clinical and keeping some of the students in an HPS lab. Some of the impacts could include budgeting, scheduling, and student success. Currently, EMS programs are struggling to compete with the nursing program and several other programs, such as premed residents, hospital employee certifications, and hospital remediations, who also need required clinical time. This problem is compounded by other colleges and EMS services in the area who have similar needs as well. The reality is there are limited sites to go to for clinical and colleges compete for them. As an example, NTC uses Aspirus as one of the clinical sites but so does Midstate Technical College. The healthcare profession does not want to sacrifice quality education just to get students through clinical. Educators seek to have a student’s time used to its full effectiveness.

**Assumptions and Limitations of the Study**

Waukesha Technical College will be given an online survey to be taken by faculty of the EMS program. Their EMS program is one of the most successful programs in the state according to their student success rates and their progressive EMS leadership within the WTCS education system. The following assumptions will exist for this research:

- The associate dean of EMS will conduct a focus group with the EMS faculty.
- Answers will be sent back on the survey.
- Not all answers will be factual but rather opinion.

Northcentral Technical College employs two fulltime paramedic faculty and 12 adjunct faculty. NTC has an average of 20 students each semester in clinical or field training and these will be the students for the pilot study. My role during this study was the Dean of Public Safety at NTC. The following assumptions existed while the pilot study was being done:

- Not all students or employees will return surveys, as NTC has an average return rate of 65% for surveys.
- Some students will not finish the EMS program.
- Data gathered from clinical sites are self- reported from students, which may be less accurate.

The following limitations will exist while the pilot study is being done:

- Due to the number of competencies required for completion, intubations will be the focus of the study.
- Paramedic level students have the most opportunity to use HPS, so they will be the only level studied.
- Every college can have different standards to achieve. State provides a baseline that can be exceeded.

## Definition of Terms

For ease of understanding, the following terms have been defined.

### *Clinical*

A clinical is a training that is conducted after didactic and lab environment competencies are met using real patients in a hospital setting (Merriam-Webster, n.d.-a).

### *Clinical Simulation*

An educational model of a phenomenon or activity that allows students to rehearse behaviors without placing clients or instructional resources at risk (Medical-Dictionary, n.d.-a).

***Emergency Medical Services***

Emergency medical services is defined as prehospital health care for patients with real or perceived emergencies from the time point of emergency telephone access until arrival and transfer of care to the hospital (National Highway Traffic Safety Administration, n.d.).

***High Fidelity***

High fidelity is defined as high quality technology capable of reproducing or imitating human characteristics in mannequins. The reproduction of an effect (as sound or an image) that is very faithful to the original (Merriam-Webster, n.d.-b).

***Human Patient Simulation***

A mannequin equipped with technologies that make it resemble and respond like a living person, used in health care education for role playing, skill building, and hands-on, active education (Medical-Dictionary, n.d.-b).

## Chapter II: Review of Literature

As educational hours increase, looking for alternatives for faculty and students to complete clinical intubations in a timely and efficient manner while ensuring competency is vital to EMS services across Wisconsin. Wisconsin formed an EMS board that oversees education curriculum and requirements pertaining to EMS licenses. Part of the board's discussion includes adding additional hours of training into the EMS curriculum which some believe are contributing to the decline in available licensed Emergency Medical Technicians (EMTs; Wisconsin Department of Health Services, 2022b).

This chapter provides an overview of the history and development of simulation in healthcare training. Much of the published research in simulation does not directly involve EMS but rather health care in general with most of it being anesthesiology. The use of high-fidelity simulation mannequins in EMS is growing, but studies are limited. According to a research literature review, only a limited number of countries have published research on simulation with prehospital staff. The review of literature also found that the number of articles drastically rose after the year 2000 (Abelsson et al., 2014). Research on simulation exercises focusing on intubation started in 1996 and still is a common focus of research today (Abelsson et al., 2014). The conclusion of this research was that simulation was described as a positive training and education method for prehospital staff. Simulation provides opportunities to assess, treat, and implement procedures under realistic conditions. The current state of prehospital care, which this review reveals, includes inadequate skills of prehospital staff regarding ventilation and CPR, on both children and adults (Abelsson et al., 2014). Not only is this evidenced in other research, but most providers can see this firsthand due to the patient's condition when they are brought to a hospital.

## History of EMS in Wisconsin

Prehospital care can be traced back to the Civil War when soldiers were trained to treat and take care of their own (West Virginia Department of Education, n.d.). According to the state of Wisconsin, 1968 was the year EMS became a section which created some coordination amongst a few doctors to start developing training. The state mandated training which consisted of an 81-hour Department of Transportation course in 1974 (Wisconsin Department of Health Services, 2022a). The first nationally recognized training course for EMTs was held in Wausau, WI in 1969. A pivotal time for EMS occurred between 1993 and 1994 legislative sessions. A more formalized framework and oversight was enacted into law (Wisconsin Department of Health Services, 2022a). The State of Wisconsin EMS section recognizes four core levels of EMS licensure along with the following required hours of education as referenced in Table 1.

**Table 1**

*EMS Levels and Associated Hours*

| Level | Didactic | Lab | Clinical | Total hours |
|---|---|---|---|---|
| Emergency Medical Responder | 27.5 | 22 | 0 | 49 |
| Emergency Medical Technician (EMT) | 60 | 120 | 10 Pt. Contacts | 180 |
| Advanced Emergency Medical Technician (AEMT) | 76 | 44 | 50 Hours | 170 |
| Paramedic | 414 | 288 | 185 Field/Lab Patient Experiences | 702 plus time for clinical |

With the hours listed above, a pre-requisite to becoming an advanced emergency medical technician (AEMT) is becoming an EMT. An individual has to take 180 hours plus 170 hours to become an AEMT. EMT is the pre-requisite for Paramedic also. The normal process is to start at emergency medical responder (EMR) and work your way up gaining experience as you go. EMR is for people who want to assist with people in their community or industry by providing advance first aid. They do not transport any patients. EMT level treats and transports patients that need help getting to a hospital. These patients can be both critical and non-critical. EMT has a set of limited skills and is only allowed to administer a few medications. AEMT level is EMT plus the ability to start IVs and deliver a few more medications. Paramedic level is the upper level of EMS and the wisconsin scope of practice allows you to administer several medications and perform additional skills like endotracheal intubations (Wisconsin Department of Health Services, 2021). It wasn't until these curriculums were released that the State adopted language to add simulations in the lab or clinical settings.

Faculty stated that the EMS program leadership and faculty were involved in writing the current curriculums and were able to set up simulation mannequin labs for the EMS classes at Northcentral Technical College. Knowing this technology was available and now the State allowed the use of simulation, NTC decided to pilot EMS classes using the high-fidelity mannequins. The simulation labs were very popular with the students and eventually spread into the nursing program. After the first year having the mannequins, the college purchased three more and expanded the simulation labs. Not only were the labs expanded but dedicated staff was brought on board to run the labs and take care of all the technology.

**History of Simulation**

Clinical simulation has had a few inspiring movements which propelled simulation forward to where we are today. One of the first pioneers of clinical simulation was Asmund Laerdal, a Norwegian toymaker (Tjomsland & Baskett, 2002). Two anesthesiologists named Dr. Peter Safar and Dr. Bjørn Lind approached Mr. Laerdal and asked him to travel to the United States to consult with Dr. Safar about making a mannequin that could imitate an unresponsive person and be manipulated in several ways. Having experienced a near drowning incident with his own child, Mr. Laerdal was eager to help develop a training aid. His knowledge of soft plastics and his ambition to get this project done made Resusci Anne come to life in 1960.

Some of the unique thoughts that went into the process for developing Resusci Anne were how to dress the mannequin and what the sex should be. Mannequins do not only need to perform correctly, but they must appeal to the consumer. Mr. Laerdal felt that male students would not do mouth to mouth on male mannequins, the developers decided to make the mannequin a female with a beautiful face but not sexy. The developers also decided to dress her in a track suit to give an impression of fitness. Resusci Anne skills trainer became the leader in the world market because of its widespread availability and low cost to consumers (Tjomsland & Baskett, 2002). Mr. Laerdal's company is still in existence today and is the market leader in CPR mannequins. Since then, simulation has evolved steadily and increased in sophistication and uses in the medical field.

In the mid-1960s, Dr. Stephen Abrahamson and Dr. Judson Denson designed and developed the Sim One mannequin (Cooper & Taqueti , 2004). This was the starting point for a true computer-controlled simulation mannequin, particularly a whole-body mannequin. Previous simulation developed was used for military medical training purposes during war time. As wars start and end, there was a need to develop a simulation that could be used anytime and not be dependent on military war time funding. Sim One was developed for this purpose. Developing a mannequin that would have peacetime applications as the demands from military were not always there and along with that was military funding depletion. Dr. Abrahamson and Dr. Denson were able to secure funding from the US Office of Education which would allow them not only to be used for military training. A study was conducted with this prototype, and they were able to demonstrate that residents learned the skills in a shorter amount of time compared to traditional learners without simulator training. Unfortunately, Sim One was never mass-produced largely in part to the cost of computers in that era (Cooper & Taqueti, 2004). The technology was too far ahead of its time, but it was groundbreaking and set the stage for future mannequins.

In 1987, two mannequin simulators were developed. Comprehensive Anesthesia Simulation Environment (CASE) was developed by Dr. David Gaba at Stanford Medical School, and Gainesville Anesthesia Simulator (GAS) was developed by Dr. Michael Good at the University of Florida (Gaba et al., 1998). Ironically, both mannequins were developed independently around the same period of time for similar purposes. CASE was designed to investigate various aspects of human performance in anesthesia. They could create critical events to measure responses and behaviors, which was called performance assessment (Gaba et al., 1998). This company was eventually sold to a company in Israel and was abandoned due to lack of demand at the time.

GAS was designed to train anesthesia residents in basic clinical skills. After attaching a lung simulator and adding controllable failure modes, the mannequin became a complete mannequin. Later versions added software to enable sequences of physiological changes with predefined fields that responded to actions (Good et al., 1988). This took the manual manipulation element out of simulation and made it more lifelike. GAS was subjected to a test of efficacy using 16 anesthesia residents. The students were divided into two groups, one with simulation and one without. Clinical evaluators were blind as to which cohort had simulation. Results indicated that the group with simulation had a more rapid learning curve than the group with no simulation. The researcher also noted that both groups achieved proficiency at the same level (Good et al., 1988). The GAS technology was sold to Medical Education Technologies Inc. (METI) in Sarasota, Florida. METI dubbed this product the HPS.

Two primary manufacturers of full body human patient simulators are Laerdal and METI. There are other manufactures that produce specialized simulators and are available in different health care areas. One example would be Gaumard, a manufacture that produces the NOELLE Victoria birthing simulator. The mannequin comes complete as an expecting mother with a newborn ready to be born. Not only do students have to care for the mother and deliver the baby, but they also have to care for the newborn baby. In a pre-hospital setting, this is the reality of starting with one patient and ending up treating two.

METI's HPS are considered high fidelity patient simulators (CAE Healthcare, n.d.). They are life-size mannequins that breathe; have heart and lung sounds, palpable pulses on all extremities, and pupils that react to light; can speak what you command it to; and have the ability to produce urine (CAE Healthcare, n.d.). The mannequins can be female or male by changing body parts. Apple technology runs the simulators by pre-programmed scenarios or "on-the-fly" responses. For example, if the lesson that needs to be taught is diabetes treatment, an instructor can use a diabetic scenario in which the mannequin will act out what a real diabetic would go through. This can be programmed to be progressive in nature, and depending on interventions given by students, the simulation can get better or worse (CAE Healthcare, n.d.).

Human patient simulators have progressed well beyond teaching students about anatomy parts or practicing procedures. Students today can learn true aspects of patient care while working in a simulation laboratory. Students can see the simulator's response to their actions and the consequences of their decisions in a safe environment. Students have time to develop critical thinking skills and clinical diagnostic skills as the mannequin reacts in a real-life manner.

Some of the literature reviews conducted over the past 20 years have led to breakthroughs in modern day training. A great example of this occurred in 2016 when a study was conducted on previous research identifying low success rates of prehospital intubation attempts due to environmental issues and lack of consistent standardized training for prehospital EMS intubations (Bischof et al., 2016). The research led to the creation of a mobile simulator lab that was configured to deliver, record, and assess intubations of a difficult airway. The simulation lab was able to create a reproducible, high fidelity, portable training environment for prehospital providers. The new mobile simulation lab created an excellent learning environment for the students and could reproduce the same difficult skills until they were either mastered or not (Henriksen et al., 2008).

Traditionally a service would have to send their employees into a hospital setting or clinical setting at a school. This new approach took away some barriers and made it easier to do. Thinking outside the box and taking a mobile approach to deliver the difficult intubation to the students could be well received by faculty and students.

Although available simulators do not reproduce the critically ill patient in his/her entirety, they do represent a giant leap forward from static mannequins. In addition, standardized scenarios that exert real-time pressure are easily developed. In an attempt to summarize why simulated patient encounters can be so valuable to students, this article summarized by Issenberg et al. (1999), says a lot:

> Unlike patients, simulators do not become embarrassed or stressed; have predictable behaviour [*sic*]; are available at any time to fit curriculum needs; can be programmed to simulate selected findings, conditions, situations, complications; allow standardised [*sic*] experience for all trainees; can be used repeatedly with fidelity and reproducibility; and can be used to train both for procedures and difficult management situations. (p. 822)

Conducting simulations in a clinical or lab setting can be directly tied to adult learning theories. One of the theories is Kolb's experiential learning theory in which he based his theory on a cycle of four elements: concrete experience, reflective observation, abstract conceptualization, and active experimentation (Henriksen et al., 2008). This theory holds true to learners that have some knowledge already such as refresher skills, advancing EMS levels, on-going training. Adding the intervention of a mobile lab also combines the opportunity to practice technical and teamwork/behavioral skills (Henriksen et al., 2008). Kolb's theory blends well with behavioral learning theory as the environment, repetition, and positive reinforcement is incorporated into the simulation lab (McLeod, 2017).

While most of the research found was mainly yielding positive results for students, there are some detractors to simulation mannequins. Simulators cannot give you the exact predictability of what patient's responses will be. Simulators still rely on "human" interventions in programming or running the scenarios. In addition, there is a lack of trainers that can operate these high-fidelity mannequins (Ziv et al., 2009). In reality, a simulation lab crosses computer science with EMS skills because you need someone with knowledge of programming and computers to create programs that drives the scenario. This can lead to higher personnel cost and can also lead to unproductive scenarios because institutions may not be using the mannequin to its full ability.

The other profound effect that simulation mannequins can have to an institution or EMS service is the budget. Most public safety agencies do not have bottomless budgets but rather are held accountable by the general public through tax revenues. Colleges may have an easier road to procure the equipment needed but the operational staff may still be an issue with funding. Capital cost for one high-fidelity mannequin can range from $34,000 to $80,000, depending on model and options. To put this into perspective, NTC had approximately 75 EMS students and 30 nursing students during a typical semester. To be able to utilize the simulation lab mannequins, the lab needed a minimum of 3 mannequins. As enrollments increase, so will the number of mannequins needed. To create the current lab, NTC spent well over $200,000 in procuring the mannequins and setting up patient rooms. The maintenance expense of the mannequins and upgrading them are additional costs incurred that is absorbed into department budgets. Lab expenses were new expenses as NTC did not have to pay for hospital clinical sites. One way NTC could help with the simulator lab cost is adding lab fees into the tuition. This would help recover the cost of the simulation lab.

# Chapter III: Methodology

The purpose of this study was to show evidence, or lack thereof, that human patient simulator learning for intubations is as effective as or better than real patient experiences in a clinical setting. The Department of Health and Human Services will accept up to 50% of clinical time using HPS labs but what remains unknown is if simulation is an ample alternative to real patient experiences. More specifically, the study will look at student performances in skill testing labs and the amount of time it took to master intubation skills.

## Research Design

The research design for this study is quantitative, and a descriptive research methodology will be used. In specific, quasi-experiment and survey will be the chosen methodology to gather the data required to address the research questions. Quasi-experiment will allow collection of data from students representing all ages, male or female, paramedic students, employees, and EMS Training Division Chiefs.

Surveys will be conducted using EMS faculty. The dependent variables will be the students achieving mastery level on intubations and the time it takes to do that. The independent variable will be the number of attempts of intubations. The control variables will be the instructors administering the skills and the HPS mannequins that will be programmed with the same scenarios.

This study was approved by UW-Stout Institutional Research Board (see Appendix).

## Population and Sample

The subjects for this study will be first- and second-year paramedic students who are male and female and currently enrolled in Northcentral Technical College's paramedic program.

The students and employees come from several different counties of our 10-county school district.

The associate dean of fire/EMS training at Waukesha Technical College, has agreed to conduct a focus group with her faculty based off of scripted questions listed below. Findings will be reported through a google docs survey.

**Instrumentation**

The instructors will use a schedule and skills sheet to accurately record the student's ability to intubate a mannequin. Every student will receive appropriate education prior to the skill being performed and a proper debriefing will occur after the procedure. Briefings to instructors and students were scripted. Data will be gathered from previous student's intubations on live patients to complete an analysis.

A survey will be written to gather information from EMS faculty and includes the following series of questions:

1. How many hours or quantity of successful intubations are needed for paramedic students?
2. Are your intubations performed in a lab or clinical site?
3. How many hours are spent observing, grading, assessing, and/or assisting each student in intubation clinical?
4. What benefits would students have using high fidelity patient simulation labs for intubations?
5. What disadvantages could students have using HPS labs for intubations?
6. How do you evaluate your students in HPS lab doing simulations?

7. Why or why not is it more time consuming and/or difficult to use live patients in a clinical setting for intubations?

**Data Collection Procedures**

Informed consent was obtained. The instructor pre-briefed students of the rules and procedures of intubation, then observed each student perform the intubation and then debriefed with the students. All failures and successes will be recorded as well as the times. All skills sheets will be put into a sealed envelope at the conclusion of each test and instructors should give to the researcher at the conclusion of each day. Pass/fail rates and times will be identified between simulator and real-life patients.

The survey was distributed and collected during the summer and fall semesters before the start of intubations. The survey was emailed to designated participants and responses gathered. There is an informed consent statement at the beginning of the survey.

**Data Analysis**

Data collected from the intubation skills lab will be categorized into

- **times:** total time of intubation from initial presentation; total time of evolution from pre-brief to debrief.
- **results:** total pass/fail; partial pass/fail.
- **attempts:** number of attempts it takes to be 100% mastery.

The survey will yield raw data in the form of short-answer responses. The researcher will code the data into useable chunks that will be transcribed into this document.

# Chapter IV: Results

The purpose of this study was to show evidence, or lack thereof, that human patient simulator learning for intubations is as effective as or better than real patient experiences in a clinical setting. The following tables and data will outline the results of the testing and surveys that were conducted with instructors and students. All students were pre-briefed on the rules and procedures of intubation and then tested. Students conducted the intubation skill scenarios in a lab with mannequins and then conducted scenario on live patients in the operating room of a local hospital. All instructors were issued the same survey and were instructed to complete in its entirety. This first study was a pilot study that was carried out during my employment at Northcentral Technical College.

## *Pilot Study Results*

The subjects for this study were eight EMS paramedic students and ten adjunct faculty at Northcentral Technical College. Table 2 shows the gender make-up of the students who completed the study.

**Table 2**

*Gender of Students Participating in Study*

| Gender | Frequency |
|---|---|
| Male | 5 |
| Female | 3 |

Table 3 shows an increase in the number of days it took for students to take what they learned in the classroom and apply it in a lab setting.

**Table 3**

*Intubation of Mannequin Versus Live Patient, Initial Time From Classroom to Lab*

| Time to intubation | Mannequin *n* | Live patient *n* |
|---|---|---|
| 0-2 days | 14 | 0 |
| 2-4 days | 10 | 1 |
| 4-6 days | 6 | 2 |
| More than 6 days | 3 | 12 |
| Total | 33 | 15 |

Table 4 shows the total time it took a student to intubate a mannequin and a live patient.

**Table 4**

*Total Evolution Time of Intubation*

| Evolution time | Mannequin *n* | Live patient *n* |
|---|---|---|
| 4 minutes | 5 | 0 |
| 5 minutes | 9 | 2 |
| 6 minutes | 8 | 3 |
| 7 minutes | 7 | 4 |
| 8 minutes | 4 | 6 |
| Total | 33 | 15 |

Table 5 shows intubation attempt results on mannequins and live patients.

**Table 5**

*Intubation Attempt Results*

| Result | Mannequin *n* | Live patient *n* |
|---|---|---|
| Pass | 27 | 14 |
| Fail | 6 | 1 |

The survey results in Table 6 show some insight as to what some of the faculty were thinking about simulation.

**Table 6**

*Faculty Responses to Survey*

| Statement | Less than expected | As expected | More than expected | Consistently more than expected |
|---|---|---|---|---|
| I am spending more time on prep than ever before. | 0 | 1 | 8 | 1 |
| I spend more time on actual instruction instead of logistics. | 2 | 8 | 0 | 0 |
| I feel I can help students reach competency faster with utilizing simulation. | 0 | 4 | 4 | 2 |
| Students have more opportunities for practice while using simulation. | 0 | 0 | 2 | 8 |
| I spend time scheduling live patient clinical for students. | 0 | 0 | 3 | 7 |
| I spend time scheduling simulation clinical for students. | 3 | 7 | 0 | 0 |
| My overall impression of simulation is… | 0 | 0 | 8 | 2 |

## Focus Group Results

A survey was written to gather information from an EMS faculty focus group at Waukesha Technical College that could show factual and perspective information gathered from their students' performances. Waukesha Technical College was chosen for this study as they have a large student population and have a very progressive EMS program. Their faculty have been using simulation labs for over 10 years to perform and test skills. With the assistance of the associate dean of fire/EMS training, a focus group was conducted with her faculty and reported through the faculty survey.

### *Survey Question 1*

Survey Question 1 asked, "How many hours or quantity of successful intubations are needed for paramedic students?" Table 7 shows the quantity of successful intubation requirements for Waukesha Technical College students.

**Table 7**

*Quantity of Successful Intubations by Type*

| Type | Live patient | Simulation | Total |
|---|---|---|---|
| Adult | 4 | 20 | 24 |
| Child | 0 | 24 | 24 |

***Survey Question 2***

Survey Question 2 asked, "Are your intubations performed in a lab or clinical site?" The four intubations are completed in the operating room of a hospital and the remaining 20 are completed in a simulation lab. All 24 pediatric intubations are completed in the simulation lab.

***Survey Question 3***

Survey Question 3 asked, "How many hours are spent observing, grading, assessing, and/or assisting each student in intubation clinical?" On average, a faculty member spends 14 hours of time for OR clinical and 21 hours of time for simulation labs per student. That equates to an average of 35 hours per student for one skill, which is shown in Table 8.

**Table 8**

*Faculty Hours per Student*

| Type | Hours spent |
|---|---|
| OR clinical | 14 |
| Simulation lab | 21 |
| Total | 35 |

***Survey Question 4***

Survey Question 4 asked, "What benefits would students have using high fidelity patient simulation labs for intubations?" Waukesha Technical College faculty responded by saying what they have experienced is that the high-fidelity patient mannequin is extremely difficult to intubate. The benefit to this difficult intubation would be that the frequency of difficult intubations could enhance the student's ability to master the skill. Some intubations fit into a high-risk, low frequency model which means students would not have the same number of opportunities with live patients to practice on.

***Survey Question 5***

Survey Question 5 asked, "What disadvantages could students have using HPS labs for intubations?" Faculty agreed that the mannequin is difficult to intubate. However, faculty still believe that students need to experience live patient intubations to become proficient.

***Survey Question 6***

Survey Question 6 asked, "How do you evaluate your students in HPS lab doing simulations?" Students have to perform as team leader and team member scenarios as part of their clinical activities. Students can also take on a role as an assistant team member to help the team leader or team member during the scenario. Each of these scenarios are minimum of 20 minutes. Clinical faculty observe and evaluate during testing and would generally use a check sheet similar to the national registry testing sheet. Students also employ peer evaluation during scenarios but not during testing.

***Survey Question 7***

Survey Question 7 asked, "Why or why not is it more time consuming and/or difficult to use live patients in a clinical setting for intubations?" Faculty report the following reasons:

- difficulty in securing operating room sites
- pediatric nearly impossible to get required intubations,
- liability concerns from doctors, anesthesiologists, or hospitals
- preceptors assigned not willing to teach students

# Chapter V: Discussion

The purpose of this study was to show evidence, or lack thereof, that human patient simulator learning is as effective as or better than real patient experiences. This study set out to answer three specific questions listed below:

1. How does learning intubation, using a high-fidelity human patient simulator, compare to learning with real patients?
2. What effect does high fidelity human patient simulation intubation have on faculty's ability to teach competencies?
3. How can high fidelity human patient simulation improve use of student and instructor time?

## Discussions

Using the three questions above, each question will be discussed using both the focus group and the pilot study for evidence and research learned through review of literature.

### *Research Question 1*

Research Question 1 asked, "How does learning intubation, using a high-fidelity human patient simulator, compare to learning with real patients?"

Research has shown that the use of mannequin simulation for intubation provides positive training and educational methods for learners (Abelsson et al., 2014). Since 1996, intubation simulations have been researched and continue to this day. One of the "a ha" moments came from research in the book *Advances in Patient Safety* (Henriksen et al., 2008), which directly correlated the comfort of a student in a simulation lab setting versus a clinical setting. They were able to control the atmosphere of the scenario which built confidence in the learners. People that have done formal clinical in an operating room setting understand the feeling of pressure to perform. Simulation labs seem to remove that barrier and allow the learner to learn. This study found that fail rates can be higher on mannequins due to no anesthesiologist working with the students to prep the airway. It should be noted that only select, almost perfect, patient airways are allowed for students to attempt airways on. This minimizes the risk for the hospital but limits opportunities for students.

The State of Wisconsin DHS EMS section mandates seven simulated and two live patient intubations be performed for paramedic licensure (Wisconsin Department of Health Services, 2021). Waukesha Technical College reports that they require 20 simulated and four live patient intubations for their paramedic students. In addition to the 24 adult intubations, they also require 24 intubations on children in which all are in simulation. These numbers are more than double of what is actually required by the state. A large part of having the ability to do additional intubations is having use of simulators. Simulators allow students repeated scenarios and skills to improve upon their mastery of the skill. Taking note that all of the required intubations are technically successful intubations, students could also have attempts that were not successful thus making their overall intubation numbers larger and more time consuming. In general, unsuccessful attempts are not tracked as only successful intubations count towards the student's requirements.

One of the key takeaways given through the focus group was that intubating a live patient feels different than intubating a simulation mannequin, but the fundamental point to take away is the study that was published for critical events in simulation showed results that students with simulation had a rapid learning curve and achieved proficiency at the same time as the students who did not have simulation (Good et al., 1988). What this indicates is that simulation builds the skills needed to perform the procedure through a controlled environment, replication, and repetition.

***Research Question 2***

Research Question 2 asked, “What effect will high fidelity human patient simulation have on faculty’s ability to teach competencies?”

The survey results in Table 6 show some insight as to what some of the faculty were thinking about simulation. Overall, the results indicated a tendency to favor simulation. Faculty revealed that simulation is a good tool for the students to master their skills, but it can be a drain on faculty time. Research showed that faculty can run into roadblocks as EMS is combining computer science with EMS skills (Ziv et al., 2009). In a perfect world where money did not matter and budgets were fictious, faculty could have people design and implement scenarios for their students which in turn would allow the EMS faculty to direct their time elsewhere. But the reality we all live in is that resources are slim and most faculty have to overcome that.

Faculty expressed that it is common for hospital policy not to let students intubate children due to the inherent risk and smaller airways. Simulations allowed faculty to actually practice on mannequin airways so the students could develop their confidence and abilities before entering the work force.

***Research Question 3***

Research Question 3 asked, “How can high fidelity human patient simulation improve use of student and instructor time?”

While the majority of the limited research focuses on quality of training, learning and scenario capabilities, there is limited research into how this affects faculty and students use of time. The pilot study showed in Table 3 that it is clearly faster to schedule and participate in a mannequin simulation lab than it is to do the same procedure with a live patient in the operating room. Mannequins are readily available to use in the classroom or lab setting which allows faculty to take their didactic and apply the learning into practical. On the other hand, scheduling an OR can take weeks if the students paperwork is completed on time. This shows a clear advantage to simulation being used by faculty.

One of the reasons for the time differences was flexibility of scheduling students in the operating room. Hospitals control their openings for students and Northcentral Technical College controls mannequin lab hours. Another reason that can cause delays in intubation of live patients can occur because the doctors have a very rigid schedule and will not let students intubate until everything else has been set up. This can cause fewer opportunities for more intubations just due to lack of time.

Scheduling has been addressed but another factor to consider are average class sizes. Each college can set their own class size but in EMS it is typically 12 to 18 students, and there can be more than one cohort at the same time. So, in reality, one faculty could be responsible for three cohorts which would mean 36 to 54 students at any given time. The number of clinical skills and hours keep multiplying with each student added. Clearly this would affect clinical time spent by faculty and control how their time is allocated.

**Conclusions**

Time seemed to favor simulation primarily due to scheduling and availability of mannequins versus live patients. Faculty perceptions about simulation were also evaluated, and the results showed faculty would favor using more simulation in lieu of live patient clinical lab. This again was primarily due to a significant time savings for the students and faculty.

Based on the findings of the study, the following conclusions were drawn:

1. Students could complete more evolutions of intubations using mannequins.
    - The mannequins were made available through a scheduling lab, which enabled students to be able to manage their own time and schedules. In an OR, students are held hostage to the clinical site schedules and unknown number of patients, if any, that day.
2. Student time from lecture to hands on was faster while using mannequin simulators rather than live patients.
    - The data and research shown has proven, for this study, that students were able to apply their knowledge they gathered and apply it sooner while in a simulated lab. This is where Kolb's experiential theory relates to EMS training. Students are able to gain the concrete experience through hands on scenarios and then allowed to reflect on the scenario. Students can begin to conceptualize how it could go better or be improved and then use the intubation lab for experimentation. The truth of EMS intubations is that there is no one way that fits all as every situation is different and every patient's airway can be different.
3. Instructors' perceptions were that the simulators were good for students but really didn't save time for faculty.
    - This was revealing in that faculty were spending more time prepping and building scenarios for the practical simulation labs than they had to before. Previous experiences with clinical involved faculty sending their students to a clinical site and not doing any of the planning for patients. This could actually cause some problems with pay and contact hours for some faculty.

4. Intubations involving high-risk, low-frequency scenarios were reproducible with simulation mannequins.
    - These types of intubations were nearly impossible to recreate in the field on live patients. The best that the faculty or preceptor could do is to talk about the event after it occurred which did not allow the student to really see or feel the actual intubation. A majority of the time if a live patient in the field has a difficult airway, the paramedic will not let the student attempt as it may make the airway worse. The simulated lab created an avenue for students and faculty to debrief a scenario and repeat the same exact conditions to allow the students to apply their renewed learning.

**Recommendations**

Based on the findings and conclusions of the study, the following recommendations were forwarded:

- An EMS training center should pilot two full classes using only simulators for clinical and record findings. These classes would need to keep accurate time recordings of student and faculty time spent doing intubations. Finally, tracking success rates for psychomotor exam results for comparison purposes.
- Research should be done on other schools for statistics related to simulation in clinical. Survey all 16 technical colleges to find out what they have for simulation mannequins. This could lead into a statewide mandate for simulation lab clinical opportunities.
- Classes need to be developed for teachers/faculty in simulation mannequins. This will aid the faculty in developing realistic scenarios and also save valuable teaching time.

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## Appendix

## UW-Stout IRB Approval

UNIVERSITY OF WISCONSIN
STOUT
WISCONSIN'S POLYTECHNIC UNIVERSITY

**Office of Research and Sponsored Programs**

101 Vocational Rehabilitation
University of Wisconsin-Stout
Menomonie, WI 54751-0790

Phone: 715.232.1126

July 21, 2021

Douglas Jennings
Teaching, Learning, & Leadership
University of Wisconsin-Stout

RE: Patient Stimulation

Dear Douglas,

The IRB has determined your project, "*Patient Stimulation*" is **Exempt** from review by the Institutional Review Board for the Protection of Human Subjects. The project is exempt under **Category #2** of the Federal Exempt Guidelines. Your project is exempt for 5 years from **July 21, 2021**. If a renewal is needed, it is to be submitted at least 10 working days prior to the approvals end date. Should you need to make modifications to your protocol, please complete the modification form.

**Informed Consent:** All UW-Stout faculty, staff, and students conducting human subjects' research under an approved "exempt" category are still ethically bound to follow the basic ethical principles of the Belmont Report: 1) respect for persons; 2) beneficence; and 3) justice. These three principles are best reflected in the practice of obtaining informed consent from participants.

If you are doing any research in which you are paying human subjects to participate, a specific payment procedure must be followed. Instructions and form for the payment procedure can be found at http://www.uwstout.edu/rs/paymentofhumanresearchsubjects.cfm

If you have questions, please contact the IRB office at 715.232.5260, or mensink@uwstout.edu, and your question will be directed to the appropriate person. I wish you well in completing your study.

Sincerely,

Mike Mensink
Interim Human Subjects Protections Administrator, UW-Stout Institutional Review Board for the Protection of Human Subjects in Research

CC: Diane Klemme