Examination of Ventilation Before and After Advanced Airway Placement During Continuous Chest Compressions Cardiopulmonary Resuscitation

INTERNSHIP PRACTICUM REPORT

Presented to the Graduate Council of the
Graduate School of Biomedical Sciences
University of North Texas
Health Science Center at Fort Worth

In Partial Fulfillment of the Requirements
For the Degree of
MASTERS OF SCIENCE IN CLINICAL RESEARCH MANAGEMENT

By
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Gordon, Teresa, Examination of Ventilation Before and After Advanced Airway Placement During Continuous Chest Compressions Cardiopulmonary Resuscitation. Master of Science (Clinical Research Management), November 2019, 55 pp., 4 figures, 4 tables, journal entries, bibliography, 16 titles.

Purpose: The aim of this project was to identify a method to measure ventilation during continuous chest compressions CPR that will improve outcomes for resuscitation attempts on out of hospital cardiac arrest patients

Hypothesis: It is possible to identify ventilation waveforms using defibrillator bioimpedance and adequate ventilation prior to placement of an advanced airway during continuous chest compressions is associated with better outcomes.

Design: Defibrillator files from 4 Resuscitation Outcomes Consortium sites were examined for evidence of ventilations. The number of ventilations, placement of an advanced airway, return of spontaneous circulation, initial heart rhythm, and ventilation rates were recorded.

Results and Conclusion: It is feasible to identify ventilations during continuous chest compressions CPR using bioimpedance. There was no significant difference between ventilation before and after an advanced airway was placed. The association between ventilation and outcome is undetermined.

Acknowledgment

This project was made possible by the University of North Texas Health Science Center and the University of Texas Southwestern. Thank you to my major professor, Dr. Lisa Hodge, and the rest of my committee members from UNT, Dr. Nathalie Sumien and Dr. Stephen Mathew. Thank you to Dr. Ahamed Idris, Dr. Ava Pierce, Pam Owens and the rest of the UT Southwestern Emergency Department. Special thanks to my fiancé, Luke, roommate Geordi, and my family for being my biggest supporters.

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Chapter 1

Introduction

The following practicum report was conducted over the course of a six-month internship in conjunction with the University of Texas Southwestern (UTSW), under the supervision and guidance of Ahamed Idris M.D., Ava Pierce, M.D., and Pam Owens. Lisa Hodge, Ph D, from the University of North Texas Health Science Center (UNTHSC), served as major professor for this project.

The purpose of this study was to identify methods that will improve outcomes for resuscitation attempts on out of hospital cardiac arrest (OHCA) patients. To accomplish this goal, patients' files previously gathered for a large, multicenter study known as the Resuscitation Outcomes Consortium (ROC), were examined for evidence of ventilations during continuous chest compression cardiopulmonary resuscitation (CPR). Along with identifying the occurrence of ventilations, the association with outcome was also examined. The files for this project were retrieved from the LifePak defibrillators (LP 12 and LP 15), a common type of defibrillator used by emergency medical services and by Dr. Idris. The information derived from this project will be used to further develop existing software for defibrillators to help emergency responders monitor and alter the ventilation patients receive during CPR prior to arriving at a hospital during cardiac arrest events.

In 2004 the ROC, based out of the University of Washington's Clinical Trial Center, was created to be a data coordinating center for 10 regional sites located in the United States and Canada to conduct randomized clinical trials on patients with cardiac arrest and life threatening trauma.[1] The Dallas-Fort Worth (DFW) metroplex combined into one site for the ROC with Dr.

Ahamed Idris as the site principal investigator. While the ROC is no longer enrolling new cases, all of the files collected during its enrollment period can be used for further research.

Chapter 2

Background

Upon arrival to a scene, one of the first steps emergency responders take is to place defibrillator pads onto the patient, in anticipation of them going into cardiac arrest. As soon as the pads are placed and the defibrillator is turned on, they immediately start recording transthoracic bioimpedance. If the patient is in lacking a pulse, the emergency medical services (EMS) responders will then start to deliver chest compressions. The American Heart Association CPR guidelines recommended that EMS deliver either continuous chest compressions with a positive-pressure ventilation with a bag valve mask (BVM) device or CPR with 30 compressions interrupted by 2 ventilations until an advanced airway is placed.[2]

Bioimpedance as a way to monitor ventilation was first studied on patients in an emergency department. The researchers chose patients who were already being mechanically ventilated and were in a hemodynamic state. With the ventilators acting as a reference for the bioimpedance data collected, they found defibrillators could be used to measure tidal volume when chest compressions are stopped.[3] Defibrillators now records every chest compression waveform and has been used to assess quality of chest compressions. Based on the placement of the defibrillator pads, as seen in Figure 1, it was conceived that the same bioimpedance signals that recorded chest compressions could also be used to measure ventilation during CPR.

To test this, in 2018 Dr. Ahamed Idris and his colleagues developed the methodology to detect bioimpedance ventilation waveforms during created during 30:2 CPR and later created software to process bioimpedance signals to detect ventilations during 30:2 CPR.[4] It was known that defibrillators record transthoracic bioimpedance and can measure chest compressions, evaluate performance of CPR and it could detect ventilations.[5,6] They used this knowledge,

combined with examining the pauses in compressions to formulate the algorithm to filter out background noise and artifacts to clearly measure the ventilation waveforms.[4] From this algorithm they were able to study several hundred files from the DFW ROC site and found a positive association between ventilation and outcomes.[7] To make this more generalizable further studies should be done to determine if the algorithm is compatible with the other types of defibrillators and to determine if ventilation is present during continuous chest compressions (CCC) and to perform multi-center studies.

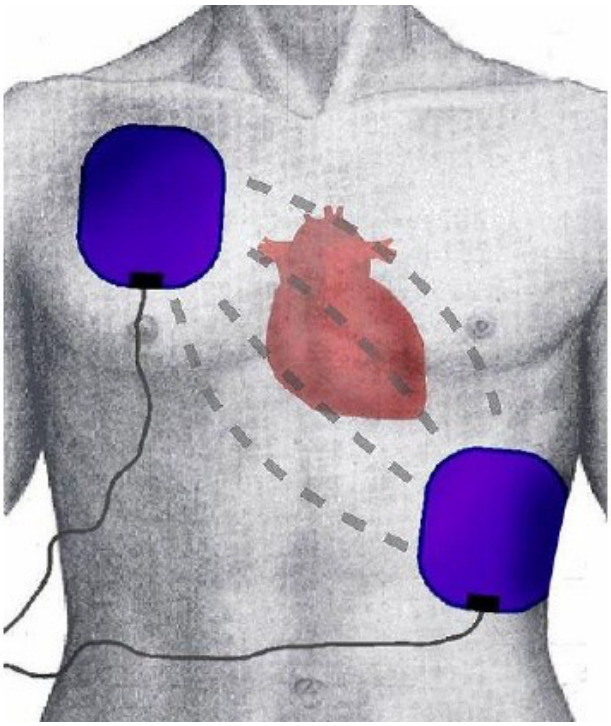

Figure 1: Placement of defibrillator pads on a chest

Significance

Prior to 2018, ventilation of OHCA patients could not be measured by EMS during CPR before the placement of an advanced airway and attachment of a spirometer; EMS also don't commonly use a portable ventilator. Even within hospital settings, measurement of ventilation is

difficult due to antiquated technology that requires frequent calibration.[8] It was thought that defibrillators could potentially be used to measure patient ventilation. Dr. Idris's team first developed the methodology to identify bioimpedance ventilation waveforms. Later, with the assistance of the Communications Engineering Department at the University of the Basque Country, Dr. Idris's team developed software to automatically identify ventilation waveforms from the bioimpedance channel recorded by defibrillators during pre-hospital CPR.

Whether or not ventilation is occurring during CCC CPR is currently unknown. This first of its kind project will follow similar guidelines as the 30:2 CPR to determine if bioimpedance can be used to detect ventilation during CCC CPR and if ventilation before advanced airway placement associated with improved out comes. The results of this study could alter how closely emergency responders monitor ventilation of patients with BVM devices. If there is an association between early ventilation, a stronger emphasis could be placed on proper delivery of ventilations with the BVM device, ensuring the chest is rising and the mask is sealed around the mouth of the patient.

Specific Aims

According to the American Heart Association's most recent updated report concerning heart disease and stroke statistics, survival to hospital discharge, defined as being transferred to rehabilitation facilities, extended care facilities or directly home, for OHCA adult patients is 10.8%, compared to 26.4% for in-hospital cardiac arrest.[9,10] While the time to treatment cannot be altered to better increase survival, because it depends on the time between notification (the 911 call) and arrival of emergency medical services (EMS), the method of treatment could be altered. There are several methods of cardiopulmonary resuscitation that can be given in the

field, the two most common given to adults being 30:2 CPR, which involves repeated cycles of 30 compressions followed by a break to allow for 2 ventilations, and continuous compressions with concurrent ventilation via a positive pressure bag mask device until an advanced airway is placed. While many believe that high quality chest compressions offer the best chance of survival, the importance of ventilation during early CPR, defined as prior to placement of an advanced airway, is unclear. This unanswered question of the role of ventilation has led to several studies to try and determine if ventilations during OHCA resuscitation improves outcomes. It is now possible to measure the quality of the ventilations given during 30:2 CPR using the bioimpedance data already recorded by defibrillators. The next step is to determine if bioimpedance can also be used to measure ventilations during CCC CPR.

In this study we hypothesized that adequate ventilation prior to placement of an advanced airway during continuous chest compressions is associated with better outcomes. To test this hypothesis, we developed the following specific aims: Aim 1) measure the incidence of ventilation before advanced airway placement during continuous chest compressions CPR and, Aim 2) assess if ventilation before advanced airway placement is associated with improved outcomes.

Chapter 3

Materials and Methods

This is a retrospective, secondary, descriptive study using de-identified defibrillator files from four of the ten ROC sites: Alabama, Dallas, Ottawa, and Vancouver. To be included in the study, the file must first be determined to have compressions that are continuous, defined as performed for a minimum of two minutes at a time without a pause. The file then had to have a note indicating an advanced airway was placed, and finally the airway must have been placed during the time recorded by a LP 12 or LP15. If an airway was placed during the time before the start of a recording or when the defibrillator was in a lead that did not record bioimpedance (Lead 12), it was impossible to determine airway placement or identify ventilations and could not be noted (annotated) in the record.

The parameters used to define a ventilation were as follows: the bioimpedance waveform must have a minimum amplitude of 0.5 ohms, equivalent to 2 mm (2 boxes) in the recording, and have a duration of at least one second, depicted by the green line in figure 1.[4] Prior studies showed that a waveform amplitude of 0.5 ohms was associated with a tidal volume of >250 mL, which is the minimum necessary for gas exchange (i.e. ventilation). Each bioimpedance ventilation waveform reflects a single lung inflation. If the waveform did not meet these criteria, they were not considered an acceptable ventilation, as indicated by the star in figure 2.

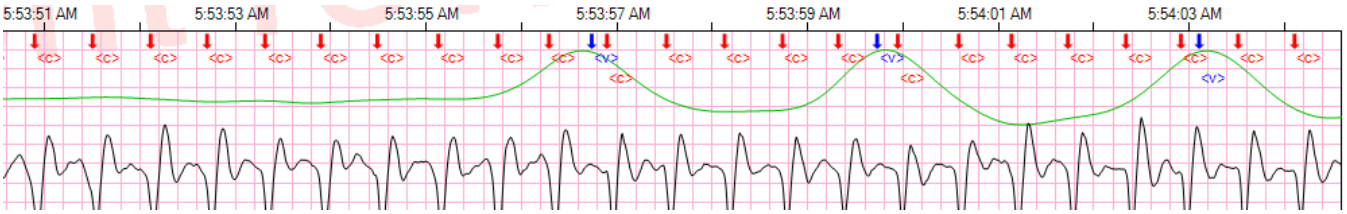

Figure 2: Example of ventilations that meet criteria

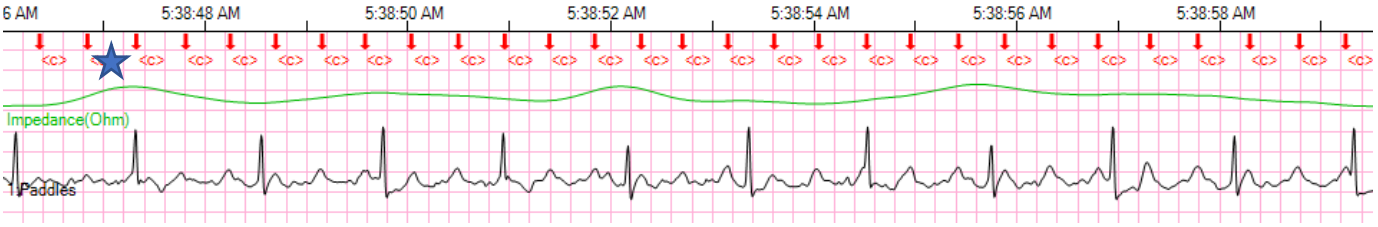

Figure 3: Example of ventilations that do not meet criteria

The following data was recorded for each file: time until advanced airway (AA) placement, the number of ventilations pre- and post- airway placement, the overall, pre- and post-airway ventilation rates, whether or not the patient had return of spontaneous circulation (ROSC), and the initial heart rhythms of the patients.

Out of the 419 files provided, the first 114 files examined were used to perform a power analysis. Of the 419 files, 17 did not have an advanced airway placed, and an additional 70 did not have the airway placed during the recorded time. This left a total of 332 files, which were subdivided according to whether the patient had ROSC or not; 109 and 223 files respectively (see Figure 4).

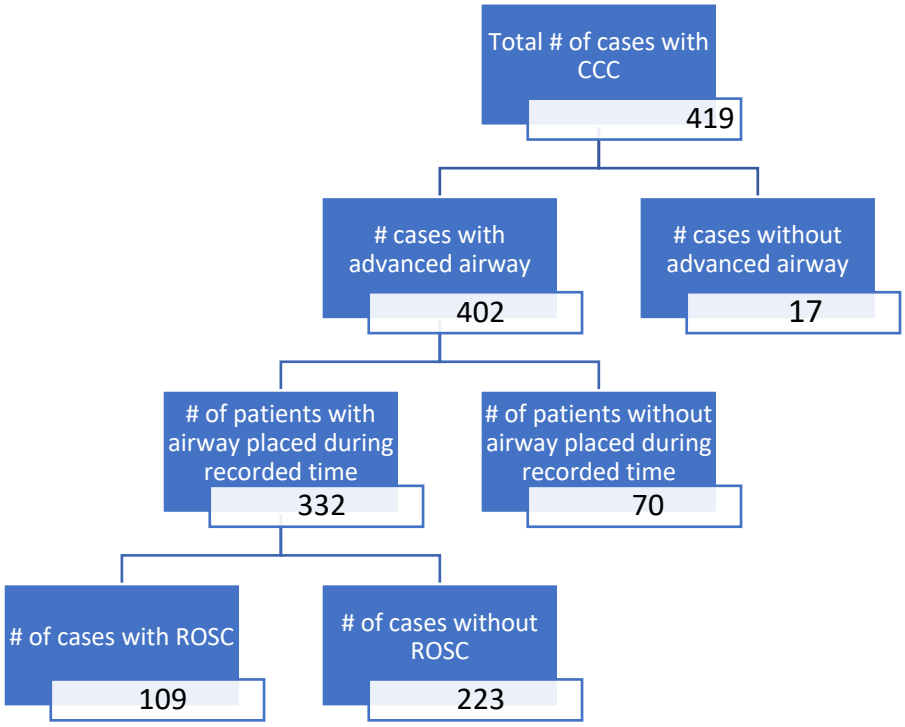

Figure 4: Study cohort and exclusions.

Results

Due to there being very little difference between the ROSC vs No ROSC group in regard to an effect size, for our findings to have adequate power, we would need a cohort size greater than 1000 cases, which we did not have available. This forced us to change the design from an observational study to a descriptive study.

We first looked at the data in its entirety, then stratified by ROSC or No ROSC, and by the patients' initial heart rhythm (IR). Table 1 shows the means ± SD, plus standard deviations, for the data overall. Table 2 compares the mean ventilation data between the ROSC and No ROSC groups. Table 3 shows the Wilcoxon Two Sample p-values comparing the ROSC and No ROSC groups.

Table 1: Averages for all Cases

Cases	N = 332
Overall Vent Rate (breaths/min)	4 ± 3
# of ventilations pre-AA	24 ±28
Time until AA placement (seconds)	630 ± 484
Pre AA vent rate (breaths/min)	3 ± 2
# of ventilations post-AA placement	86 ± 85
Time elapsed after AA placement (seconds)	1045 ± 672
Post AA vent rate (breaths/min)	5 ± 5

Table 2:Comparing ROSC with No ROSC

Cases	Cases with ROSC (N = 109)	Cases with No ROSC (N = 223)
Overall Vent Rate (breaths/min)	4 ± 3	4 ± 3
# of ventilations pre-AA	22 ±22	25 ±31
Time until AA placement (seconds)	646 ± 653	622± 377
Pre AA vent rate (breaths/min)	2 ± 2	2 ± 2
# of ventilations post- AA placement	89 ± 90	85 ± 83
Time elapsed after AA placement (seconds)	1146 ± 901	996 ± 521
Post AA vent rate (breaths/min)	5 ± 3	5 ± 5

Table 3: Wilcoxon Two Sample Test p-values

Cases	p-values
Overall Vent Rate (breaths/min)	0.807788628
# of ventilations pre-AA	0.766028861
Time until AA placement (seconds)	0.636497144
Pre AA vent rate (breaths/min)	0.310905438
# of ventilations post-AA placement	0.837087502
Time elapsed after AA placement (seconds)	0.589557232
Post AA vent rate (breaths/min)	0.704721043

Table 4:Comparing Initial Hearth Rhythms

	ASY (N=136)	PEA (N=118)	VF (N=74)	P-values
Overall Vent Rate (breath/min)	3 ± 3	4 ± 3	5 ± 3	3.22E-05
# of ventilations Pre-AA	20 ± 23	25 ± 26	32 ± 37	0.00703786
Time until AA placement	623 ± 391	646 ± 629	631 ± 376	0.838298745
Pre AA vent rate	2 ± 2	2 ± 2	3 ± 2	0.000831735
# of ventilations Post-AA	80 ± 92	74 ± 69	116 ± 86	2.29E-05
Time elapsed after AA placement	1022 ± 612	956 ± 611	1208 ± 830	0.077582486
Post AA vent rate	4 ± 6	4 ± 3	6 ± 4	0.000157518

Discussion

With our primary goal of this project being to determine if ventilations could be measured during CCC CPR, we first looked at the number of ventilations given to a patient before and after an advanced airway was placed. In regard to the ventilations given prior to an advanced airway, the hypoventilation along with the large deviation we saw indicates possible issues with the operation of the bag valve mask, BVM, device by the EMS providers. While a BVM device may appear to be easy to use, there are many steps to use it appropriately. The most important step is ensuring the mask is sealed around the mouth and nose; if it is not, the air pumped into it will leak around the facemask. Once the seal is secure, the airway needs to be opened. This is done by tilting the head back via raising the chin. If the tongue is blocking the airway, an oropharyngeal airway can be inserted to position it forward.[11] Upon delivering the ventilations, the EMS provider must watch for the chest to rise to ensure air is reaching the lungs.[12] If the chest does not rise, the provider could be deflating the bag too quickly or the opening to the pharynx could be occluded. In both instances the air is going into the stomach instead of the lungs.

The higher ventilation count and deviation seen in the number of ventilations after the advanced airway was placed could be due to how much time had passed since the placement, hyper- or hypo- ventilation by the EMS provider, or incorrect placement of the airway. The most common airways were supraglottic devices (King tubes) and endotracheal intubation with endotracheal (ET) tubes, both of which are then connected to the manual bag until arrival at the hospital. For endotracheal intubation, the ET tubes are passed through the vocal chords into the trachea with the use of a laryngoscope.[13] This form of intubation requires skill and can be difficult for inexperienced personnel to perform during CCC CPR. The tube could be placed too

far down into one bronchus, allowing only one lung to receive the air, or it could be placed too high. Supraglottic devices such as the king tube sit on top of the esophagus, blocking the opening and forcing all of the air to go into the trachea. While this method still requires experience to ensure proper placement, it can be easier to place during CCC CPR.[13] The king tube could be placed too loosely, allowing some air to enter the esophagus or too deeply into the esophagus, blocking airflow into the trachea.

While the number of ventilations before and after airway placement were vastly different, the vent rates weren't, the means only differed by two ventilations per minute. While the target vent rate is between 6 and 8 vents per minute, neither of the mean vent rates were within the target window.

The purpose of comparing ROSC vs No ROSC was to determine if there was a specific parameter that was significantly different that could lead to the patient developing ROSC. There are many other outcomes for OHCA that can be studied, such as prolonged ROSC, survived event, and survival to hospital discharge. Prolonged ROSC is defined as having 20 consecutive minutes where chest compressions are not required and signs of circulations persist, such as a pulse with blood pressure.[14] In the case of OHCA, a survived event means the patient sustained ROSC until they were admitted to the hospital and care was transferred to hospital staff.[13] Survival to hospital discharge simply means the patient has been discharged alive from the hospital's acute care unit; it does not give any indication to the patients' neurologic status or where they are being transferred upon discharge.[14] Due to the files of this study being de-identified, the only outcome we had access to was if the patient had ROSC during the recorded CPR timeframe.

Due to our small sample size and large deviations within the data, A Wilcoxon Two Sample Test was performed comparing the ROSC and No ROSC groups. There were no significant differences between the groups for any variable examined. While the mean time to advanced airway placement was insignificantly shorter in the No ROSC group than the ROSC group it was not, when compared to the 30:2 study performed by Dr. Idris where the average time to advanced airway placement was 13 minutes, 780 seconds, both of our groups had a shorter average time to placement. When it came to the ventilation rates between the two groups, they had the same overall and post airway placement rates, and the ROSC group had a higher ventilation rate by one vent/minute.

When comparing the data based on the patient's initial heart rhythm, there were significant differences between the groups. The differences were most evident within the ventricular fibrillation (VF) group, who had higher overall, pre and post airway placement vent rates, and highest average number of ventilations given, both before and after the airway was placed. These differences within the VF group compared to the others could be caused by the increased potential to be resuscitated due to the presence of electrical activity in the heart. With VF, the patients conduction system within the heart is misfiring, but is still actively working, as compared to the asystole and pulseless electrical activity groups.

In every set of calculations, there are vast deviations from the mean for every metric studied; largely in part due to the unpredictability of cardiac arrest and human error. In a few of the cases, the post airway ventilation rate exceeded the target range of 6-8 vents/minute. This hyperventilation can lead to increased intrathoracic pressure, blocking return of blood back towards the heart in between each compression.[15] With the blocked flow of blood, less blood

returns to the heart and perfusion to the rest of the body decreases, reducing the effectiveness of the compressions.[15]

The location of the event can also affect the large data variations, especially in the length of time it takes to place an airway and how much time elapses after it is placed. If the patient is alone or in a underpopulated area, they could be without care for an extended period of time after suffering from cardiac arrest. Even in cases where the arrest is witnessed by a bystander, the fear of giving mouth-to-mouth CPR may prevent the bystander from providing CPR.[14]

Conclusions

Through this project we have shown that transthoracic bioimpedance recorded by defibrillators can be used to monitor ventilation during continuous chest compressions of patients with an out of hospital cardiac arrest. The software Dr. Idris and his associates in Spain had previously created using the 30:2 CPR data can be updated to automatically detect ventilations during continuous chest compressions CPR. To add validity to the correlation between ventilations and the bioimpedance waveform, additional files that also have end-tidal CO2 (EtCO2) waveforms recorded will need to be examined. EtCO2 is the concentration of carbon dioxide at the end of an exhaled breath and is measured using a capnograph that is attached to an endotracheal tube.[16] While the association between ventilation prior to advanced airway placement and outcomes was undetermined during this study, there is potential going forward that an association can be found.

Chapter 4

Internship experience

Throughout this internship I was exposed to both the administrative side of clinical research and the scientific side. In order to begin on my project, I had to familiarize myself with the project and any other background information that lead to it, submit the necessary paperwork to the IRB to be added to the project, and complete required training for HIPPA and Good Clinical Practice for researchers. Due to our study being classified as a "non-human" study, there wasn't any other change required to the protocol that needed to be approved by the IRB.

Once the administrative tasks were complete, I was able to move onto examining the deidentified patient files and recording the necessary data for my project. It was an evolving process determining the best way to annotate and record the data for the files. I tried various methods and ultimately settled on recording the start and end times of the file, and the time of an airway placement. If it wasn't within the time frame, I wouldn't annotate the file because it was going to be thrown out of the study. If the placement was within the time frame, I would then annotate the file for the ventilations and record the necessary counts.

When it came time to scheduling my defense and meeting times to go over my paper, I had to balance several peoples travel schedules to find a time when everyone would be available. This was a constant issue throughout my internship, but it forced me to be very prepared and constantly thinking about what the next steps needed to be.

Internship Site

The internship was conducted at UT Southwestern in the Emergency Medicine Department, under the supervision of Dr. Ahamed Idris, Dr. Ava Pierce, and Pam Owens.

Journal Summary

The journal depicts my day to day activities during the internship, such as meetings, required training sessions, and file annotation.

Appendix

Journal Entries

Teresa Gordon

UT Southwestern EM Internship Journal

Summer and Fall 2019

Tuesday 5/28

Today I spent the day getting a physical lay of the land. I was shown the two different offices, who works in each one, and the most efficient paths to get to each from the parking lot. I met with several people in the emergency medicine department, including Pam Owens and KB, who assisted me in starting the onboarding and credentialing process. Due to staff changes I was told the onboarding process would take longer than normal because the person who left was the person responsible for new interns. While I did not get to meet the two physicians I am working under, Dr. Ava Pierce and Dr. Ahamed Idris, due to night shift scheduling and traveling, I was given information about the several projects in progress that I could join. I was told to read through the several articles provided, make notes of what interested me the most, and come up with potential sub-projects surrounding the current ones. Until my credentialing was completed, and Dr. Idris was back from his travels I won't have much to work on.

Wednesday 5/29

Due to unforeseen circumstances my initial meeting with Dr. Pierce was pushed until Thursday at 11 AM. I was tasked with continuing my work with the articles.

Thursday 5/30

I met with Dr. Pierce today, partly to get familiar with one another but mostly to discuss what needed to be done by the time the committee meeting. We discussed dates for the meeting, that I needed to have my project selected and fleshed out as much as possible and in the form of a presentation. My onboarding was still in the process, so I was to work from home Friday and Monday; Tuesday is the earliest any sort of university training would be available for me to complete in order for me to get a badge and an email account. After the meeting I met up with Pam and another intern within the department to learn how to annotate defibrillator files for a project that was currently ongoing. My project is most likely going to be similar to this, except looking at continuous chest compression CPR instead of 30:2 CPR, so she wanted me to get familiar with how to read the files and how to use the software.

Friday 5/31 and Monday 6/3

During my time working from home I have finished reading through the articles and creating the outline of the presentation for the committee meeting. Credentialing still isn't ready, but everyone is hoping it will be by tomorrow. Until then I am working on annotating defibrillator files.

Tuesday 6/4 and Wednesday 6/5

I still have not been given access to any training modules required for the credentialing process. Both days I went in to work on defibrillator files, but the other interns were in the office occupying the computers, so I did not have anything to do. Dr. Idris is still out of town.

Thursday 6/6

The credentialing process has finally gone through, I now have a school ID and access to my school email. With this I can start the university mandated training modules that allow me to begin my research. This includes several CITI Program training modules and other specific UTSW lab safety and campus safety modules. Until Dr. Idris gets back to town on the 11th, I will be working on completing all of these modules and the other paperwork for working at UTSW.

Friday 6/7

Today I completed the HIPPA and the Good Clinical Practice (GCP) Courses of the CITI program. While I had already completed courses similar to these for UNT, these courses were organized specifically for researchers at UTSW as opposed to other employees and students. The HIPPA training focused on the privacy rule and the use of data sets for research. It also included information on recruitment and the use of PHI. The main focuses of the GCP training was informed consent, adverse events, and medical devices.

Monday 6/10

I confirmed with Dr. Idris the time of our meeting tomorrow and reviewed my notes of the ongoing projects he is conducting. I made a detailed list of what needed to be discussed and finalized for the committee meeting scheduled for Thursday the 13th at 10 AM. My name was submitted as a researcher to the IRB, we are now just waiting on their confirmation they received the update.

Tuesday 6/11

During my meeting with Dr. Idris he gave me a short synopsis of each project he was working on and potential sub-projects that I could perform for my practicum. The project that intrigued me the most from my readings was about the association of ventilation on outcomes of out of hospital cardiac arrest cases, which is an extension of larger study known as the Resuscitation Outcomes Consortium (ROC). The ROC is a vast collection of cardiac arrest cases from ten sites in North America that can be used to learn how to best treat people who suffer from a cardiac arrest event. At this point in his study, Dr. Idris had created a methodology for identifying ventilations on LifePak defibrillators and had examined the cases that had the standard form of CPR, which is 30 compressions to 2 ventilations for a cycle of 2 minutes. He suggested my project could look at the continuous chest compressions arm of the ROC study to first determine if ventilations prior to an advanced airway being placed were visible of the defibrillator files, meaning they were occurring, and second the incidence of ventilation before and after airway placement.

After our meeting, I joined the weekly research coordinator meeting being with the other members of Dr. Idris' team so I could meet everyone and hear about the other projects that were ongoing. I also learned that Dr. Idris would be out of town again from June 16th to the 29th but would be available via email if I needed help with anything. Once the meeting ended, I went home to gather the background information on my project for the committee meeting presentation.

Wednesday 6/12

This morning I went into the office to finalize the number of cases I would need for each part of my study. We settled on 10 to determine the methodology I would use, 100 additional ones to be used for the power analysis, and about 600 to determine if significance and if there was any associations. Pam said she would begin pulling the first 110+ case files from the ROC files for the first two parts of my study and they should be ready to begin being reviewed by the afternoon of the 13th. I spent the rest of the day compiling all of the background information and other information and finished up the committee meeting presentation.

Thursday 6/13

I had my first committee meeting in the Emergency Medicine Department office at UTSW at 1 PM. After presenting all of the possible projects for me, it was agreed the ventilation project was going to be the best given the time frame of the program. We established a timeline for the completion of the practicum proposal.

- **June 26th** – draft of proposal to Dr. Hodge for review
- **July 1st** – final draft of proposal to committee members for review
- **July 10th** – final draft of proposal must be approved by committee and submitted to GSBS.
- 1 month prior to defense – intent to defend form to GSBS
- 2 weeks prior to defense – final practicum report to committee members for review/approval
- Will set up a meeting with Dr. Hodge sometime between now and November to discuss other more specific writing deadlines.

Key takeaways regarding what should be included in my proposal were to have a large introduction, provide a lot of background information on the study and why this research is important to medicine. After the committee meeting, I started working on the first 10 files to create the methodology. I completed the first couple with Pam so that she could answer any questions I might have regarding the files themselves.

Friday 6/14

Monday 6/17

The parameters for a ventilation in the 30:2 arm of the study are:

- Bioimpedance waveform with at least 0.5 ohms in amplitude and 1 second duration
- The reason 0.5 ohms was used is a tidal volume of about 4 mL/kg (300 mL) correlated to the size waveform across different devices. A tidal volume of 300 mL is on average enough air to cause the chest to rise, which is the visible sign CPR providers look for to determine adequate ventilation of the patient.

These parameters shouldn't be different between the arms of the study so I decided to follow them to identify ventilations. I performed a first pass of the 10 files following these parameters to count the number of vents the occurred before and after an airway was placed. If I was unable to determine where the airway was placed based on a lack of time given, note in the file, or a change in waveform size and frequency I would make a note to look at it with Pam. I scheduled a meeting with Pam and Dr. Pierce for the afternoon of the 18th to review the files with them and get their feedback on my methodology.

Tuesday 6/18

The meeting that was scheduled for today with Dr. Pierce and Pam got pushed back a day due to a family emergency, so I focused on writing the introduction to my proposal.

Wednesday 6/19

During the meeting with Pam and Dr. Pierce we reviewed the 5 files I had questions over or I found difficult to annotate. The most challenging part of annotating the files is determining where the airway was placed. Most of the time we are given a time it was placed, but it isn't always an accurate time due to it being the time it was logged by the paramedic. To mark the most accurate time an airway is placed, I have to go to the time stated in the PCR doc to see if it appears accurate. If it's not accurate I have to search the file a little before and after the time to determine if the breathing pattern changes, indicating the placement.

Thursday 6/20

To ensure I was recording all of the necessary data points, I emailed Dr. Idris for his suggestions on what data would be most beneficial and useful. I was already recording the number of vents pre and post AA placement, if they patient had ROSC or not, and the time of the airway placement. After discussing with Dr. Idris, I also started recording the time until AA placement. It is taking a bit of trial and error to determine the most efficient way of annotating, counting vents and recording the data, but I am getting a nice routine down.

Friday 6/21

I met with Pam and Dr. Pierce to inform them of the updated parameters I was recording and to go over any lingering questions I had about the annotating or about the ROC study from which

my study stemmed. I finished the first part of my study today, having annotated a total of 12 files. I was provided extra cases in case any didn't actually have an advanced airway placed. With the first part finished, I now need to focus on writing my proposal and getting the first draft to Dr. Hodge.

Monday 6/24 – Wednesday 6/26

Having finished the first part of my study, developing the methodology of determining vents and recording data, I spent these days writing up my proposal in order to meet the deadline of getting the draft send to Dr. Hodge on the 26th.

Thursday 6/27

With my proposal in the hands of Dr. Hodge for editing, I started the next phase of my research, the 100 case files to determine how many more files I'd need to annotate for significance. The files can vary from only a few minutes in length of compressions to upwards of an hour of compressions. If a file is short, or doesn't have an airway, I can move through them at a decent pace. However, if the files are longer than 20 minutes, it can take me almost as much time annotating and counting the ventilations. Due to the strain annotating the files can take on the eyes, Dr. Idris said going forward, I could set any kind of schedule I wanted, as long as I got the work done. I set a deadline of one week to complete the 100 files, equaling a minimum of 15 defibrillator files a day. On this day it took me about 5 and a half hours to complete 9 files that came from the Birmingham site, and 12 files that came from the Dallas site. In this bunch there were 3 files that appeared to have the airway placed before the CPR report was started, meaning it should be excluded from the study do to the inability to count the vents pre placement.

Friday 6/28

I got to the office this morning around 9:30 am, completed 14 files from the Dallas site and started a 15th. There was one file that had the airway placed before the CPR report time started. I spent four hours working on the files and made notes in the excel spreadsheet if there were any other issues that I wanted to bring to Pam and Dr. Idris' attention. I still haven't received any notes on my proposal from Dr. Hodge. I am hoping I get them soon as I am supposed to send my final draft to my committee members on Monday.

Monday 7/1

I arrived at the office at 10 am and finished the file I started yesterday and completed 28 more files from the Dallas site. There was one file where the airway was placed before the CPR report started and it was only a LifePak 1000 file. This is an AED file, not a defibrillator file meaning the filters of the program used to annotate the files don't work and I can't see if any ventilations were going on. Often times if there is an AED file, there is one or more defibrillator files associated with it, but in this instance, there was only an AED file. I ended the day with 1 file from Ottawa, totaling 29 files for the day. I am now a little more than halfway done with the 100 files. I got home to an email from Dr. Hodge with revisions on my draft. However, I had some questions regarding them so I was unable to get my final draft out to the committee today.

Tuesday 7/2

I've settled into a routine of getting to the office between 9:30 and 10 and then getting right to my annotating and data recording. I finished the last 6 files that came from the Ottawa site, I left

one incomplete, I wanted to review it with Pam because I couldn't tell where ROSC had started and stopped. It was a very long file with multiple instances of the patient going in and out of ROSC. I then continued on to complete 15.5 files from the Vancouver site. Of those files I marked 2 that had the airway placed before the CPR report started. There was another AED file, but this time it did have an associated defibrillator file with it so I was able to gather data from it. I completed a total of 21 files and left one annotate but not recorded.

Wednesday 7/3

I got to the office earlier than normal today, so I could finish my set number of files today in case the office closed early ahead of the holiday weekend. I completed 11 files, including the one I started yesterday, and started another one. These 11 took me a lot longer than I anticipated, as they were all long with difficult to read waveforms. There was also one file where the CPR report stopped before the airway was placed, leaving me no way to compare ventilations before and after airway placement. I left for the holiday weekend with only 6 more files to complete.

Monday 7/8

Due to unforeseen circumstances, combined with conflicting travel schedules, I was greatly delayed in getting my proposal sent to my committee members. I got it sent today, and scheduled an appointment with Dr. Hodge on August 7th to discuss the issues, reiterate the expectations of the program, and to finish our timeline from this point until my defense. I received additional revisions from Dr. Idris today, which I promptly made and sent to my committee. I got the confirmation email from the UTSW IRB that they have added me to the ventilation, which I was needing so I could get IRB approval from the UNTHSC IRB.

Tuesday 7/9

I got confirmation from Dr. Hodge that my committee approved my proposal and got it submitted to the GSBS office. This situation made my thankful for the flexibility of my committee but also taught me to build a larger buffer into my timeline to accommodate potential unforeseen issues in the future. I got to the office around 10 am and finished out the last 6 files of this phase of my project. Thankfully there were no problems with these last files. I emailed Pam to let her know I was finished with the first 100 but there were several I wanted to go over with her. We set a meeting for Thursday at noon.

Wednesday 7/10

I was sick with a stomach bug and was unable to come into the office.

Thursday 7/11

I met with Pam at noon today to review the files I had mentioned to her. Over the course of the week of data collection, I made notes in the spreadsheet of interesting waveforms I had seen, or inconsistencies within the files. There were others that I wanted confirmation that where I had labeled the airway placement was as accurate as possible. During the meeting we also discussed her pulling the next batch of files for me. We wouldn't know the exact numher we would need until after Dr. Idris had done the power analysis, but we agreed it would be a minimum of 600. She agreed to start pulling as many files as she could find. After our meeting, I focused on updating the spreadsheet and recollecting the data for a few of the files in which I had changed the specific part of the file where the airway was placed.

I also met with Dr. Idris to discuss if I had noticed and trends or anything that was consistent with all of the files. We somehow both forgot that we should know how much time elapsed from the airway placement until the end of the CPR report, that way we could calculate ventilation rates pre and post AA placement. So I now need to go back and add that information to the spreadsheet and then calculate the vent rates.

Friday 7/12

I started the process of determining how much time occurred from AA placement to the end of the CPR report. I got through the first half of the files today.

Monday 7/15

I continued recording the elapsed time after an airway was placed and finished all of them by noon. I then started calculating the vent rates for each case, making sure the numbers made sense with the overall vent rate for the file I had also recorded. If the numbers didn't make sense, I would go to that case and recount all of the vents and recalculate the vents rates. I was told by Pam that she would have the first batch of files for my next phase of the project on the computer tomorrow.

Tuesday 7/16

I went into the office with the intention of starting the last phase of my data collecting, but when I got there and started on the first file, I realized I did not have an updated spreadsheet with the PCR doc times for placement of airways for each case. I emailed Pam asking for the updated

spreadsheet. Until I get this information, I cannot know if/when an airway was placed. In some instances in the past, I was given some files that didn't have an airway placed at all, so to know if the case can be used for the study, I have to wait. I worked on vent rates from home.

Wednesday 7/17

I received the updated spreadsheet from Pam around 4 in the afternoon, so I was unable to get started on the new set of files today.

Thursday 7/18

I was working on the vent rates and found some discrepancies with some of them. So while at the office I recounted the vents and updated the data. They were cases that I had wanted Pam's input on and after I got it, I forgot to update the data. I also found a couple other cases that needed to be relooked at, mostly for the large amount of variation with the bioimpedance waveforms. I reviewed them with Pam and updated the spreadsheet with the new data.

Friday 7/19

I finished calculating the vent rates and sent the spreadsheet off to Dr. Idris for the power analysis to be performed. Hopefully there is enough of a difference between the pre and post vent rates that our finally case number isn't too off from our estimate.

Monday 7/22

I started on the set of 213/600 that Pam initially pulled from the ROC files for the last phase of the data collection. I completed 19 cases all from the Birmingham site. Out of these, 5 of the cases were not on the PCR doc times spreadsheet and had no previous annotation of an advanced

airway being placed. 2 had their airways placed after the CPR report stopped recording data, and another 2 were part of the second phase of 100 files. I made notes of all of these but waited to inform Pam until I had been through more files. I have found its best to save all of my questions/problems until a lot have accumulated so that I can use her time most efficiently. She isn't in the office often, due to visiting other research sites so her time is valuable. I am continuing my pace of a minimum of 15 files a day.

Tuesday 7/23

I spent the day gathering all of the documents needed for UNTHSC IRB approval. I had been waiting on a few more approvals from UTSW which is why I've taken so long to get them passed along to UNT. Dr. Idris acknowledged the receipt of the finished 100 file spreadsheet and said he would work on the analysis over the weekend.

Wednesday 7/24

Today I uploaded, annotated, and recorded data for 21 files. These were all from the Birmingham site, which brings the total of the site to 40 cases. Of the newest 21 files, 4 were not on the PCR doc times spreadsheet, and an additional 3 had interesting findings that I wanted to discuss with Dr. Idris and Pam at a later date. Some had very little vents that met our criteria, but a lot of attempted ventilations. Another simply had no ventilation attempts at all, even after the advanced airway was placed.

Thursday 7/25 and Friday 7/26

I took these two days off of in order to take care of other time sensitive matters.

Monday 7/29

I continued with annotating the files and completed 9 files from Birmingham and 5.5 from Dallas. There were only 2 files from Birmingham that were not on the spreadsheet and 2 from Dallas that I could not visible see where an airway was placed. While there was a PCR doc time, there was no visible change in waveform size, duration, or frequency to indicate that an airway was placed properly. There is the possibility that the medics were as good as a machine at providing ventilations, but the most often issue is the airway is improperly placed or it wasn't placed at all.

Tuesday 7/30

Today's files were all longer than normal and took me longer to annotate. I worked through 10 files from the Dallas site, 3 of which had issues. 2 were files that had an airway reportedly placed prior to starting the CPR report, making it unable for me to compare before and after rates. The third utterly confused me, I made a note to look at it with Pam the next time she is in the office.

Wednesday 7/31

I emailed Pam with the case numbers of the files that were not on the PCR doc spreadsheet so that when she came into the office she could find them for me.I also asked for her to review a few of the files I marked as difficult to annotate with me to get her opinion. She informed me that all but 2 of the files that weren't on the PCR doc didn't have an airway placed so they were not going to part of my study; the other two she found the times for and would be added to the spreadsheet tomorrow.

Thursday 8/1

Before my meeting with Pam I worked on 5 files from Dallas. During our meeting, we discerned that the one file from Tuesday that confused me was an EMS witnessed cardiac arrest where the patient was most likely intubated prior to their cardiac arrest. She knew this because the CPR report had been running for a long time without any waveforms, and during this time the PRC doc time said the airway had been placed. When this happens, it is most likely an ems witnessed arrest. After the meeting I completed 18 more files, totally 23 files for the day. There was a total of 2 that had the airway placed before the CPR report started and 3 more that had irregular ventilations.

Friday 8/2

I had to take my car to Austin to get the passenger side window fixed after it broke yesterday, so I was unable to come into the office today.

Monday 8/5

I got to the office around 9:30 this morning. I completed 16 cases from the Ottawa site. This batch of cases had a number of noteworthy issues. There were 2 files that I was unable to use because the airway was placed before the CPR report started. An additional 3 files had attempted ventilations that didn't meet our criteria or I simply couldn't see them on the report. For the case that I couldn't see the waveforms, I made a note to go over it with Pam to see how to handle it. By this point in my project, I've noticed I can work through about 4 cases an hour, which includes importing the file into the code stat program, annotating the file, and recording the data.

Tuesday 8/6

I continued with the Ottawa case files and completed 15 files. I came across one file that appeared to have the airway placed prior to the start of the CPR report. This was evident by the size and frequency of the ventilation waveforms from the very start of the report. Another file also had an airway placed before the report started. I knew this by the presence of EtCO2, end tidal CO2, readings from the very beginning of the report. The only way to get these readings is for any airway to be placed and hooked up to the capnography. It measures how much CO2 is present in the blood at the end of an exhalation.

I also met with Dr. Idris to go over the results of the power analysis. From the first 110 files, the difference between our two groups, patients who had ROSC and patients who didn't, was so small that to have our data be significant we would need a sample size of 1000+. Unfortunately, there aren't that many files that are both continuous chest compressions CPR and had an advanced airway placed, so the project has turned into being a descriptive study. We also decided to make it an even 300 files for this phase, so I needed an additional 80+ files. Some of the characteristics we will be examining is the time to ROSC, time to advanced airway placement, potentially compression rate. We also may be comparing the CCC data to the 30:2 data.

Wednesday 8/7

Today I had a meeting with Dr. Hodge in Fort Worth to discuss the timeline until my defense date, which is November 1st from 2-4 PM. We also discussed the progress of my project, any

issues I've run into, how I'm liking the research, and how she can help me going forward. The most prevalent issue is the large amount of traveling of Dr. Idris and other committee members. Right around when the proposal was due multiple members were traveling all on different dates, which made it difficult for me to balance. Dr. Hodge and I also went over what the PowerPoint presentation for my defense should generally look like and the formatting of it.

Thursday 8/8

I started the day by completing the last 4 files from the Ottawa site. There was one case that was on the PCR doc times spreadsheet that I didn't have the actual file for, so I emailed Pam asking if she could find it for me and upload it to the computer. I then continued on to the Vancouver cases. I started encountering a lot of cases that had 2 files associated with them, one usually being an AED file and the other being a defibrillator file. Out of the 10 cases from Vancouver that I recorded, 3 of them had 2 files. If one of the files is an AED file, it doesn't add too much extra time per case because all I have to record is the time it starts and stops, due to the vent filters not working on AED files. However, if both files are defibrillator files, it can double the amount of time I take for the case. I completed a total of 14 files today, but I couldn't collect data for 3 of the files because the airway's were placed during either the time when they were using and AED or when the defibrillator was turned to Lead 12, both of which I can't count the vents before.

Friday 8/9

The very first case of the day was one that wasn't on the PCR doc times spreadsheet, and in my experience, where there is one there is usually more. This was proved 2 files later where another

case wasn't on the spreadsheet. Of the 16 other cases that I worked through, 2 were on the PCR doc spreadsheet but I didn't have the file on my computer. And 1 case was only an AED file. I waited to email Pam with my findings until I had finished the first 231 files she originally gave me in case there were other issues.

Monday 8/12

I had a personal meeting in Austin that I couldn't reschedule so I didn't make it into the office today.

Tuesday 8/13

Today I joined the research coordinators meeting to be updated on the other projects going on and to give them an update on mine. The meeting started at 11 and went until 12:30. After lunch, I worked on 3 more files that were all pretty lengthy and difficult to annotate.

Wednesday 8/14

I continued working on the Vancouver cases and completed a total of 16 cases. Of these files there were 3 that I was unable to get all of the data I needed due to the time of airway placements. One file had the airway placed after the CPR report ended, another had it placed after the lead for the defibrillator came off. The last case was composed of an AED file and a defibrillator file. In this case, the airway was placed during the time frame of the AED, rendering me unable to count the vents prior to the placement.

Thursday 8/15

Out of today's 18 cases that I worked through, only 3 had issues. The first case that had an issue was a multi file case, in which both files were LifePak 1000s, or AED files. The next two cases didn't have PCR doc time provided and based on the waveforms and the lack of EtCO2 values, I was unable to determine where an airway was placed.

Friday 8/16

I completed 21 cases today, of which 4 cases had airways placed either during a time frame where the defibrillator was in Lead 12, or during the time frame of an AED file. After today, I only have 25 more files on the computer. I am still waiting for Pam to upload the last chunk of files to the computer to complete my 300 cases. I sent myself the spreadsheet with all of my data on it so that I could start calculating the vent rates. With this large of a case load, it will take a bit of time to do the rates.

Monday 8/19

I spent the day calculating pre and post AA placement vent rates.

Tuesday 8/20

I finished the last 25 files of the 230+ files today. There were 2 cases where the AA was placed after the CPR report stopped and 1 case that had 2 LifePak 1000s files and no other files. Out of this group 4 of the cases were not on the PCR doc times spreadsheet, meaning they most likely did not have advanced airways placed. I am also missing one file that is on the PCR doc times spreadsheet. I emailed Pam about the missing file and the ones not on the spreadsheet to make

sure I had all of the right information. Now I am waiting for the last bit of files and am working on vent rates.

Wednesday 8/21

I continued working on ventilation rates. Pam should get the last files added to the computer tomorrow afternoon when she comes into the office.

Thursday 8/22

I got the email from Pam that she got the last files added to the computer. I continued calculating the vent rates and emailed what I had so far to myself so I could access the spreadsheet from the office computer.

Friday 8/23

I started the new group of files today. I worked through all 14 of the new Dallas cases, the 2 Alabama cases, and 2 of the Ottawa cases. Of the Dallas cases 2 of the files had an AA placed prior to the start of the CPR report. The fist Ottawa case had a lot of time prior to the placement of the advanced airway that had no waveforms, so I made a note to discuss it with Pam and Dr. Idris after I finished all of the cases. In total I completed 19 cases.

Monday 8/26

I met with Dr. Idris today to discuss an additional project that he wanted me to work on that would add validity to the results of my study. He wants me to select 20ish files and correlate bioimpedance with EtCO2 readings. We are looking to see how many vents are detected by

bioimpedance only and how many vents are associated with an EtCO2 reading. This will enhance my findings and help make the use of bioimpedance to evaluate ventilation during CPR a more common and reliable method.

Tuesday 8/27

I started on the Vancouver cases, which has become the site with the most cases in this study. I completed 24, very long, cases. I had a personal goal to have all of my cases finished by the first week of September, so I made a concerted effort to get as many done in a day as possible.Of these 24, 4 had problems with determining airway placement time. One had it placed during the timeframe of the AED, another was after the CPR report stopped, one had very little vents so it was impossible to determine the placement, and the last had it placed when the lead was off.

Wednesday 8/28

I continued with the Vancouver cases and completed 23 more files. Of these, one case was only a LifePak 1000 file, and another had the airway placed while the defibrillator was in Lead 12. I made note of another case that had a lot of time spent in lead 12, but it didn't alter my ability to count vents before or after the airway was placed.

Thursday 8/29

I worked through 13 more files today. 2 of them had very little change in waveform to determine where the airway was placed and another 2 had the airway placed after the CPR report stopped. I will have 8 more files to complete after the holiday weekend. I have a family wedding over the weekend, so I will not be in the office again until the 4th.

Wednesday 9/4

I completed the last 8 files of the project, and the only problem that arose was one case was not on the PCR doc times spreadsheet, meaning there was no airway placed. All that's left now is to finish calculating the pre and post airway vent rates and send the data to Dr. Idris, and to meet with Pam to review all of the cases I took notes over.

Thursday 9/5 – Wednesday 9/11

I spent these days calculating vent rates and reexamining some of the files. I met with Pam on Tuesday the 10th and we discussed all of the cases that either didn't have any vents before or after airway placement or didn't have visible evidence of where the airway was placed. A few of them she was able to assist in determining placement, but when she even she couldn't, she said it could just be a poor placement. I also found out on this day that Dr. Idris was leaving town on Friday and would be gone until the 28th. I finished calculating the vent rates on Wednesday the 11th and sent the data off to Dr. Idris. Until he gets back I will be working on writing my practicum report.

Monday 9/30

I selected 20 cases from the most recent phase of my project for the end tidal study, 5 cases were from each of the four sites. I counted the number of vents that were detected by bioimpedance and the number of vents that occurred after EtCO2 readings started recording. I also made note of the type of device used and how long it took to get EtCO2 readings.

Tuesday 10/1

I got to the office around 9:45 this morning to continue writing my report. I am also gathering my last 2 signatures for my intent to defend form that is due tomorrow. Due to Dr. Idris not having a chance to look at the data and run any sort of analysis of it, I am having to push my draft submission to Dr. Hodge until Monday the 7th so that I can hopefully have some results.

I also worked with Pam on the 20 end tidal files to send to Spain. We needed to make sure the files were all deidentified and that the compression annotations were all accurate. We were able to export the files from the program to a file on the computer while maintaining the file names.

Wednesday 10/2

I met with Dr. Idris today to discuss how far I have gotten on my report, what else should be included, and other information that would be beneficial for my report and presentation. He provided me with a previous presentation that has the images that I can include in my report to show how we came up with the methodology of determining what a ventilation is. We discussed a lot of background information that I was unaware of, such as what happens to the lungs and heart muscle immediately after someone goes into cardiac arrest and why our research matters.

He has reached out to a statistician for her suggestions on what sorts of analysis we should perform, and he is looking at the data this week. I should have some results by the end of the week that I can put into my draft for Dr. Hodge.

Friday 10/4

We got conformation for a meeting with a statistician on October 7th at 10 AM. Since we won't have the data until after that date, I decided to perform some simple calculations myself so that I can have results and discussion in my report draft.

Monday 10/7

Dr. Idris met with the statistician, Xilong who thinks he can have the analysis done by next week. I have been tasked with cleaning up the data, making sure there is only one set of data per case and that every cell is filled with the appropriate values or left blank. I also converted all of the times into seconds to make the analysis simpler.

I also sent my draft off to Dr. Hodge and Dr. Idris for their edits.

Thursday 10/10

Dr. Idris has suggested we add initial heart rhythm as another variable to our analysis. Pam started gathering the data and will send me the updated spreadsheet when it is complete. She thinks it will be done by Monday.

Friday 10/11

After Xilong looked at the data, he found a few more issues that needed fixing. Once I corrected the issues I sent the data back to him to complete the analysis

Monday 10/14

Pam has finished adding the IR to the spreadsheet but was unable to locate the ECG for one file. She has asked me to come in on Wednesday to look for it with her.

Wednesday 10/16

We were still unable to find the ECG file, so what we will do is Pam will make a copy of the original file and re-import it into the system for me to reannotate. I spoke with Dr. Hodge today to discuss how "complete" my report should be when I send it to my committee members, and seeing as how it should be as complete as possible I requested an extension so that I could have my final data analysis reported in it. My committee agreed to give me until October 25th to send it.

Thursday 10/17-Moday 10/21

I worked on my practicum presentation PowerPoint. I sent it to Dr. Hodge Monday evening ahead of our meeting on Tuesday.

Tuesday 10/22

I met with Dr. Hodge to review my presentation. I didn't have my data in the presentation due to only having received it this morning, but other than that there were just minor modifications needed. I mostly need to make sure there is consistency throughout.

Wednesday 10/23-Friday 10/25

I finished writing my report to send to my committee members. There is still some data missing, because we added it late to the analysis, but the majority is present in the report. Whatever isn't will be included in my presentation on Friday November 1st and added to my report after.

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