Executive Development

The Development of Advanced Airway Management Strategies
To Improve the Standard of Care at Littleton Fire Rescue
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CERTIFICATION STATEMENT

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

Signed: ____________________________________________
Abstract
The problem is Littleton Fire Rescue does not have a reliable advanced airway strategy to ensure patients receive dependable airway management in emergencies. The purpose of this action research was to develop a new airway strategy by answer three research questions on how often tracheal tubes get misplaced, what strategies are used by first responders to ensure dependable airway management and what strategies are used by physicians to reduce airway mistakes. Results from this research indicate the current airway strategy was ineffective in eliminating misplaced tracheal tubes. Recommendations to improve the standard of care include developing a comprehensive standard operating procedure for airway management, upgrading medical equipment, modifying training methodology and enhancing the quality assurance process for airway management events.
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The Development of Advanced Airway Management Strategies
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Introduction

The skill of positioning a tracheal tube correctly in a patient’s airway to provide advanced life support ventilations can save someone’s life in cases of respiratory or cardiovascular collapse from medical or trauma related events. On the other hand a misplaced tracheal tube, one that has been inserted inadvertently into the esophagus rather then in the trachea, can quickly end a patient’s life in minutes from the unrecognized mistake. Paramedics performing the skill believe they are ventilating the lungs when in reality they are simply putting air into the stomach. This potentially lethal mistake, if not recognized quickly, can lead to rapid death from lack of oxygen, neurological injury, poor patient outcome, personal liability and organizational liability. Several recent research studies have shown that these unrecognized mistakes take place with more frequency then ever reported in the past.

The problem is that Littleton Fire Rescue (LFR) does not have a reliable airway management strategy to ensure that all patients receive dependable airway control in life threatening situations. This problem has lead to poor patient care.

The purpose of this applied research project (ARP) is to develop a new advanced airway strategy to eliminate the possibility that a LFR paramedic would misplace a tracheal tube in someone needing artificial ventilations and not recognize their mistake. This low frequency but high risk skill must be performed in minutes in austere environments and often under difficult situations and the bottom line is it has to be right. Anything short of perfect could mean death or injury to patients, pain and suffering for their families and may potentially have a tremendous
psychological impact on the individual who is accused of making the unintentional deadly mistake.

This research could be perceived as being centered on the paramedic who inserts the advanced airway device into the patient’s airway but it’s really a much deeper issue. The matter of proper tracheal tube placement in emergency situations is an emergency medical service (EMS) system challenge. Most patients and their families expect the EMS system to work in critical times when lives are on the line and advanced airway support is imperative. The EMS system must design a strategy to support and guide the paramedic inserting a tracheal tube and afford them the training, tools and technology to make them successful at getting the job done correctly.

This ARP will utilize action research methodology to investigate and develop a new airway strategy to improve the standard of care at LFR. The following research questions will be answered to assist in cultivating the new airway strategy: (a) How often do tracheal tubes get misplaced and the error goes unrecognized leading to poor patient care? (b) What strategies are used by first responders to ensure dependable airway management? (c) What strategies do hospital physicians use to reduce the possibility of unrecognized airway placement errors?

Background and Significance

Even though EMS has been around for more than thirty years, the profession is still relatively new in the fire service. Prior to the 1970’s EMS was done by anyone who was willing to take on the task of providing first aid. Back then, few if any people had any training in caring for the sick or injured. There were no EMS text books, little equipment and no organized approach to providing first aid for heart attack victims or people injured in auto accidents.
It wasn’t until 1965 that the nation began to take notice that thousands of people were dying on America’s highways as victims of trauma. That year the National Academy of Sciences released a white paper titled *Accidental Death and Disability: the Neglected Diseases of Modern Society*. This historic white paper identified for the first time that 52 million accidental injuries killed 107,000 Americans, disabled more than 10 million and permanently impaired 400,000 more at a cost to society of more than $18 billion annually. This paper made a number of recommendations to the nation on how to reduce these needless deaths. These recommendations included standards for ambulance design and construction, standardizing EMS supplies and equipment and standardized training for ambulance personnel. In 1966, shortly after the white paper was released, Congress enacted the National Highway Safety Act and mandated the newly formed Department of Transportation (DOT) to establish minimum standards for the care of accident victims. This was the first organized approach by the U.S. government to establish national standards for patient care.

EMS progressed very slowly through the late 1960’s until a television show of the early 1970’s captured the attention of the nation and put the word *paramedic* in the spotlight. The show *Emergency* with Johnny Gage and Roy DeSoto, paramedics in the fire service, suggested that EMS was saving lives in communities across the country when in fact most communities still had no organized EMS squads. This television show is credited with helping many communities across the country create EMS programs to care for their sick and injured, including LFR in Littleton, Colorado.

In 1973, inspired by the show *Emergency*, then Deputy Fire Chief Pete Cernich of LFR traveled to both coasts from Colorado to investigate how to develop a paramedic program in Littleton. In 1974, in conjunction with a local hospital, 14 Littleton firefighters went to school to
become paramedics even before there were books. These fledgling paramedic firefighters learned many new medical skills and graduated as the first official paramedics in the State of Colorado. LFR is one of the first fire based EMS services in the country.

Founded in 1890, LFR has been providing fire and emergency services for 117 years. The department protects 225,000 residents in an 86 square mile fire district located south of Denver, Colorado in the shadows of the Rocky Mountains. LFR employs 125 cross-trained-dual-role career firefighters who are trained as emergency medical technicians. Half of the firefighters are trained to the advanced level of paramedic. LFR responded to 11,798 incidents in 2006, 69% of which were emergency medical calls. LFR provides advanced life support (ALS) on every incident with paramedic firefighters responding on each of the seven engine companies, five transport ambulances and one ladder company.

LFR has a proven history of providing high quality EMS. The department is known locally and regionally for outstanding patient care with a staff of very experienced paramedics. LFR gained national exposure in 1999 in the wake of the Columbine High School shooting. In retrospect, the medical care received by the shooting victims is credited with having saved many lives during the tragic shooting incident.

An essential skill preformed by Littleton paramedics is the technique of inserting a plastic tube into the trachea of patients who have stopped breathing. The skill is known as intubation. Performed correctly, this skill can save a person’s life by providing artificial ventilation directly into their lungs when their natural ability to breathe has spontaneously stopped. Without adequate ventilations, natural or artificial, the patient has a four to six minute window of survival before possible brain death occurs (American Heart Association [AHA], 2006). Since the
beginning of the paramedic program in Littleton 33 years ago, LFR paramedics have been performing this critical skill on a regular basis with little direction or oversight.

The paramedic staff at LFR has a wide variety of experience. Paramedic experience varies widely from 25 years of practice to the newest paramedic right out of school with little practical field experience. Currently, after a paramedic has finished their initial paramedic training and state certification, LFR does not have a strategy to ensure that each paramedic has retained the skill of intubation past their initial training period. Some paramedics may not insert a tracheal tube for years and as with any skill, if it is not practiced on a regular basis, the ability to perform the skill may degrade and mistakes will occur. Paramedics who are assigned to engine companies do not have the same opportunities to insert tracheal tubes compared to those who regularly work on a transport unit.

Equipment used to monitor tracheal tubes after insertion, electronic end-tidal carbon dioxide (ETCO2) detectors, also know as waveform capnography, are not standardized on every unit throughout the department. The first arriving engine company paramedic may incorrectly insert a tracheal tube into a patient and the error may go unrecognized until the arrival of the transport unit with capnography minutes after the tube insertion. Airway equipment is also spread out in a number of medical bags and may not be immediately available when needed. Some of the equipment used may be outdated technology and be ineffective when used in advanced airway insertions.

The retrospective quality assurance process currently in place has been ineffective in eliminating airway mistakes. Every tracheal tube attempt is not automatically reviewed and little oversight is provided after tracheal intubation. The fire department receives little follow-up from
the local hospitals about airway intubations unless the tube has been misplaced. Patient follow-up usually comes days or weeks after the event.

The problem is the current airway strategy and protocol are ineffective and do not ensure that patients receive dependable airway management. The problem of misplaced tracheal tubes has been reported to LFR by emergency physicians from local hospitals who have received patients with unrecognized misplaced tubes in place. It was also reported to LFR by the local coroner who received a body of a patient with a misplaced tube in the esophagus after resuscitation efforts were terminated in the home.

This is a serious problem because these unrecognized misplaced tracheal tubes may lead to unnecessary death or disability of LFR patients. These mistakes can be eliminated if the fire department had a more reliable strategy in place to reduce any possibility of unrecognized error. A new airway strategy and standard operating procedure (SOP) should be designed to support and direct the paramedic inserting the tube and guarantee that they are well trained, properly equipped, airway encounters are well documented to ensure good quality control and there is an effective process in place to examine each intubation attempt. The current strategy has not been effective in eliminating these mistakes and this has led to poor patient care.

The impact of the problem is very difficult to measure. In some cases the paramedic may have inserted the tracheal tube correctly but it may have become dislodged while moving the patient. In other cases, the tube may not have been inserted correctly from the start and was never checked again after tube insertion. Three cases of misplaced tubes were reported in 2006. In two cases the tracheal tube was inserted incorrectly or became dislodged and the problem went unrecognized by the attending paramedic. The third case was discovered by the coroner. In another 27 cases, resuscitation efforts began and ended in the patient’s home and the patient was
never transported to the hospital. These patients received tracheal intubation and failed to respond favorably to resuscitative efforts and were pronounced dead at the scene and left for the coroner. Since there has not been a formal SOP developed to ensure that the tracheal tube was ever placed and monitored correctly there is no assurance that an incorrect tube placement did not lead to the poor outcomes. In 73% of the of intubation cases in 2006 at LFR, no objective tube confirmation was ever performed with waveform capnography.

As the EMS Chief for LFR, it is the author’s responsibility to ensure that patients are receiving the highest standards of care at the most reasonable cost provided by the best trained paramedics using the most advanced equipment available. At the same time, the author must find ways to reduce organizational liability through paramedic oversight and good quality assurance while improving the standard of care for all patients. This problem has never been studied in 33 years that LFR has been inserting tracheal tubes in patients.

There is no information in the Learning Resource Center at the National Fire Academy to support that this problem has ever been studied by an Executive Fire Officer candidate. Colwell, et al. (2005) noted very high success rates for tracheal tube insertion in one urban EMS service in Colorado while also finding that patients still arrived at the emergency department with unrecognized misplaced tracheal tubes in place. Colwell’s study is in stark contrast to what Wang, Lave, Sirio and Yealy (2006) found in a much larger study of 400 EMS services across Pennsylvania. They discovered that intubation errors occurred much more often then reported with error rates as high as 40% percent.

This research project can be related directly to the National Fire Academy’s Executive Development course, unit 10, service quality (ED-Student Manual, 2006, p.SM 10-9). As an Executive Fire Officer, it is the author’s responsibility to ensure that the performance of the EMS
system is reliable and meets or exceeds the needs of the customers. This problem is also linked
directly to the United States Fire Administration’s (USFA) strategic plan and operational
objective number three, appropriately respond in a timely manner to emergent issues (USFA
Web page, 2007). A new airway strategy to eliminate clinical errors has emerged as an important
issue and it is appropriate to immediately respond to reduce these potentially deadly mistakes.

Literature Review

A literature search was conducted to acquire information from the existing body of
knowledge on airway management strategies. The intent of the search was to determine what
research had already been done on the topic of airway management strategies and what
information has been discovered by other researchers which may have an impact on this ARP.

The literature review began in the Learning Resource Center (LRC) at the National Fire
Academy in February, 2007 to find any Executive Fire Officer (EFO) research papers on the
topic. There were no papers found that addressed the topic of airway management. The database
search was then expanded to include all documents, publications and materials in the LRC
related to answering the three research question. While some article on the topic did exist, the
information was limited.

The search expanded to the Internet. The Internet literature search was conducted during
March and April, 2007 and multiple sources including books, journals and magazines were
searched. The results of the search did yield articles and other studies related to airway
management. Key words used in the literature search were airway management, intubation, pre-
hospital care, paramedic protocols, airway control strategies, intubation complications,
misplaced tracheal tubes, advanced life support, carbon dioxide detection, capnography,
emergency physicians, medical errors and resuscitation errors.
Primary airway studies were found spanning the last ten years that helped answer the first question about how often tracheal tubes get misplaced. These studies were conducted in local or regional EMS systems but no central point of EMS data collection on a national level was found.

A study conducted in Denver, Colorado was published by Colwell, et al. (2005) and measured the success and complication rates associated with endotracheal intubation (ETI) in an urban EMS system. This study has some local significance to this research project since the location of the study is just miles way from LFR. This is a retrospective study of ETI using data collected from paramedic charts, hospital records and coroner’s reports to identify complication rates associated with ETI. This study concluded that very high success rates of ETI in the out-of-hospital venue are possible in an urban EMS system. Of the 278 patients studied the success rate for placing tracheal tubes correctly was reported to be 84%. Complications were reported in 8% of the intubations. Complications included three tubes which were incorrectly positioned, two which were undetected esophageal intubations and one which was positioned incorrectly in the posterior airway but found not to be in the esophagus.

In a second study published by Wang, et al. (2006) researchers examined a broader view of ETI performed by 42 ALS services from across Pennsylvania. This study combined data from both rural and urban patient populations. It also examined the relationship between airway management errors and EMS system characteristics. Those characteristics included annual call volume, annual intubations, personnel mix (volunteer vs. career), number of ALS providers and response times. This prospective study defined the ETI error rate as “that proportion of patients receiving ETI efforts who were exposed to clinical error.” The results of studying 1,953 patients showed much higher ETI error rates then reported by other researchers. Errors occurred in 444 patients ranging from misplaced tubes in 61 patients, multiple attempts at intubation in 62
patients and failed intubations in 359 patients. The intubation error rate among different agencies in the study varied widely and was noted to be as high as 40 percent. The study also found tracheal tube misplacement was much more pronounced in children under the age of six. The results showed lower ETI errors in services that performed more than 50 intubations annually and higher errors in services which exceed 5000 patient contacts annually. These demographics are similar to those found at LFR which had 92 intubation and 8,143 patient contacts in 2006. The study found little difference in intubation error rates between personnel mix, number of paramedic in the system or response times. The study results concluded one in four patients was exposed to ETI errors. It also showed that errors were not limited to certain EMS services in the study or a certain patient population mix.

A third study was also selected because of the similarities between the study demographics and LFR. Similarities include an urban environment with a decentralized EMS system, 2-tiered response system with multiple responders and a service where ETCO2 monitoring is not consistently used and has not yet become the standard of care. Paramedics in both systems have received no specialized or additional airway training after their initial certification with the exception of passing an airway station during ALS certification class every two years. Both services also had a patient survive after a tracheal tube was misplaced in the esophagus. This study was conducted by Katz and Falk (2001) in Orange County, Florida. This prospective study found after studying 108 patients requiring advanced airway management that their community had a very high incidence of misplaced tubes which were confirmed after transport by the receiving physician at the hospital. Misplaced tubes were found in the esophagus in 67% of the patients and 58% of those patients died in the emergency department. 33% of the misplaced tubes were incorrectly positioned in the back of the airway and 33% of those patients
died in the emergency department. Further conclusions by the Katz and Falk found that with proper ETCO2 verification and monitoring of tracheal tube placement, which has routinely been used by some physicians for years, “unrecognized misplaced tracheal tubes can virtually be eliminated.”

In summary, after reviewing over 15 studies on misplaced tracheal tubes, the author determined that there is wide variation to how often tracheal tubes get misplaced. Intubation errors vary widely from area to area and from service to service. It was shown that intubation error rates can be as high as forty percent.

A limitation of the EMS airway literature is that there is no central point of data collection in the EMS industry similar to the fire service model. The National Fire Protection Association (NFPA) has been collecting national fire service data for years. A new national EMS data collecting effort has recently been started with the National Emergency Medical System Information (NEMSIS) project. The NEMSIS project focuses on collecting national EMS data to add to the body of knowledge in pre-hospital medicine. This data will be used in developing nationwide training curriculum, facilitating research efforts, establishing national fee schedules and reimbursement rates, coordinating disaster resources and evaluating domestic preparedness needs in emergency medicine. Currently 48 states support the NEMSIS project.

The next research question analyzes the strategies used by other first responders to ensure dependable airway management. The literature reviewed started with the basic question of what airway strategies are taught during initial paramedic training. What methods does the DOT curriculum recommend to achieve dependable airway management?

Paramedic text books follow DOT curriculum standards and are the basis for paramedic training and education across the country. A widely circulated paramedic text book by Sanders
(2001) recommends that correct intubation should be confirmed by auscultation over the anterior chest and abdomen with a stethoscope confirming lung sounds and lack of air entering the stomach. The level of tube depth at the teeth should be noted and the tube secured with a commercial tube securing device to avoid dislodgement. Tube placement should be reconfirmed again by auscultation over all lung fields. A secondary confirmation method, a mechanical device, should be used as a definitive check of proper placement. Sanders emphasizes revisiting tube placement often to confirm that it continues to stay properly located. Also recommended is monitoring the airway device, at a minimum, every time the patient is moved or their condition changes. Recommended devices for monitoring include the esophageal detector device (EDD), pulse oximeter, and ETCO2 detector.

An EDD is a bulb or syringe type device that attaches to the end of the tracheal tube and works on the principle that the esophagus is a collapsible tube. When a negative vacuum remains in the bulb or syringe after applying suction, the tube is incorrectly positioned in the esophagus and should be removed. If the tube is correctly placed in the trachea the device quickly refills with air from the lungs since the rigid trachea is not collapsible.

Pulse oximeters determine effective patient oxygenation by measuring the transmission of near-infrared light through the arterial beds. These devices calculate oxygen saturation and display the reading on a monitor. Sanders (2001) noted that pulse oximeters are not reliable and may produce false readings and recommend that they should always be used with other monitoring devices.

Two types of ETCO2 detectors are recommended: the colorimetric device and the electronic ETCO2 monitor. The colorimetric device is made of white plastic and contains a chemical indicator paper sensitive to expired ETCO2 gas. Attached to the end of the tracheal
tube, any color change in the chemical paper due to expired ETCO2 gas indicates correct tracheal tube placement and no color change indicates placement in the esophagus. This device is noted to be unreliable in the presence of vomit and ineffective if the patient recently consumed carbonated beverages. In very low cardiac output states, as in cardiac arrest, the colorimetric device is unreliable and may show no color change even when the tube is positioned correctly. The second recommendation, an electronic ETCO2 monitoring device, uses an infrared analyzer to measure the percentage of expired ETCO2 at each phase of respiration. That information is displayed in a waveform on the cardiac monitor. This technology can confirm successful tube placement in seconds, rule out tube dislodgement and has become the *gold standard* to ensure proper tube location after intubation.

A second educational source for airway management strategies is the American Heart Association (AHA), leaders in resuscitation research. Most paramedics are certified by the AHA and follow AHA guidelines in resuscitation. The AHA (2006) recommends a number of strategies to ensure proper tracheal tube placement. AHA recommends confirming proper tracheal tube placement with a physical exam of the patient by watching for equal chest rise, listening for breath sounds over four areas of the chest then listening for absences of sounds over the stomach. The AHA recommends measuring ETCO2 which should be present in the tube if correctly positioned in the airway and confirming tube placement again using an EDD which will eliminate the possibility of placement in the esophagus. They advocate securing the tube with a commercially made device to prevent dislodgement during patient movement. Finally, the AHA emphasizes measuring ETCO2 to ensure proper tube placement and continuous monitoring of the tube for possible dislodgement.
The airway strategy most services follow in the Denver, Colorado area is found in the Denver Metro Protocols (DMP), a uniform set of treatment guidelines (see Appendix A). These protocols, written in the late 1980’s, updated last in 2003, were developed specifically to standardize care for the EMS community in the Denver. They represent a consensus among the Denver area Medical Directors on how medical care should be rendered throughout the region and express a consistent approach to quality patient care.

DMP (2003) requires that all tracheal tubes be confirmed using the colorimetric device or continuous ETCO2 monitoring device, if available. The colorimetric CO2 detector should be used to confirm proper tube placement and an ETCO2 monitor used to determine if the tube has become dislodged during transport. The protocol notes two complications with the colorimetric device. First, when contaminated with blood or secretions the colorimeter detector is ineffective. Secondly, the device may be inaccurate in patients without spontaneous circulation who have stopped breathing, as in cardiac arrest situations.

A very comprehensive and proactive strategy of airway management was instituted by San Diego Fire-Rescue Department (SDFD) in San Diego, California in 2003. SDFD paramedics handle thousands of advanced airway procedures annually. The goal of their policy was to have zero unrecognized esophageal intubations.

Brainard (2006) states that the strategy used by SDFD incorporates an Airway Paramedic, objective confirmation methods to ensure proper tube placement, airway transfer policy, Airway Debriefing Team, realistic training procedures and a consistent quality assurance process that reviews all patient encounters where intubation was attempted.

The role of the Airway Paramedic was established to ensure the airway is appropriately managed at all times throughout the incident. The Airway Paramedic, the person that inserted the
tracheal tube, has direct oversight for airway management throughout the incident and must accompany the patient to the hospital. They may delegate the physical task of ventilating the patient to other providers but they never are relieved of the responsibility of continuously monitoring the tracheal tube and ETCO2 readings.

SDFD uses objective quantitative confirmation data to determine tube placement during each patient encounter where an intubation occurred. The old standard of tube placement confirmation is very subjective: listening to chest and stomach sounds, misting in the tracheal tube and rise and fall of the chest. Direct visualization of the tube going into the trachea and thru the vocal cords is only good until the patient is moved at which time the tube can be dislodged. Brainard (2006) believes that the most reliable source of objective data to ensure proper tracheal tube placement is continuous measurement of ETCO2. Anything less is really a best guess approach due to subjectivity of other confirmation methods. In 2005, six tubes inserted in patients transported by SDFD were declared by the receiving emergency physician as “bad” or misplaced on arrival at the hospital. Objective data from continuous ETCO2 monitoring proved otherwise. After reviewing the ETCO2 values with the receiving emergency physician, it was determined that all tubes were correctly placed by SDFD.

SDFD has instituted an airway transfer policy which encourages receiving physician to confirm tube placement on the paramedic cot instead of after the patient has been moved to the emergency department bed due to the possibility of tube dislodgement. This protects the paramedic from being assigned responsibility of a misplaced tube that may have been dislodged during the transfer from cot to hospital bed.

SDFD developed an Airway Debriefing Team, available day or night by pager, to consult with the Airway Paramedic immediately after the patient is turned over to the emergency
physician or a patient is pronounced dead at the scene. The team collects subjective and objective data points related to the patient’s airway encounter. Suspected misplaced tubes are investigated before the crew returns to duty. Brainard (2006) sites two key elements for the success of the program, honesty and confidentiality. These elements were established from the start of the process to facilitate open dialogue about the events related to managing the patient’s airway. After each debriefing the data is submitted to a central collection point and analyzed for trends. Three frequent trends emerged from the data collection at SDFD: (a) Paramedic’s inability in troubleshooting the ETCO2 monitoring device. The device was often reported to have malfunctioned when it had not. (b) Lack of critical airway equipment left in the ambulance and not immediately available at the patient’s side to begin intubation. (c) The Airway Paramedic neglecting to physically manage the airway device when the patient was being moved. SDFD also changed their training methodology adopting a *practice and test as you play* approach. As much as physically possible, nothing is simulated during resuscitation training. All training is realistic and performed in real time encompassing anything that could be encountered during a real resuscitation effort in someone’s home. Realistic mega-code testing ensures that all paramedics are on top of their game or they are offered skills remediation. SDFD uses a consistent quality assurance process to review every airway control encounter. This approach ensures the right equipment was available at the right time and is being used by highly trained paramedics using objective data to guarantee patients are receiving optimal care when advance airway management measures are in use. In other research Silvestri et al. (2005) found in a study of 248 patients receiving out-of-hospital intubation that the overall incident of misplaced tubes within a regional EMS service was 9%. When the airway strategy included continuous ETCO2 monitoring the rate of
unrecognized misplaced tubes was zero but when the strategy excluded ETCO2 monitoring it was 23%. ETCO2 monitoring is an important part of any airway strategy but paramedics often fail to use the technology despite its reliability and known performance.

To answer the last research question about what strategies are used by hospital physician to reduce the possibility of unrecognized airway placement error two specific physicians groups were investigated. The most intimate group involved in advanced airway placement is anesthesiologists who insert and monitor advanced airways during surgery everyday in the operating room. Anesthesiologists perform the skill in a very controlled environment with patients who are not in emergency need of airway management. They follow practical airway guidelines which are recommendations supported by the analysis of current literature, expert opinion and clinical data. The guidelines recommend a number of strategies to anesthesiologists to reduce the possibility of unrecognized airway placement errors. The second group of physicians involved in intubation is emergency physicians who insert advanced airways in critical medical or trauma patients. No airway management guidelines were discovered for emergency physicians.

The American Society of Anesthesiology (ASA) has specific guidelines to direct anesthesiologists during intubations. The purpose of the guidelines is to reduce the likelihood of adverse patient outcomes associated with airway placement. These guidelines are regularly updated and revised to stay current with best practices and the evolution of new equipment and monitoring technology. The ASA defines difficult airway management as “a clinical situation in which a conventionally trained anesthesiologist experiences difficulty with face mask ventilation of the upper airway, difficulty with tracheal intubation, or both (American Society of Anesthesiologist, 2003)”
The first recommendation is that the clinician reviews the patient’s airway history before performing intubation whenever possible. The purpose of this history review is to detect medical, surgical and anesthetic factors that may indicate airway management problems. A physical airway examination should also be conducted prior to airway management. The purpose of this physical examination is to detect physical characteristics that may indicate the possibility of airway placement problems. The anesthesiologist may then request additional evaluations, diagnostics tests or consults with other physicians from the history and physical findings of the patient.

The ASA recommends that all necessary equipment be readily available prior to airway insertion. One portable storage unit that contains specialized equipment for airway placement and monitoring should include various sizes of rigid laryngoscope blades, tracheal tubes of various sizes, tracheal tube guides to assist in tube placement, non invasive back-up airway devices of various sizes and flexible fiber optic intubation equipment. Equipment suitable for emergency airway access, usually a surgical technique, should also be available. The use of supplemental oxygen before and after airway control is also suggested to reduce related adverse outcomes.

Equipment that detects and monitors expired ETCO2 should be available to assist in recognizing tube dislodgement. Two confirmation tests of successful tracheal intubation are recommended by the ASA. One test should be performed using an EDD and the second test using ETCO2 detection. The ASA believes that the use of these devices “will lead to fewer adverse patient outcomes (American Society of Anesthesiologist, 2003).”

The ASA recommends that a formulated strategy or protocol for intubation should be followed. Their protocol was developed for anesthesiologists in 1992 and is entitled *Difficult*
**Airway Algorithm** (see Figure 1). Their strategy also recommends a plan to remove the tracheal tube if the patient wakes up with the tube in place.

The final recommendation by the ASA is that all airway procedures be well documented. The intent is to guide and facilitate the delivery of future care from the success and failures of past airway encounters. The documentation should include a description of any airway difficulties that were encountered with each tube placement attempt and the various management techniques that were used and what techniques were beneficial or detrimental in managing the patient’s airway.

A second study on airway management from Italy (Italian Society of Anesthesia, Analgesia, Resuscitation and Intensive Care [SIAARTI], 2003) published guidelines and recommendations for airway control strategies in 1998. Their efforts were a multidisciplinary collaboration of various healthcare providers involved in airway management. SIAARTI, while researching literature and data to base their recommendations on, found peculiar aspects of airway management. Difficulties in placing advanced airways are rare and individual to certain patients. Few airway specialists develop enough experience to be considered experts in field of airway management. Rapid development in airway technology may suddenly transform previously recognized devices into old and even dangerous procedures and may introduce new devices that are poorly supported by scientific research. Finally, it’s difficult to get a clear view and precise estimates of airway problems and actual incidents due to the reluctance of airway specialists to report failures and near misses.

The strategy recommends (SIAARTI, 2003) that an anesthetist should personally evaluate each patient for airway management issues in both the elective and urgent settings. The anesthetist should perform multiple evaluations to determine ventilation and intubation...
predictability and select appropriate pharmacological agents to allow a quick return of spontaneous breathing and consciousness in the event of airway control failure. Their strategy emphasizes that patient oxygenation is mandatory and is a priority in advanced airway control measures and should be done before and after each attempt to view the anatomy with a laryngoscope. The airway specialist should not exceed three attempts to place the airway device with the same technique and after three attempts an alternative device or procedure should be used and re-oxygenation should occur often. Once the device is placed, it is mandatory that correct tube position is routinely checked with both chest auscultation and instrumental techniques. SIAARTI strongly recommends that tube confirmation be done using a fiber optic device to view the tracheal rings and the tube location and then monitor for evidence of ETCO2 with repeated readings. If ETCO2 monitoring is not available, the aspiration test should be performed with an EDD. In the event that no airway device can be placed in the emergency setting, the specialist should have adequate knowledge and skill to use a commercially available percutaneous cricothyrotomy device to achieve emergency airway access.

SIAARTI suggests that each airway specialist have adequate knowledge of each procedure they must perform and that simulated manikin training is mandatory with all devices to access proficiency prior to clinical performance. Periodic maintenance and equipment checks are recommended to ensure that all equipment is available and a complete text of airway techniques is available for each airway specialist to review. The airway specialist should completely identify and monitor all useful indicators of airway management to allow for continuous quality improvement and risk management. In 2005, SIAARTI published a *Difficult Airway Algorithm* for the adult patient (see Figure 2).
Surprisingly, few studies were located during an extensive literature search for airway strategies used by emergency physicians in the emergency department. No actual protocols, procedures or strategies were discovered.

Nolan and Clancy (2002) published a study titled *Airway Management in the Emergency Department* which appeared in journals in United States of America (USA) and United Kingdom (UK). This research addressed the controversy of whether emergency physicians should even be performing advanced airway management in the emergency department or should the skill be left to the more experienced anesthetist who performs the skill every day in the operating room. The premise of this study is that whatever specialty group chooses to perform the skill they must have the competencies to ensure safe airway management.

A study that Graham (2003) published in the USA found that emergency residents or attending physicians insert tracheal tubes in the emergency department 93% of the time. This skill is often performed using an anesthetic or neuromuscular blocking drug that paralyzes the patient’s ability to spontaneously breathe on their own. This procedure is referred to as rapid sequence intubation or rapid sequence induction (RSI). Emergency physicians perceive airway management to be a core skill in resuscitating critically ill patients but few in the USA supplement their initial training with any advanced airway training courses. In the UK, emergency physicians have supplemented their training with three months of further advanced airway training. To maintain skills competency over one’s career Graham (2004) recommended that a refresher course be taken by physicians. Two such courses are the National Emergency Airway Management Course and the Scottish Airway and Ventilation Emergency (SAVE) Course. All intubations performed in the UK by emergency physicians are audited continuously.
to provide data to show that airway training is effective in maintaining skill competency and to give some indication as to the level of intubation activity required to maintain the skill.

The controversy over who should provide intubation to a critically ill patient in the emergency department continues to be a topic of discussion between emergency physicians and anesthetists. Graham (2004) mentioned that anesthetists are concerned that they are “expected to pick-up the longer-term consequences of the emergency physician’s actions, despite having no part in the initial decision to induce anesthesia and intubate the patient.” Anesthetist, both in the USA and UK, follow very specific airway management guidelines whereas the literature search revealed that most emergency physicians do not.

One final study (DeIorio, 2005) on airway management and emergency physicians in the USA centered on the availability and use of colorimetric qualitative carbon dioxide (CO2) detection device and quantitative ETCO2 monitoring device. The quantitative ETCO2 monitoring device is considered by anesthetists to be the gold standard for verifying tracheal tube placement and an objective method to avoid misplaced tubes. The respondents to the study’s survey noted that the colorimetric CO2 detection device exists in most hospitals while continuous ETCO2 monitoring capabilities only exist in 25% of hospitals. Only 14% of the physicians that have continuous ETCO2 monitoring say they “always” use it and 57% say they “rarely” or “never” employ it to confirm tube placement.

In summary, many national organizations recommend and endorse the use of continuous ETCO2 monitoring to confirm tracheal tube placement. This study shows that in emergency departments across the country this technology is neither widely available nor consistently applied by emergency physicians.
Procedures

Four different procedures are utilized to answer the three research questions. Those procedures include a retrospective analysis of 2006 intubation data for LFR, prospective observational airway skills assessment, first responder’s survey and emergency physician’s survey.

The first procedure involves a retrospective examination of LFR advanced airway activity during 2006. Each patient experiencing airway intubation will be identified by the incident number of their patient care report. The reports will be extracted from the electronic records management system and examined for the nature of incident, type of intubation (oral or nasal), success or failure of intubation, number of attempts, tube placement verification method, patient transport or scene pronouncement and unrecognized tube misplacement. Data will be entered into a spreadsheet during June, 2007 for evaluation.

The second procedure is an observational evaluation of LFR paramedic performance in airway intubation. The airway skills assessment is designed to observe how often LFR paramedics misplace tracheal tubes and do not recognize their error. Each paramedic will intubate an infant, child and adult manikin just as they would during an actual incident. Hall et al. (2005) found that paramedic students who trained with manikin simulation are as effective in intubation as those that trained on human subjects. This simulation is designed to examine successful intubation on first attempt, intubation attempts lasting over 30 seconds, correct tube size, recognizing misplaced tubes by listening, identifying misplaced tubes using the colorimetric device and using waveform capnography. The skills assessment will be completed on three different shift days, June 12, 18 and 28, 2007. All paramedics on duty will be tested and the results were entered into a spreadsheet for analysis.
The third procedure is to develop a survey for first responders. The purpose of the survey is to determine how often tracheal tubes are reported to be misplaced and what airway strategies are used to prevent these mistakes. The survey will be distributed using Survey Monkey, an Internet company specializing in survey development and distribution. A sample size of 100 first responder services from across the country from multiple disciplines is the goal. Those disciplines include fire based EMS, private ambulance services, city ambulance services, county ambulance services, hospital based services and air medical transport services. The distribution lists are exclusive to students from the National Fire Academy who also represents medical services from around the country. The survey will also be distributed in Colorado. The surveys will be distributed via email link in two batches. The first group of 70 surveys will be emailed on May 27, 2007 and a second group of 60 surveys will be emailed on June 10, 2007. The first responder survey requests information on EMS demographics, intubation statistics, unrecognized tubes, poor patient outcomes, litigation resulting from airway mistakes, airway equipment, non invasive airway devices, ETCO2 monitoring devices, training and airway strategies (see Appendix B). The respondents are requested to email a copy of their policy or procedure to the author if available. The survey will be open for data collection for 30 days. All results are collected anonymously through the internet site and the data will be entered into a spreadsheet for analysis.

The last procedure is to develop a second survey for emergency physicians. The author decided to survey only emergency physicians since the literature search revealed that anesthesiologist have had a defined airway strategy in place for years. Only Colorado physicians will be surveyed since access to email addresses of physicians outside of Colorado is very limited and might restrict the sample size. A sample size of 40 emergency physicians from
around Colorado is the goal. The physicians will be asked to answer questions about paramedics arriving in the emergency department with unrecognized misplaced tracheal tubes in place, frequency of tube placement errors, how did they confirm the error, did the error lead to a poor patient outcome, how do emergency physicians confirm correct tube placement, what ETCO2 detection devices do they use, remedial airway training, quality assurance and airway strategies (see Appendix C). The survey will be distributed in June, 2007 using Survey Monkey and will be open for data collection for 30 days. All results will be collected anonymously through the internet site and the data will be put into a spreadsheet for analysis.

Results

The first research procedure is a retrospective paramedic chart analysis of intubation data. The data showed how often tracheal tubes were misplaced at LFR in 2006 and what effect it had on patient outcome. Specific data points were established to discover how many oral and nasal tubes were successfully or unsuccessfully inserted, number of intubation attempts, what methods were used to confirm correct tube placement and what methods were used to monitor the tube (see Appendix D).

Results showed that there were 11,798 total incident responses for LFR in 2006 with EMS incidents accounting for 69% of the total call volume. One percent of the EMS incidents required intubation. There were 71 chances for paramedics to insert an oral tracheal tube and it took 108 attempts to correctly place 58 tubes. The success rate for oral tube placement was 81% with a failure rate of 19%. Of the failed attempts 31% of the patients were declared dead at the scene and 69% were transported to the hospital while being ventilated using basic life support measures. One oral tracheal tube was reported to have been dislodged during transport and removed. One tube was misplaced and the error went unrecognized until the patient arrived in
the emergency department. One tube was noted to have been misplaced by the county coroner after receiving the patient’s body. There were 17 chances to place nasal tracheal tubes. It took 19 attempts to correctly place 14 nasal tracheal tubes. The success rate for nasal tracheal tube placement was 82% and the failure rate was 18%. One nasal tracheal tube was reported to have been dislodged during transport and removed. It was discovered on arrival at the emergency department that one nasal tracheal tube was misplaced and the error went unrecognized. The patient survived the event attributed mostly to his ability to spontaneously breathe around the misplaced tube. Only 27% of all the intubation were verified and monitored using waveform capnography.

The second research method, an airway skills assessment, provided a concurrent view of airway placement at LFR (see Appendix E). It was observed that 73% of the paramedics correctly intubated the infant manikin on the first attempt, child manikin 71% of the time on the first attempt and 85% on the first attempt in the adult manikin. Multiple attempts were required 23% of the time to place the tracheal tube correctly. One tube was misplaced in the infant manikin and the error went unrecognized. Identifying correctly from incorrectly placed tubes the results indicated that 80% of LFR paramedics could identify improperly placed tracheal tubes using chest sounds and 93% of the paramedics could identify a misplaced tube using waveform capnography. Only 29% of the paramedics could identify a misplaced tube using the colorimetric CO2 detection device.

The third research method is the first responder’s survey (see Appendix F). 130 surveys were sent to services around the country yielding a 68% survey return rate (N-89). Surveys produced results from 28 states. 78% of the surveys were returned from fire based EMS services with other disciplines accounting for fewer than 4% respectively. The highest volume of EMS
incidents for any one service was 82,000 in 2006 and the lowest was 58 incidents. One service indicated they had 1,800 successful intubations in one year and 13% responded that they do not track successful intubation statistics. Another service responded that they had 1,600 unsuccessful intubations in one year and 14% of the services do not track unsuccessful intubation statistics.

28% of the services reported that they had delivered a patient to the emergency room with an unrecognized misplaced tracheal tube in place and 3% said that an unrecognized misplaced tracheal tube had led to litigation against their service from a poor patient outcome.

95% reported that the primary methods of tube confirmation used is seeing the tube pass through the vocal cords, 98% also listen for proper chest sounds, 81% look for chest expansions, 65% look for improvements in oxygen saturation and 41% reported using an EDD. For tube confirmation and monitoring, 71% of the services use waveform capnography, 56% use the colorimetric CO2 detector while 32% use a capnometer. The Combitube is used as a non invasive back-up airway by 59% of the services and 22% use the LMA. 35% of the services use surgical cricothyrotomy for emergency airway access while 56% employ needle cricothyrotomy.

Airway training and skills retention by paramedics are paramount to successful outcomes when inserting advanced airways. 67% of the services do not require a minimum number of successful intubations annually. 79% do have an annual airway skills competency test to evaluate skills retention. 64% of the respondents follow a formal protocol or procedure to ensure that tracheal tubes are properly placed and monitored at all times. The respondents submitted 11 airway protocols to the author for review.

A second survey was sent to emergency physicians practicing in Denver area hospitals (see Appendix G). 80 surveys were emailed yielding an 81% survey return rate (N-65). 85% of the physicians responded they had witnessed a paramedic bring a patient into the emergency
department with an unrecognized misplaced tracheal tube. 68% noted the frequency of this error to be one or two misplaced tubes a year. 19% said they see three to five misplaced tubes annually. In the opinion of 74% of the physicians, a misplaced tracheal tube has led to a poor patient outcome. Only 25% of the physicians use ETCO2 detection, 51% use oxygen saturation and only 8% have fiber optic intubation equipment available to confirm tube placement. To monitor the tube during patient care 95% of the emergency physicians use the colorimetric CO2 detector. 95% of the physicians report using the LMA for a non-invasive back-up airway device and 66% use surgical cricothyrotomy as an emergency technique to gain airway access.

80% of emergency physicians responded that they have no formal policy or procedure to follow when performing airway management and 94% never had any remedial airway training. Surprisingly, 80% reported that there was no quality assurance process that reviews each intubation case.

The results answer and support the first research question that tracheal tubes do get misplaced and the error goes unrecognized. The review of 2006 intubation data for LFR found that two tubes were confirmed to be misplaced and the error went unrecognized by the paramedic. Another tracheal tube was reported to be misplaced by the county coroner but may have been dislodged when transporting the patient’s body. During the airway skills assessment it was observed that a paramedic did misplace a tracheal tube in the infant manikin and not recognize their mistake. Both surveys support that these clinical errors do occur and may in fact lead to poor patient outcomes even though the frequency of the mistake is relatively small.

The results answer the second research question that 64% of the first responders do have an airway strategy or follow a defined protocol or procedure to ensure proper tracheal tube placement and monitoring. 25% of the services have no strategy. ETCO2 monitoring with
waveform capnography is used in 71% of the services to monitor tube placement. The Combitube is the preferred non-invasive back-up airway device. Needle cricothyrotomy is used for emergency airway access by 56% of the services.

The results of the literature review and the physician’s survey answer what strategies hospital physicians use to ensure reliable airway control. The literature review revealed that anesthesiologist, both in the USA and Italy, have had a defined airway management strategy for years but 80% of the emergency physicians surveyed indicated that they do not have a written policy or procedure that they follow. Emergency physicians typically do not have ETCO2 monitoring technology available and when it is available it is not widely used in the emergency department. The survey indicated 95% of the physicians use the CO2 colorimetric detection device to confirm tube placement while only 26% have electronic ETCO2 monitoring capabilities. 95% use the LMA as a non-invasive back-up airway device and 63% use surgical cricothyrotomy for emergency airway access situations. It was revealed that 94% of the emergency physicians are never required to have any remedial airway training. 80% indicate that there was no formal quality assurance process in place to review every intubation case.

Discussion

The literature search and applied research support that tracheal tubes inserted by paramedics do get misplaced and the errors go unrecognized and these mistakes do lead to poor patient outcomes. As demonstrated by the results, LFR does not face this problem alone. Some services reported very low rates of intubation error while at other services the mistakes are numerous and costly. Emergency physicians and paramedics both acknowledged that they know these potentially deadly errors continue to occur in low frequency but most services do not have a comprehensive airway strategy to reduce the small number of intubation errors that occur.
Colwell et al. (2005) found “reasonable success and complication rates of endotracheal intubations in the out-of-hospital setting can be achieved in a busy urban EMS system without medication.” But even in Colwell’s study, “reasonable success and complication rates” still produce misplaced tracheal tubes in real patients which may lead to injury and even death. Wang et al. (2006) thought that “in the spirit of “first do not harm,” we might consider not intubating at all.” However, and the author agrees, “this strategy challenges the long-standing but unsubstantiated belief in the United States that ETI is the optimum method for airway management.” Any airway strategy adopted by LFR must be designed to ensure that intubation mistakes, which will happen, are immediately recognized and any risk of harm to the patient is eliminated. The author agrees with Brainard (2006) that since many paramedics have never had a “bad” tube, getting them to adopt a new airway management strategy becomes more of a cultural change that may be difficult for some paramedics to adapt to.

The author has interpreted the results to indicate that a misplaced tracheal tube can happen in any EMS service and if unrecognized will lead to a bad outcome for the patient. Although tracheal intubation is widely used by paramedics, failure during tube insertion is common and often goes unrecognized. The author supports Brainard’s goal: zero unrecognized esophageal intubation. “It’s acceptable to miss the intubation, but it’s not acceptable to fail to recognize that you missed.”

The research shows that most services do have an advanced airway strategy, protocol or plan to follow when intubation is required however the literature search found that of the most strategies were very basic. These strategies are often not inclusive enough to provide good directions and support to the paramedic performing the skill. A comprehensive airway strategy
must include all the necessary components to reduce unrecognized airway mistakes. Brainard (2006) found that:

We had all the necessary diagnostic tools and data available to us to ensure continual monitoring, care and documentation of our airway management, but we needed to formalize our approach more and provide a means of backing up our EMS providers in the event of a complication or allegations that proper care was not rendered (p.64).

As demonstrated by this research, most paramedics do have the equipment, training and a very basic airway management strategy, but like LFR, it has fallen short of eliminating clinical errors.

This research supports what Silvestri et al. (2005) found: most paramedics rely on subjective evaluations for tube placement confirmation and these have shown to be unreliable and inaccurate. The author interprets the literature to support that any new airway strategy or standard operating procedure must include non subjective tube confirmation techniques. Objective information includes the use of EDD or quantitative ETCO2 detection, either waveform capnography or capnometric device. “As a system manager, you can’t afford not to use capnography. As a paramedic, you can’t justify not using a device that lets you have 100% certainty that you are doing no harm (Brainard, 2006).”

The research found that strategies for airway management in the hospital arena were developed by anesthesiologist and that most emergency physicians have no standardized protocol that they follow. The ASA and SIAARTI both agree that some form of airway management strategy or guideline is necessary to “facilitate the management of the difficult airway and reduce the likelihood of adverse outcomes (ASA, 2003).” The author interprets the results to show that their strategies are similar and have the same goal: reduce the likelihood of adverse patient outcomes. Any comprehensive airway strategy should address the evaluation of
the patient’s history, physical examination, need for specialized airway equipment, pre-
formulated strategies for intubation and extubation, documentation of airway success and failure, training and quality assurance.

It is surprising to the author, as demonstrated by the results of the literature search and survey, that emergency physicians have not formalized an airway management strategy for the emergency department. The research results suggest that most emergency physicians don’t have waveform capnography available to properly determine tracheal tube placement and when they do it is not widely used as the standard of care (Delorio, 2005).

There are limitations that should be note with this research study. It is assumed that every misplaced tracheal tube causes poor patient outcomes. This assumption is difficult to measure since some patients may have died anyway even if the tracheal tube was not misplaced. Electronic ETCO2 monitoring with waveform capnography is still relatively new. Many services and hospitals may be financially unable to include this technology in their airway strategy. Emergency physicians are assisted by respiratory therapists on tracheal intubations in the emergency department. Respiratory therapists are often responsible for tracheal tube monitoring. This may have directly affected the responses by the emergency physician to the physician’s survey. Respiratory therapists should also be surveyed on airway management in the emergency department.

The organizational implication of this APR will change the standard of care delivered by LFR paramedics to patients receiving advanced airway management. Recommendations will benefit patients by reducing the possibility of misplaced tracheal tubes. A new comprehensive airway management strategy and standard operating procedure will give added support and direction to LFR paramedics as they perform this intricate skill.
Recommendations to improve the standard of care have resulted from this research. These recommendations are based on this ARP and the findings of other researchers. As a result of this study it was discovered that the current advanced airway strategy at LFR is inadequate and can be improved to provide better support and direction for paramedics. Combes et al. (2006) concluded that “when prehospital airway management is standardized, failure to intubate is a rare occurrence and the incident of a difficult tracheal intubation is low.” It was discovered that ETCO2 monitoring equipment needed to ensure proper tracheal tube placement and continuous monitoring is not always available to LFR paramedics. The colorimetric CO2 detection device used on LFR intubations is known to give inaccurate information about tracheal tube location and should not be used. It was revealed that the airway training methodology currently practiced is deficient and an airway skills assessment tool is lacking. Also uncovered was the quality assurance process to retrospectively analyze each airway case was vague, unfocused and not comprehensive. As a result of this research a number of recommendations to improve the standard of care when using advanced are being suggested.

Recommendations

The first recommendation is that LFR develop and adopt a new advanced airway strategy. The strategy starts with a new SOP that is more comprehensive and detailed then the current Denver Metro Protocols which LFR paramedics currently follow. This SOP will outline indications for advanced airway use, contraindications, detailed procedures for tube insertion and removal, tube monitoring requirements, paramedic responsibilities, required documentation, transfer of care and the quality assurance process that will follow each advanced airway use. This SOP is a mixture of best practices discovered through current literature, strategies of other EMS services and recommendations of hospital physicians. The SOP will be submitted to the Medical
Director for final approval after a 10 day review and comment period by LFR paramedics. The SOP should be implemented immediately after the final approve from the Medical Director. The organizational benefits from this new strategy will be enhanced support and direction for paramedics, improved standards for patient care, elimination of unrecognized misplaced tracheal tubes and reduction in personal and organizational liability. A draft of the new protocol is found in Appendix H.

The second recommendation focuses on medical equipment. Currently ETCO2 monitoring with waveform capnography, the gold standard for confirming tracheal tube placement, is only available on cardiac monitors located on transport units, not engine company cardiac monitors. This can cause significant delay in confirming tube placement using waveform capnography when the engine company arrives before a transport unit. All cardiac monitors must have waveform capnography available immediately on insertion of a tracheal tube. A capital purchase request for capnography upgrades to cardiac monitors on all engine companies has been submitted for the 2008 budget. The colorimetric CO2 detection device, which the literature states are often unreliable, should be removed from use and replaced with the EDD. Fiber optic laryngoscope technology, new in the prehospital environment, should be explored by a research and development committee along with needle cricothyrotomy devices. LFR currently uses surgical cricothyrotomy for emergency airway access which is a difficult procedure to perform in the prehospital environment. All airway equipment should be consolidated into one difficult airway bag. Airway equipment is currently spread out in three different medical bags and may not be available when the immediate need arises. The organizational benefits of these budgetary expenses will guarantee that LFR paramedic will have the latest technology available for airway management and monitoring and will improve the standard of care by reducing clinical errors.
A third recommendation is to provide annual airway management training for LFR paramedics using a combination of classroom didactics, instructional airway video and airway simulation manikins. Each paramedic will demonstrate their intubation skills and knowledge of the new airway management SOP annually. Airway training will be added to next year’s 2008 EMS training schedule. Each paramedic will directly benefit from instituting airway skills refresher training and this will give them added confidence in their airway skills even if they don’t intubate on a regular basis. The training will simulate real situation and LFR will adopt a “train as you fight” methodology.

The fourth recommendation is that all tracheal intubation attempts will be reviewed by the Quality Assurance Officer within 24 hours of their occurrence. An advanced airway encounter card will collect vital information about the event and be submitted to the Quality Assurance Officer for analysis. The emergency physician who confirms correct tube placement will sign off on the airway encounter card to confirm that the tube is positioned correctly on arrival at the emergency department. LFR will form an Airway Debriefing Team that will respond to the hospital to support LFR paramedics if any allegation of a misplaced tracheal tube occurs. These recommendations should be implemented immediately after the implementation of the SOP and will benefit LFR paramedic by giving them added administrative support and quicker feedback on their airway management performance.

These recommendations will significantly improve the standard of care when advanced airway devices are deployed. After instituting these changes a retrospective review of airway intubation data should occur every three months to evaluate these operational improvements and determine if they have improved the standard of care and patient outcome. The paramedic staff should also be surveyed at the end of one year to get their feedback on the new changes.
In conclusion, researchers may wish to perform a similar assessment of their service’s airway strategy to improve the standard of care and patient outcome using the information contained in this APR. The author hopes that the new comprehensive airway SOP presented in this ARP will be a model for others to use to improve the standard of care in EMS. Finally, the author encourages other fire and EMS professional to aggressively pursue research and become well educated in issues that affect our patient’s health and welfare. The future of the fire service is now deeply involved with EMS. Fire and EMS service across the country should support the national EMS data collection effort through the NEMSIS project to facilitate further research efforts in EMS to benefit our patients and our profession.
References


*Annals of Emergency Medicine, 47*(6), 532-541.
Appendix A

Denver Metro Protocol

ADVANCED AIRWAY MANAGEMENT

OROTRACHEAL INTUBATION

Indications

In most cases orotracheal intubation provides definitive control of the airway. Its purposes include:

A. Actively ventilating the patient
B. Delivering high concentrations of oxygen
C. Suctioning secretions and maintaining airway patency
D. Preventing aspiration of gastric contents, upper airway secretions, or bleeding
E. Preventing gastric distention due to assisted ventilation
F. Administering positive pressure when extra fluid is present in alveoli
G. Administering drugs during resuscitation for absorption through the lungs
H. Allowing more effective CPR

Precautions

A. Do not use intubation as the initial method of managing the airway in an arrest. Oxygenation prior to intubation should be accomplished with pocket mask or BVM as needed.
B. Appropriate intubation precautions should be taken in the trauma patient. Nasotracheal intubation is preferred in the breathing patient. Oral intubation with in-line cervical immobilization is the best alternative for a trauma patient requiring definitive airway control.
C. Never lever the laryngoscope against the teeth. The jaw should be lifted with direct upward traction by the laryngoscope.
D. Prepare suction beforehand. Vomiting is particularly common when the esophagus is intubated.
E. Intubation should take no more than 15-20 sec to complete: do not lose track of time. If visualization is difficult, stop and re-ventilate before trying again.
F. Orotracheal intubation can be accomplished in trauma victims if an assistant maintains stabilization and keeps the neck in neutral position. Careful visualization with the laryngoscope is needed, and McGill forceps may be helpful in guiding the ET tube.

Technique

A. Use BSI including gloves, mask, eye protection. Assemble the equipment while continuing ventilation:
   1. Choose tube size (see table on next page). Use as large a tube as possible.
   2. Introduce the stylette and be sure it stops ½” short of the tube’s end
   3. Assemble laryngoscope and check light.
   4. Connect and check suction.
B. Position patient: neck flexed forward, head extended back. Back of head should be level with or higher than back of shoulders.
C. Give a minimum of 4 good ventilations before starting procedure.
D. Have an assistant apply gentle cricothyroid pressure to prevent aspiration and to assist in visualization of vocal cords.
E. **Gently** insert laryngoscope to right of midline. Move it to midline, pushing tongue to left and out of view.

F. Lift straight up on blade (no levering) to expose posterior pharynx.

G. Identify epiglottis: tip of curved blade should sit in vallecula (in front of epiglottis); straight blade should slip over epiglottis.

H. With gentle further traction to straighten the airway, identify trachea from arytenoid cartilages and vocal cords.

I. Insert tube from right side of mouth, along blade into trachea under direct vision.

J. Advance tube so cuff is 1-1.5“ beyond cords. Inflate cuff with 5-10 ml of air, clamp if necessary to secure against leaks. Positioning the ET tube so that the 19 cm mark (females) or 21 cm mark (males) is at the teeth will help to avoid endobronchial intubation.

K. Ventilate and watch for chest rise. Listen for breath sounds over stomach (should not be heard) and lungs and axillae.

L. Note proper tube position and secure tube with tape or ties.

M. Re-auscultate over stomach and both sides of chest whenever patient is moved.

N. Tube placement should also be evaluated by other devices such as an end-tidal CO2 detector.

O. Accurate documentation includes indications for intubation as well as measures taken for tube verification.

**Complications**

A. Esophageal intubation: particularly common when tube not visualized as it passes through cords. The greatest danger is in not recognizing the error. Auscultation over stomach during trial ventilations should reveal air gurgling through gastric contents with esophageal placement. Also make sure patient’s color improves as it should when ventilating.

B. Intubation of right mainstem bronchus: be sure to listen to chest bilaterally.

C. Upper airway trauma due to excess force with laryngoscope or to traumatic tube placement.

D. Vomiting and aspiration during traumatic intubation or intubation of patient with intact gag reflex.

E. Hypoxia due to prolonged intubation attempt.

F. Cervical spine fracture in patients with arthritis and poor cervical mobility.

G. Cervical cord damage in trauma victims with unrecognized spine injury.

H. Ventricular arrhythmias or fibrillation in hypothermia patients from stimulation of airway.

I. Induction of pneumothorax, either from traumatic insertion, forceful bagging, or aggravation of underlying pneumothorax.

<table>
<thead>
<tr>
<th>OROTRACHEAL TUBE SIZE</th>
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<tbody>
<tr>
<td><strong>AGE</strong></td>
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<tr>
<td>Preemie</td>
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<tr>
<td>Newborn</td>
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<tr>
<td>6 mos.</td>
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<td>18 mos.</td>
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<td>3 yrs.</td>
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<tr>
<td>15 yrs.</td>
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<tr>
<td>Adult</td>
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Appendix B

1. What state is your EMS service in? Please type full state name.

2. What type of EMS service is your agency?
   - Fire based service
   - Private ambulance service
   - City ambulance service
   - County ambulance service
   - Hospital based ambulance service
   - Air ambulance service
   - Other (please specify)

3. How many EMS calls did your agency run in 2006?
   - My agency does not track these statistics
   - I don't know this information
   - Number of EMS calls in 2006

4. My EMS service uses advanced life support airway control methods
   (Endotracheal intubation).
   - Yes
   - No (if your answer is no, the survey ends after the next page)

5. At my EMS service, endotracheal intubation can be performed in the
   following age groups. (Select all that apply)
   - Infants
   - Pediatric
   - Adult

6. In 2006, how many successful intubations (oral or nasal) did your service
   document?
   - My agency does not track these statistics
   - I don't know this information
   - Number of successful intubations

7. In 2006, how many unsuccessful intubations (oral or nasal) did your service
   document?
   - My agency does not track these statistics
   - I don't know this information
   - Number of unsuccessful intubations

8. Has your service ever documented a case where a patient was delivered to
   the emergency room with a unrecognized misplaced endotracheal tube?
   - Yes
   - No
9. Has your EMS service ever been sued because a misplaced tracheal tube resulted in a poor patient outcome?
   Yes
   No
   Unknown

10. Does your service require annual skills competency testing for each paramedic on their ability to intubate infants, children and adults?
    Yes
    No

11. Does your service require each paramedic to perform a specific number of successful intubations annually?
    No
    Yes (if yes, how many?)
    # of Required Intubations Annually

12. What primary tube confirmation method does your service use to ensure proper tracheal tube placement at the time of insertion? (check all that apply)
    See the tube passing through the cords
    5-point auscultation, hearing proper sounds
    See the chest expand with each ventilation
    Noted improvement in the level of oxygen saturation
    See vapor condense in the tube with ventilations
    Esophageal detector device - bulb or syringe plunger device that will not expand or pull outward if in the tracheal tube is in the esophagus

13. What secondary tube confirmation method does your service use to ensure proper tube placement during patient care and transport? (check all that apply)
    Only primary methods are used
    Colorimetric end-tidal CO2 detector (changes color)
    Capnometers - digitally displays a single numeric value for highest amount of expired CO2
    Capnographic waveform - continuous waveform displays of the amount of expired CO2
    Other (please specify)

14. In the event an EMS provider cannot successfully insert a tracheal tube, what back-up devices are available for their use to gain airway control? (check all that apply)
    There is no back-up device available
    ETC - Esophageal Tracheal Combitube Airway
    LMA - Laryngeal Mask Airway
    PtL - Pharyngo-Tracheal Lumen Airway
    EOA - Esophageal Obturator Airway
    EGTA - Esophageal Gastric Tube Airway
King Airway System
Surgical Cricothyrotomy
Needle Cricothyrotomy

15. Does your agency have a written protocol or policy to ensure that all endotracheal tube placements are confirmed and monitored at all times during the patient's care and transport?
   Yes (if yes, please email me a copy at wzygowicz@littletongov.org)
   No
Appendix C

1. I am an emergency physician who works in the emergency room?
   Yes
   No

2. Have you ever witnessed a paramedic crew bring a patient into the ER with an unrecognized misplaced endotracheal tube?
   Yes
   No

3. How did you verify that the endotracheal tube was misplaced? (Check all that apply)
   Absent chest expansion while ventilating
   Absent breath sounds while ventilating
   Visualize tube location
   Low oxygen saturation
   Capnography

4. In your opinion, has an unrecognized, misplaced tracheal tube inserted by an EMS provider ever lead to an adverse patient outcome?
   Yes
   No

5. Please estimate how often you see a unrecognized misplaced tracheal tube inserted by EMS arrive undetected in the emergency room in a one year period?
   I have never seen this happen
   1-2
   3-5
   5-7
   7-10
   10-15
   More then 15 times in a year

6. What primary tube confirmation method do you use in the emergency room to ensure proper tracheal tube placement at the time of insertion? (check all that apply)
   See the tube passing through the cords
   5-point auscultation, hearing breath sounds
   See the chest expand with each ventilation
   Noted improvement in the level of oxygen saturation
   See vapor condense in the tube with ventilations
   Esophageal detector device - bulb or syringe plunger device that will not expand or pull outward if the tracheal tube is in the esophagus
   Fiber-optic intubation device
7. What secondary tube confirmation method is used in your emergency room to monitor tube placement during patient care? (check all that apply)
   - Colorimetric end-tidal CO2 detector (changes color)
   - Capnometer - digitally displays a single numeric value of highest amount of expired CO2
   - Capnographic waveform - continuous waveform displays the amount of expired CO2
   - Other (please specify)

8. In the event that you cannot successfully insert a tracheal tube, what backup device or procedure do you use to gain airway control? (check all that apply)
   - ETC - Esophageal Tracheal Combitube Airway
   - LMA - Laryngeal Mask Airway
   - PtL - Pharyngeal-Tracheal Lumen Airway
   - EOA - Esophageal Obturator Airway
   - EGTA - Esophageal Gastric Tube Airway
   - King Airway System
   - Surgical Cricothyrotomy
   - Needle Cricothyrotomy

9. Is there a written policy or procedure that you follow to ensure that all endotracheal tube placements are confirmed and monitored at all times during patient care. (if yes, could you please email me a copy at wzygowicz@littletongov.org)
   - Yes
   - No
   - Other (please specify)

10. Is there a minimum number of successful intubations that you are required to do in a defined time period?
    - Yes
    - No

11. Are you ever required to do remedial airway training if you have not intubated enough patients in the defined time period?
    - Yes
    - No

12. Is there a quality assurance process that reviews each intubation case?
    - Yes
    - No
## Appendix D

<table>
<thead>
<tr>
<th>Total Incidents in 2006</th>
<th>11,798</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total EMS Incidents 2006</td>
<td>8,143 (69%)</td>
</tr>
<tr>
<td>Total Intubations 2006</td>
<td>88 (1%)</td>
</tr>
</tbody>
</table>

### 2006 Intubation Statistics

<table>
<thead>
<tr>
<th></th>
<th>Oral intubation</th>
<th>Nasal Intubation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total intubations</td>
<td>71</td>
<td>17</td>
<td>88</td>
</tr>
<tr>
<td>Trauma in nature</td>
<td>7</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Medical in nature</td>
<td>64</td>
<td>15</td>
<td>79</td>
</tr>
<tr>
<td># of attempts</td>
<td>108</td>
<td>19</td>
<td>127</td>
</tr>
<tr>
<td>Successful intubations</td>
<td>58</td>
<td>14</td>
<td>72</td>
</tr>
<tr>
<td>Not successful</td>
<td>13</td>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td>Visualization of tube thru cords</td>
<td>20</td>
<td>N/A</td>
<td>20</td>
</tr>
<tr>
<td>Breath sounds X4</td>
<td>42</td>
<td>8</td>
<td>50</td>
</tr>
<tr>
<td>Chest rise</td>
<td>16</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>Tube misting</td>
<td>19</td>
<td>6</td>
<td>25</td>
</tr>
<tr>
<td>Colorimetric CO2 detection</td>
<td>21</td>
<td>5</td>
<td>26</td>
</tr>
<tr>
<td>Capnography</td>
<td>19</td>
<td>5</td>
<td>24</td>
</tr>
<tr>
<td>Pulse Ox</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Patient transported to hospital</td>
<td>44</td>
<td>17</td>
<td>61</td>
</tr>
<tr>
<td>Pronounced at scene, no transport</td>
<td>27</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>Misplaced tracheal tube</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Dislodged tube during transport</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
Appendix E

Table E1
1. The paramedic was able to intubate the infant manikin?

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Misplaced the tube</td>
<td>2.40%</td>
</tr>
<tr>
<td>First attempt</td>
<td>73.20%</td>
</tr>
<tr>
<td>Second attempt</td>
<td>17.10%</td>
</tr>
<tr>
<td>Third attempt</td>
<td>4.90%</td>
</tr>
<tr>
<td>Fourth attempt</td>
<td>2.40%</td>
</tr>
</tbody>
</table>

Table E2
2. The paramedic was able to intubate the child manikin?

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Misplaced the tube</td>
<td>0.00%</td>
</tr>
<tr>
<td>First attempt</td>
<td>70.70%</td>
</tr>
<tr>
<td>Second attempt</td>
<td>19.50%</td>
</tr>
<tr>
<td>Third attempt</td>
<td>4.90%</td>
</tr>
<tr>
<td>Fourth attempt</td>
<td>4.90%</td>
</tr>
</tbody>
</table>

Table E3
3. The paramedic was able to intubation the adult manikin?

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Misplaced the tube</td>
<td>0.00%</td>
</tr>
<tr>
<td>First attempt</td>
<td>85.40%</td>
</tr>
<tr>
<td>Second attempt</td>
<td>12.20%</td>
</tr>
<tr>
<td>Third attempt</td>
<td>2.40%</td>
</tr>
<tr>
<td>Fourth attempt</td>
<td>0.00%</td>
</tr>
</tbody>
</table>

Table E4
4. The paramedic selected the proper tube size for the infant?

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>85.40%</td>
</tr>
<tr>
<td>No</td>
<td>14.60%</td>
</tr>
</tbody>
</table>
### Table E5

6. The paramedic selected the proper tube size for the adult?

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>95.10%</td>
</tr>
<tr>
<td>No</td>
<td>4.90%</td>
</tr>
</tbody>
</table>

### Table E6

7. The paramedic could identify a misplaced tube using primary confirmation methods? (Visual, breath sounds)

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>80.50%</td>
</tr>
<tr>
<td>No</td>
<td>19.50%</td>
</tr>
</tbody>
</table>

### Table E7

8. The paramedic could identify a misplaced tube using the colorimetric device?

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>29.30%</td>
</tr>
<tr>
<td>No</td>
<td>70.70%</td>
</tr>
</tbody>
</table>

### Table E8

9. The paramedic could identify a misplaced tube using capnography?

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>92.70%</td>
</tr>
<tr>
<td>No</td>
<td>7.30%</td>
</tr>
</tbody>
</table>
### Table F1

**What type of EMS service is your agency?**

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire based service</td>
<td>78.70%</td>
</tr>
<tr>
<td>Private ambulance service</td>
<td>3.40%</td>
</tr>
<tr>
<td>City ambulance service</td>
<td>3.40%</td>
</tr>
<tr>
<td>County ambulance service</td>
<td>3.40%</td>
</tr>
<tr>
<td>Hospital based ambulance service</td>
<td>2.30%</td>
</tr>
<tr>
<td>Air ambulance service</td>
<td>2.30%</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>6.70%</td>
</tr>
</tbody>
</table>

### Table F2

**At my EMS service, endotracheal intubation can be performed in the following age groups.**

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infants</td>
<td>96.30%</td>
</tr>
<tr>
<td>Pediatric</td>
<td>98.80%</td>
</tr>
<tr>
<td>Adult</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

### Table F3

**Has your service ever documented a case where a patient was delivered to the emergency room with an unrecognized misplaced endotracheal tube?**

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>27.50%</td>
</tr>
<tr>
<td>No</td>
<td>57.50%</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>15.00%</td>
</tr>
</tbody>
</table>

### Table F4

**Has your EMS service ever been sued because a misplaced tracheal tube resulted in a poor patient outcome?**

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>2.50%</td>
</tr>
<tr>
<td>No</td>
<td>86.30%</td>
</tr>
<tr>
<td>Unknown</td>
<td>10.00%</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>1.30%</td>
</tr>
</tbody>
</table>
Table F5

**What primary tube confirmation method does your service use to ensure proper tracheal tube placement at the time of insertion?**

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>See the tube passing through the cords</td>
<td>94.90%</td>
</tr>
<tr>
<td>5-point auscultation, hearing proper sounds</td>
<td>98.70%</td>
</tr>
<tr>
<td>See the chest expand with each ventilation</td>
<td>80.80%</td>
</tr>
<tr>
<td>Noted improvement in the level of oxygen saturation</td>
<td>65.40%</td>
</tr>
<tr>
<td>See vapor condense in the tube with ventilations</td>
<td>69.20%</td>
</tr>
<tr>
<td>Esophageal detector device - bulb or syringe plunger device that will not expand or pull outward if in the tracheal tube is in the esophagus</td>
<td>41.00%</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>28.20%</td>
</tr>
</tbody>
</table>

Table F6

**What secondary tube confirmation method does your service use to ensure proper tube placement during patient care and transport?**

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only primary methods are used</td>
<td>3.90%</td>
</tr>
<tr>
<td>Colorimetric end-tidal CO2 detector</td>
<td>56.40%</td>
</tr>
<tr>
<td>Capnometers</td>
<td>32.10%</td>
</tr>
<tr>
<td>Capnographic waveform</td>
<td>70.50%</td>
</tr>
</tbody>
</table>

Table F7

**What back-up devices are available for their use to gain airway control?**

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is no back-up device available</td>
<td>2.60%</td>
</tr>
<tr>
<td>ETC - Esophageal Tracheal Combitube Airway</td>
<td>59.00%</td>
</tr>
<tr>
<td>LMA - Laryngeal Mask Airway</td>
<td>21.80%</td>
</tr>
<tr>
<td>PtL - Pharyngo-Tracheal Lumen Airway</td>
<td>1.30%</td>
</tr>
<tr>
<td>EOA - Esophageal Obturator Airway</td>
<td>1.30%</td>
</tr>
<tr>
<td>EGTA - Esophageal Gastric Tube Airway</td>
<td>3.90%</td>
</tr>
<tr>
<td>King Airway System</td>
<td>11.50%</td>
</tr>
<tr>
<td>Surgical Cricothyrotomy</td>
<td>34.60%</td>
</tr>
<tr>
<td>Needle Cricothyrotomy</td>
<td>56.40%</td>
</tr>
<tr>
<td>Other</td>
<td>18.00%</td>
</tr>
</tbody>
</table>
Table F8

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>78.50%</td>
</tr>
<tr>
<td>No</td>
<td>10.10%</td>
</tr>
<tr>
<td>Other</td>
<td>11.40%</td>
</tr>
</tbody>
</table>

Table F9

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>67.10%</td>
</tr>
<tr>
<td>Yes</td>
<td>29.10%</td>
</tr>
<tr>
<td>Other</td>
<td>3.80%</td>
</tr>
</tbody>
</table>

Table F10

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>63.60%</td>
</tr>
<tr>
<td>No</td>
<td>24.70%</td>
</tr>
<tr>
<td>Other</td>
<td>11.70%</td>
</tr>
</tbody>
</table>
Appendix G

Table G1

<table>
<thead>
<tr>
<th>Have you ever witnessed a paramedic crew bring a patient into the ER with an unrecognized misplaced endotracheal tube?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Answer options</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>Other</td>
</tr>
</tbody>
</table>

Table G2

<table>
<thead>
<tr>
<th>How did you verify that the endotracheal tube was misplaced?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Answer options</td>
</tr>
<tr>
<td>Absent chest expansion while ventilating</td>
</tr>
<tr>
<td>Absent breath sounds while ventilating</td>
</tr>
<tr>
<td>Visualize tube location</td>
</tr>
<tr>
<td>Low oxygen saturation</td>
</tr>
<tr>
<td>Capnography</td>
</tr>
<tr>
<td>Other</td>
</tr>
</tbody>
</table>

Table G3

<table>
<thead>
<tr>
<th>In your opinion, has an unrecognized, misplaced tracheal tube inserted by an EMS provider ever lead to an adverse patient outcome?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Answer options</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>Comments</td>
</tr>
</tbody>
</table>

Table G4

<table>
<thead>
<tr>
<th>Estimate how often you see an unrecognized misplaced tracheal tube inserted by EMS arrive undetected in the emergency room in a one year period?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Answer options</td>
</tr>
<tr>
<td>I have never seen this happen</td>
</tr>
<tr>
<td>One to two</td>
</tr>
<tr>
<td>Three to four</td>
</tr>
<tr>
<td>Five to Ten</td>
</tr>
<tr>
<td>More then ten times in a year</td>
</tr>
</tbody>
</table>
### Table G5
**What primary tube confirmation method do you use in the emergency room to ensure proper tracheal tube placement at the time of insertion?**

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>See the tube passing through the cords</td>
<td>100.00%</td>
</tr>
<tr>
<td>5-point auscultation, hearing breath sounds</td>
<td>86.20%</td>
</tr>
<tr>
<td>See the chest expand with each ventilation</td>
<td>66.20%</td>
</tr>
<tr>
<td>Noted improvement in the level of oxygen saturation</td>
<td>78.50%</td>
</tr>
<tr>
<td>See vapor condense in the tube with ventilations</td>
<td>61.50%</td>
</tr>
<tr>
<td>Esophageal detector device - bulb or syringe plunger device that will not expand or pull outward if the tracheal tube is in the esophagus</td>
<td>10.80%</td>
</tr>
<tr>
<td>Fiber-optic intubation device</td>
<td>9.20%</td>
</tr>
<tr>
<td>Other</td>
<td>21.50%</td>
</tr>
</tbody>
</table>

### Table G6
**What secondary tube confirmation method is used in your emergency room to monitor tube placement during patient care?**

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colorimetric end-tidal CO2 detector (changes color)</td>
<td>90.80%</td>
</tr>
<tr>
<td>Capnometer - digitally displays a single numeric value of highest amount of expired CO2</td>
<td>24.60%</td>
</tr>
<tr>
<td>Capnographic waveform - continuous waveform displays the amount of expired CO2</td>
<td>41.50%</td>
</tr>
<tr>
<td>Other</td>
<td>9.20%</td>
</tr>
</tbody>
</table>

### Table G7
**What back-up device or procedure do you use to gain airway control?**

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETC - Esophageal Tracheal Combitube Airway</td>
<td>15.40%</td>
</tr>
<tr>
<td>LMA - Laryngeal Mask Airway</td>
<td>95.40%</td>
</tr>
<tr>
<td>PtL - Pharyngeal- Tracheal Lumen Airway</td>
<td>0.00%</td>
</tr>
<tr>
<td>EOA - Esophageal Obturator Airway</td>
<td>1.50%</td>
</tr>
<tr>
<td>EGTA - Esophageal Gastric Tube Airway</td>
<td>0.00%</td>
</tr>
<tr>
<td>King Airway System</td>
<td>0.00%</td>
</tr>
<tr>
<td>Surgical Cricothyrotomy</td>
<td>63.10%</td>
</tr>
<tr>
<td>Needle Cricothyrotomy</td>
<td>43.10%</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>24.60%</td>
</tr>
</tbody>
</table>
### Table G8

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>4.60%</td>
</tr>
<tr>
<td>No</td>
<td>80.00%</td>
</tr>
<tr>
<td>Other</td>
<td>15.40%</td>
</tr>
</tbody>
</table>

**Is there a written policy or procedure that you follow to ensure that all endotracheal tube placements are confirmed and monitored at all times during patient care?**

### Table G9

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>6.20%</td>
</tr>
<tr>
<td>No</td>
<td>93.80%</td>
</tr>
</tbody>
</table>

**Are you ever required to do remedial airway training if you have not intubated enough patients in the defined time period?**

### Table G10

<table>
<thead>
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<th>Answer options</th>
<th>Response Percent</th>
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**Is there a quality assurance process that reviews each intubation case?**
Appendix H

<table>
<thead>
<tr>
<th>Littleton Fire Rescue</th>
<th>SOP #</th>
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<tbody>
<tr>
<td>Advanced Airway Control Strategy</td>
<td>Implementation – (Draft) Revised -</td>
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</table>

**Advanced Airway Control Strategy**

**Purpose:** The purpose of this SOP is to improve patient care by standardizing the strategy and tactics used by Littleton Fire Rescue paramedics when deploying advanced airway adjuncts.

**Scope:** This SOP is applicable to all Littleton paramedics. In the event that a paramedic student is performing intubation, a Littleton paramedic will supervise and have direct oversight of the student and will ensure that this SOP is followed in all cases of tracheal intubations or advanced airway maneuvers.

**Policy:** Littleton paramedics should intubate patients who are apneic, severely hypoxic, unresponsive, or who may have impending airway problems (facial burns, severe asthma, impending respiratory arrest, etc.).

**Definitions:**

- **Intubation Attempt** – An intubation “attempt” is defined as the introduction of airway equipment or tracheal tube that passes the patient’s teeth. Individual intubation attempts should not last longer than 25 seconds.

- **Airway Paramedic** – The individual paramedic who successfully inserts the airway device into the patient airway. The Airway Paramedic will always accompany the patient to the hospital and is solely responsible for monitoring the patient’s airway device and ETCO2 readings even though the physical task of ventilating the patient may be delegated to another individual.

- **Airway Debriefing Team** – An individual on the Airway Debriefing team will respond to the hospital anytime an intubation is declared by the emergency physician to have been “misplaced.” The Airway Debriefing team member will support the paramedic involved the alleged misplaced tube and investigate the circumstances surrounding the incident.

- **Esophageal Detector Device (EDD)** – A bulb type device used to confirm that a tube is not in the esophagus. The EDD bulb will not re-inflate if the tracheal tube is in the esophagus.

- **Advanced Airway Encounter Card** – This card will be filled out with airway data from an advanced airway encounter every time a patient is intubated. The card should be submitted to the Quality Assurance Officer within 24 hours of an intubation attempt.

**Advantages for Advanced Airway Control:**

- Facilitates positive pressure ventilations
- Prevents aspiration
- Facilitates airway suctioning
Advanced Airway Management Strategies

- Provides a route for selected medications

**Disadvantages/Complications of Advanced Airway Control:**
- Requires special training and equipment
- May be difficult to avoid cervical spine movement
- Airway trauma
- Tracheal tube misplacement
- Esophageal placement resulting in hypoxia
- Potential for simple or tension pneumothorax
- Gastric distention

**Indications for Advanced Airway Control:**
- Apnea or inadequate respiratory effort
- Patients in severe respiratory distress or respiratory failure
- Unconscious patients unable to protect their own airway
- Need for prolonged ventilatory support
- Multi-systems trauma with decreased mental status where bag-valve-mask (BVM) is not effective
- Inhalation injury with edema at the vocal cords

**Contraindications for Advanced Airway Use:**
- Patients with an intact active gag reflex (consider nasal intubation)
- Maxillo-facial trauma with unrecognizable facial landmarks
- Patients actively seizing
- Isolated medical arrest suspected from hypoglycemia or narcotics overdose

**Responsibilities:**
- It is the responsibility of every paramedic that they wear all appropriate body substance isolation (BSI) equipment for every airway control attempt (see SOP EMS 605 – Infections Disease Control). The minimal level of BSI for intubation is gloves, goggles or prescription glasses and an isolation mask.
- It is the responsibility of the Airway Paramedic to ensure that the tracheal tube is correctly placed and monitored for dislodgment at all times after insertion. The Airway Paramedic will continue to monitor the tube and the ETCO2 readings until they transferred care to the receiving emergency physician.
- It is the responsibility of the Airway Paramedic to fill out and submit an Advanced Airway Encounter Card to the EMS Bureau within 24 hours of the incident. The card should be signed by receiving emergency physician verifying that the intubation was correct.
- It is the responsibility of the Airway Paramedic to immediately notify the Airway Debriefing Team from the hospital that a tracheal tube is suspected of being misplaced. The Airway Paramedic will notify the Battalion Chief, remain out of service and be debriefed about the circumstances surrounding the suspected misplaced tube.
- It is the responsibility of the Airway Debriefing Team to respond to the hospital and support the Airway Paramedic indicated in misplacing a tracheal tube. The Airway
Debriefing Team will act as the liaison between the fire department and the hospital, discuss the circumstances of the incident, print the code summary from the cardiac monitor, assist in filling out the Advanced Airway Encounter Card and notify and brief the EMS Bureau Chief, or in his absence, the Quality assurance Officer or their designee.

- It is the responsibility of the EMS Bureau to support the Airway Paramedic during the inquiry into the incident and to notify the Medical Director within 24 hours of the suspected misplaced tracheal tube.

**Equipment:**
- BSI must be worn by any personnel working around any patient’s airway.
- The Difficult Airway Bag should immediately be made available to the paramedic preparing to intubate.
- A mechanical suction device must be immediately available in case of secretions, blood or vomit in order to reduce the possibility of aspiration.
- A cardiac monitor should be applied and ETCO2 monitoring should be immediately made available at the time of intubation.

**Preparation for Intubation:**
- Apply BSI
- Maintain cervical spine precautions as indicated, apply cervical collar where needed
- Assure adequate basic life support airway management, note the presence of a gag reflex
- Pre-oxygenate with 100% oxygen and BVM
- Monitor for hypoxemia and bradycardia as indicated
- Check laryngoscope for proper blade size and ensure the light is working
- Check suction
- Select proper tracheal tube size, use Braslow Tape as indicated
- Test cuff for air leaks and apply lubricant as indicated
- Position the patient’s head in the “sniffing” position if no spine precautions needed

**Intubation Procedure:**
- The most skillful paramedic on the scene should perform intubation.
- Pre-oxygenate the patient with 100% oxygen.
- Open the mouth and inspect the airway for obstruction
- Visualize the epiglottis and the vocal cords with the laryngoscope.
- Cricoid pressure should be applied during intubation to protect against regurgitation of gastric contents.
- Insert the endotracheal tube until the entire balloon is 2 cm past the vocal cords.
- Inflate the balloon until stiff and ventilate the tube with BVM.
- Listen for equal breath sounds in all lung fields and absence of sound in the stomach.
- Observe equal chest rise and fall
- After a primary confirmation of tube placement has been made by subjective methods, an EDD should be used to objectively confirm placement.
- Note the level of the tube at the teeth.
- Secure the tube with the Thomas ET holder.
• ETCO2 monitoring with wave form capnography should be applied immediately to every intubated patient. Numerical values and waveforms will be recorded by pushing the “event” button on the cardiac monitor.
• Ventilation rate and depth should be adjusted to reflect optimal ETCO2 values, usually between 33-43 mmHg.
• ETCO2 values and waveforms will be recorded by the Airway Paramedic at the time of tube insertion, any time the patient has been moved and after arrival at the emergency department.
• If resuscitation efforts are terminated in the home, ETCO2 values will be recorded prior to terminating efforts.

Intubation Failure:
• An airway placement attempt should stop after 25 seconds and the patients should be re-oxygenated with 100% oxygen.
• After three attempts by the same paramedic, the next most skillful paramedic should attempt intubation.
• After two paramedics have tried and failed (a total of six intubation attempts) the King Airway System should be employed.
• If an airway device can not be correctly inserted and tube placement confirmed, consider needle cricothyrotomy as a last resort. Cricothyrotomy is a difficult and hazardous technique that is to be used only in extraordinary circumstances when the patient can not be ventilated by any other means.

Endotracheal Tube Placement Confirmation - The following methods of tracheal tube confirmation are to be used to ensure proper tube placement in all cases of intubation:
• Visualization of the tube passing through the vocal cords
• Auscultation of breath sounds in all lung fields
• Check for breath sounds over the epigastrium, suggesting esophageal intubation. If present, remove the tube at once.
• EDD – After the patient has been intubated and a subjective tube placement confirmation has been made, confirm placement with the EDD. Compress the bulb, attach to the endotracheal tube and release. Allow the bulb to reinflate. If the bulb reinflates within 5 seconds the tube is most likely in the trachea. If the bulb takes longer than 5 seconds, or if vomit returns, remove the tube, suction if needed, and ventilate the patient with a BVM.
• ETCO2 detection with wave form capnography – This confirmation method should immediately be applied after confirming placement with the EDD and will be applied for all intubated patients. An ETCO2 range of 30-50 mmHg is desirable. Readings of 20-30 mmHg are acceptable but reading below 20 mmHg should not be relied on for proper tube confirmation.
• If, despite all of the above steps, the location of the tube is unclear, the tube should be removed and the patient ventilated with the BVM.

Transfer of Care:
• On arrival at the emergency department, the Airway Paramedic will give the patient report including the last ETCO2 reading recorded after arrival.
• The Airway Paramedic will request that the emergency physician confirm tracheal tube placement prior to moving the patient from the cot to the hospital bed.
• The Airway Paramedic will have the physician sign the Advanced Airway Encounter Card, fill the card out and submit it to the EMS Bureau with a copy of the code summary within 24 hours of the incident.
• If resuscitation efforts are terminated in the home, the Airway paramedic will fill out the Advanced Airway Encounter Card and submit it with the code summary within 24 hours.

**Documentation Points:**
- Size of the ET tube
- Number of attempts
- ET measurement (cm) at the teeth
- Visualization of the vocal cords
- Equality of breath sounds
- Absences of epigastric sounds after intubation
- Chest rise and fall after intubation
- EDD bulb syringe check
- All ETCO2 capnography reading
- Method of securing the tube
- Suction required
- Any complications with intubation procedures

**Quality Assurance:**
- An Advanced Airway Encounter Card will be submitted to the Quality Assurance Officer within 24 hours of every intubation attempt, successful or unsuccessful.
- The Quality Assurance Officer will review every advanced airway encounter and track all related data. A quarterly Advanced Airway Encounter Report will be submitted to the EMS Bureau Chief and the Medical Director for review. The report will be disseminated to all paramedics via email.

**Endotracheal Extubation** – An endotracheal tube should be removed in alert patients with an intact gag reflex who are in obvious discomfort or in a state of agitation from the tracheal tube. The patient must have an elevated level of conscious and have the ability to follow commands prior to extubation. These extubation steps are recommended:
- Contact medical control, if possible, to consider if sedation is more appropriate then removing the tube.
- Explain the procedure to the patient.
- Ventilate the patient for approximately 8 breaths.
- Suction the mouth to remove all secretions that may be above the cuff of the tube.
- Instruct the patient to take a deep breath.
- Attach the syringe, deflate the cuff and have the patient cough as the tube is gently removed from the airway.
- Supplement the patient with high flow oxygen via non-rebreather mask for the duration of the prehospital care.
• Monitor the patient carefully for respiratory distress, be prepared to re-intubate if necessary.
Figure 1. The American Society of Anesthesiologist difficult airway algorithm.
Figure 2. The Italian Society of Anesthesia, Analgesia, Resuscitation and Intensive Care difficult airway algorithm for the adult patient.