Reducing Community Risk Through an Analysis of Emergency Lights and Siren Usage

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Certification Statement

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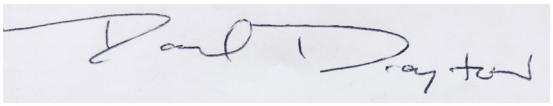

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Abstract

The problem was Redmond Fire & Rescue (RF&R) had not conducted a risk/benefit analysis on the usage of emergency lights and siren (L&S) on emergency medical services (EMS) incidents. The purpose of this research was to conduct a risk/benefit analysis on the usage of emergency L&S on EMS incidents. Descriptive methodology guided the following research questions: (a) What percentage of RF&R's EMS calls are responded to with L&S? (b) How much time, if any, does utilizing L&S reduce response times? (c) Which types of patients potentially benefit from the time savings of responding with L&S? (d) What percentage of EMS calls and types of patients are transported with L&S? (e) How much time, if any, does transporting with L&S reduce transport times? (f) What criteria should providers consider when deciding to transport with L&S? This research utilized a survey, interviews, and analyzed prehospital care report data to answer the research questions. The results showed L&S saved time both responding and transporting as well as identified patients who may clinically benefit from the time savings of using L&S. Recommendations based on the results were: (a) reduce L&S usage on most Charlie and some Delta determinants, (b) update policies to allow providers to downgrade a response for certain criteria, (c) develop a protocol to guide L&S usage during transport, (d) review any patient care report where a patient was transported L&S, (e) update policies and provide training for securing equipment, patients, and providers, (f) order future ambulances with improved safety design.

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Reducing Community Risk Through an Analysis of Emergency Lights and Siren Usage

A commonly held belief is that emergency vehicles should use lights and siren (L&S) to reduce travel times, leading to quicker treatment and better patient outcomes (Kupas, 2017, p. 7). A counterintuitive thought is not using L&S may save as many, or more lives than using them does (Clawson & Dernocoeur, 2001, p. 3.33). The reasoning behind this paradigm shift is the risks associated with using L&S are not benign. An emergency vehicle utilizing L&S exposes responders, pedestrians, and occupants of other vehicles to an increased risk of injury or death from a motor vehicle collision (Clawson, Martin, Cady & Maio, 1997, p. 43; Pirrallo & Swor, 1994, p. 128; Saunders & Heye, 1994, p. 124; United States Fire Administration, 2014b, p. 55; Watanabe, Patterson, Kempema, Magallanes, & Brown, 2019). When exposing personnel and the community to risk, it is vital that the anticipated benefits outweigh the risks (Bona & Friedman, 2018, para. 2; Dami, Pasquier, & Carron, 2013, p. 55; Kupas, 2017, p. 42; Kupas, Dula, & Pino, 1994, p. 229; Pons & Markovchick, 2002, p. 47; United States Fire Administration, 2018b, p. 32).

The problem addressed by this research was Redmond Fire & Rescue (RF&R) had not conducted a risk/benefit analysis on the usage of L&S on emergency medical services (EMS) incidents. The purpose of this research was to conduct a risk/benefit analysis on the usage of L&S on EMS incidents. Descriptive methodology guided the following research questions: (a) What percentage of RF&R's EMS calls are responded to with L&S? (b) How much time, if any, does utilizing L&S reduce response times? (c) Which types of patients potentially benefit from the time savings of responding with L&S? (d) What percentage of EMS calls and types of patients are transported with L&S? (e) How much time, if any, does transporting with L&S reduce transport times? (f) What criteria should providers consider when deciding to transport

with L&S?

Background and Significance

Redmond Fire & Rescue protects nearly 41,000 people in a 322.5 square mile area that encompasses the city of Redmond, large areas of unincorporated rural land, and the communities of Eagle Crest and Terrebonne (Redmond Fire & Rescue, 2018a, p. 17). Operating out of four fire stations, RF&R provides (a) structural and wildland fire suppression, (b) aircraft rescue firefighting, (c) basic and advanced life support transporting ambulance service, (d) operations level hazardous materials response, and (e) awareness level technical rescue (Redmond Fire & Rescue, 2018a, p.10). Redmond Fire & Rescue's daily minimum operational staff is 14 personnel, consisting of (a) a battalion chief, (b) three captains, (c) four engineers, (d) two firefighter/paramedics, (e) two EMS only paramedics, and (f) two EMS only EMT-Basics. These personnel staff (a) two dedicated advanced life support (ALS) ambulances, (b) a dedicated basic life support (BLS) ambulance, (c) a dedicated ALS engine, (d) two cross staffed ALS engines and ambulances, (e) an aircraft rescue crash truck, and (f) a duty officer. Redmond Fire & Rescue's administrative staff consists of the (a) fire chief, (b) deputy chief, (c) chief financial officer, (d) division chief of EMS, (e) training chief, (f) fire marshal, (g) office administrator, and (h) three administrative assistants.

In 2017, RF&R responded to 5,473 calls for service with 4,060 (74%) of those calls being medical responses (ImageTrend, 2018). On EMS incidents, RF&R's ambulances primarily transport patients to two area hospitals. The first hospital, St. Charles Medical Center-Redmond is located in the city of Redmond and is the receiving facility for the majority of RF&R's ambulance transports. St. Charles Medical Center-Redmond (SCMC-Redmond) is a level three trauma center with very few specialty services (e.g., no cardiology, cardiothoracic, or

neurosurgicaletc.). The second hospital, St. Charles Medical Center-Bend, is located twenty miles south in the city of Bend. St. Charles Medical Center-Bend (SCMC-Bend) is a level two trauma center with neurosurgical services and a cardiac catheterization lab. When indicated, RF&R ambulances will bypass SCMC-Redmond and transport patients requiring these specialty services to SCMC-Bend.

Redmond Fire & Rescue is dispatched by Deschutes County 911 (DC911) which utilizes the Medical Priority Dispatch System (MPDS) for dispatching medical emergencies. When a dispatcher receives a call for medical assistance, they use the MPDS to question the caller and classify the call into one of six different determinant levels: (a) Omega, (b) Alpha, (c), Bravo, (d) Charlie, (e) Delta, and (f) Echo (Clawson & Dernocoeur, 2001, p. 3.26). These levels do not correspond to the severity of the patient's condition but are instead designed to help determine a response assignment (Clawson & Dernocoeur, 2001, p. 3.25). A response assignment is what resources should be sent to a call, and whether they should respond with or without L&S (Clawson & Dernocoeur, 2001, p. 3.25). The MPDS recommendation for Alpha and Bravo determinants is a BLS resource, with an Alpha response being without L&S and a Bravo being with L&S (Clawson & Dernocoeur, 2001, p. 3.26). The recommendation for Charlie, Delta, and Echo determinants is an ALS resource, with the Charlie determinant being without L&S and the Delta and Echo determinants being with L&S (Clawson & Dernocoeur, 2001, p. 3.27).

The MPDS is designed so agencies can determine their response assignment to each of the six determinant levels as well as to the different call types (e.g., seizure, chest pain, etc.) and determinant descriptors (e.g., not alert, altered level of consciousness, abnormal breathing, etc.) within each determinant level (Clawson & Dernocoeur, 2001, p. 3.25). The MPDS recommends agencies set up response assignments based on whether it will make a difference in patient

outcome, saving an L&S response for incidents where the potential benefit to the patient outweighs the risk of driving L&S, recognizing there are very few emergencies where this is the case (Clawson & Dernocoeur, 2001, p. 3.32).

Redmond Fire & Rescue utilizes the MPDS determinants in deciding its response assignments. Omega, Alpha, and Bravo incidents have a BLS ambulance assigned and RF&R's response plan (2018b) states units responding to Omega, Alpha, and Bravo determinants will respond code one (p. 5). Code one driving is defined in RF&R's driving policy (2011) as using no warning devices (no L&S) (p. 1). Charlie determinants receive an ALS ambulance, and counter to the MPDS recommendation, the RF&R response plan (2018b) states the unit should respond code three (p. 5). Code three driving is defined as utilizing all warning lights, headlights, and an audible warning device (Redmond Fire & Rescue, 2011, p. 1). Delta determinants receive an ALS ambulance and ALS engine with the closest unit responding code three (Redmond Fire & Rescue, 2018b, p. 5). Echo determinants receive an ALS and BLS ambulance as well as an ALS engine with all responding units driving code three (Redmond Fire & Rescue, 2018b, p. 6).

Redmond Fire & Rescue's Standard of Cover (2017) specifies a goal to arrive at emergency calls in under eight minutes, 90% of the time (p. 15). The Standard of Cover does not define what is considered an emergency call. The document also does not specify a response time standard for non-emergency calls. Brown, Whitney, Hunt, Addario, and Hogue (2000) stated that EMS systems often develop their L&S response policies in the absence of objective data (p. 70). Before this research, RF&R's response plan appeared to fit that description, with the response time requirements and response assignments developed without an objective study or a risk/benefit analysis. Redmond Fire & Rescue's EMS Division Chief Doug Kelly (personal communication, November 28, 2018; Appendix B) indicated RF&R's response practices are

rooted in regional history and did not mention objective data as a foundation for current L&S practices.

To reduce risk and liability, the decision to use L&S and put others at risk must be supported with objective data and a risk/benefit analysis. Continuing to operate without objective data to support the benefits of using L&S could present significant risk and liability problems for RF&R in the future. Motor vehicle collisions present the highest liability risk for EMS agencies and using L&S increases the risk of a collision (Clawson, Martin, Cady, & Maio, 1997, p. 43; Kupas, 1994, p. 226; Pirrallo & Swor, 1994, p. 128; Saunders & Heye, 1994, p. 124; United States Fire Administration, 2014b, p. 55; Watanabe, Patterson, Kempema, Magallanes, & Brown, 2019; Wang, Fairbanks, Shah, Abo, & Yealy, 2008, p. 260; Wolfberg, 2016, para. 23). Given the inherent risks to personnel and the community of driving with L&S, it was necessary to conduct this research to ensure the benefits of driving with L&S outweighed the risks.

This research was completed as a requirement for the Executive Analysis of Community Risk Reduction (EACRR) course of the Executive Fire Officer Program. Two of the course goals for EACRR were "focus on reducing risks in the local community" and "reduce line-of-duty deaths (LODDs) among firefighters" (United States Fire Administration, 2018a, p. ix). Driving with L&S puts responders, pedestrians and occupants of other vehicles in the community at an increased risk for injury or death from a collision (Dami, Pasquier, & Carron, 2013, p. 55; Kupas, 2017, p. 43; United States Fire Administration, 2014b, p. 77). Completing this research provided the opportunity to potentially reduce risk to the community and prevent a LODD from a vehicle collision. This research was also conducted to help achieve the United States Fire Administration's (USFA) goal to "reduce fire and life safety risk through preparedness, prevention, and mitigation" (United States Fire Administration, 2014a, p. 9). According to

Clawson and Dernocoeur (2001), reducing the unnecessary use of L&S is one method to prevent a loss of lives from a collision involving an emergency vehicle (p. 3.33). Completing this research provided the opportunity to potentially reduce life safety risk by preventing a collision caused by the unnecessary use of L&S.

Literature Review

The care provided by prehospital personnel has been evolving since the inception of EMS. At its inception, personnel had little to no medical training, meaning when they responded they had no meaningful medical interventions to offer the patient (Kupas, 2017, p. 8). The one intervention they could offer was rapid L&S transport to a hospital where care was available (Kupas, 2017, p. 8; O'Brien, Price, & Adams, 1999, p. 127). Modern-day paramedics are now an extension of an emergency room doctor, capable of starting intravenous lines, administering a large number of medications, and performing advanced airway procedures. Because EMS now brings advanced care to the patient, the need for L&S transport should be minimal; however, previous research has not shown that to be the case. Kupas (2017) found between 2010 and 2015, EMS agencies used L&S at some point in their transports 22.7% of the time (p. 10). Bona and Friedman (2018) argued that the status quo of EMS agencies transporting over 25% of their calls with L&S is no longer acceptable due to the risks associated with using L&S (para. 2). As a goal, Kupas (2017) believed agencies should aim for transporting less than five percent of their calls with L&S and only utilize L&S during transport when the benefit to the patient outweighs the risks (p. 43). The less than five percent goal appears achievable in light of Garza, Gratton, McElroy, Lindholm, and Glass's (2008) review of 24,844 patients who were transported and found only 5.4% of those patients were transported with L&S (p. 26). The same study found that Delta and Echo MPDS determinants were most likely to be transported with L&S, with Echo

determinants being the highest proportion (64.5%) of patients transported with L&S (Garza, Gratton, McElroy, Lindholm, & Glass, 2008, p. 26).

Using L&S to the scene is thought to be more useful than during transport because a patient's condition is not fully known and modern EMS systems bring advanced life support to a patient in need (Murray & Kue, 2017, p. 209). Kupas (2017) found that EMS systems use L&S during response 76% - 77.5% of the time with the primary goal of trying to save time getting to the scene (pp. 7-9). In a summary of studies looking at L&S usage, Kupas (2017) stated that the average amount of time saved responding with L&S was between 1.7 and 3.6 minutes (p. 32). Brown, Whitney, Hunt, Addario, and Hogue (2000) found that using L&S in an urban EMS system reduced response times by an average of 1:46 (p. 71). The authors stated the time saved was statistically significant but questioned whether that amount of time was clinically significant outside the need for a critical lifesaving intervention such as defibrillation or clearing an airway (Brown, Whitney, Hunt, Addario, & Hogue, 2000, p. 71). In a study of a rural EMS system, Ho and Lindquist (2001) found using L&S during the response to a scene saved an average of 3.63 minutes with the most significant predictor of time-saving being the distance traveled to the scene (p. 161).

According to Kupas (2017), the average time saved across multiple studies using L&S during transport was between 0.7 and 3.8 minutes (p. 32). O'Brien, Price, and Adams (1999) showed a statistically significant time savings of 230 seconds comparing transport with L&S to without (p. 129). However, the authors remarked that the time saved was not clinically significant for patient care (p. 130). The authors went on to remark that when paramedics accomplish their treatments, the need for L&S transport is limited (p. 130). Marques-Baptista, Ohman-Strickland, Baldino, Prasto, and Merlin (2010) found using L&S during transport saved

2.62 minutes but noted none of the patients transported with L&S received a time-critical hospital intervention within those 2.62 minutes (p. 337). Dami, Pasquier, and Carron (2013) also showed a statistically significant time savings of 105 seconds using L&S during transport in the daytime, but only 10.2 seconds (not statistically significant) during the night (p. 54). These results showed a time benefit to using L&S, but little to no clinical benefit for the patient (p. 55).

Many EMS systems use L&S to help meet a response time goal. The most common response time goal is to arrive at the scene in under eight minutes, 90% of the time (Bona & Friedman, 2018, para. 2; Kupas, 2017, p. 9; McCallion, 2012, para. 4). Pons and Markovchick (2002) stated this widely adopted response time standard was the product of a single study of survival in cardiac arrest in the 1970s (p. 43). The study found survival increased when BLS arrived within four minutes and ALS arrived within eight minutes (Pons & Markovhick, 2002, p. 43; Kupas, 2017, p. 43; Al-Shaqsi, 2010, p. 2). National Fire Protection Association (2016) 1710, Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments, adopted the four and eight-minute response time requirements for emergency medical incidents, making it the industry standard for fire department response times to all EMS incidents, not just cardiac arrest (p. 9).

Many authors have argued it is not rational to adopt a universal response time standard based on a single and infrequent type of call (cardiac arrest), and agencies should be more thoughtful in developing their response time requirements (Al-Shaqsi, 2010, p. 2; Kupas, 2017, p. 38; Pons & Markovchick, 2002, p. 47). Berger (2010) went as far as calling the eight-minute response time standard an “artificial standard” (p. 19A). In 2003, the National Association of EMS Physicians (NAEMSP) released a position statement on response times that urged EMS

agencies to consider their community's needs, resources, and attributes to develop realistic response time standards rather than blindly adopting a response time standard (Bailey & Sweeney, 2003, p. 397). The NAEMSP position paper also advocated for using a priority dispatch system to categorize calls and establishing different response time standards for emergent, urgent, and nonurgent calls for service (Bailey & Sweeney, 2003, p. 397).

The evidence of the four and eight-minute response time standards having any benefit on patient outcomes is very slim (Blackwell, Clawson, Eckstein, Miramonti, & Wang, 2011, p. 14; United States Fire Administration, 2014b, p. 80). Pons et al. (2005) looked at survival rates of patients based on the eight-minute response time standard (p. 594). The authors reported there was not an increase in patient survival for those who received an ALS ambulance within eight minutes (p. 597). They concluded that more ambulances could respond without L&S and it would not harm patients (p. 597). In the same study, Pons et al. (2005) did find an increase in survival if an ALS ambulance arrived in under four minutes; however, the authors concluded they were not sure what patients outside of cardiac arrest would benefit (p. 597). Blackwell, Kline, Willis, and Hicks (2009) studied patient outcomes in an EMS system with a response time standard of 10:59 for emergent, life-threatening calls (p. 449). They compared patients who received an ALS ambulance before the response time goal to those who did not and concluded there was no increase in mortality when response times exceeded 10:59 (p. 449). Similar to Pons et al. (2005), Blackwell et al. (2009) found a higher survival rate if response times were under five minutes but stated in the EMS system studied, meeting a five-minute response time may only save up to 10 lives per year (Blackwell, Kline, Willis, & Hicks, 2009, p. 448). Pons and Markovchick (2002) found no statistically significant difference in survival rates between trauma patients who received an ALS ambulance in under eight minutes compared to those who

received an ALS ambulance after eight minutes (p. 47). The authors concluded factors other than response time affect patient outcomes in trauma (p. 47).

Beyond response times, the evidence for a widely accepted prehospital trauma mandate regarding short scene times and rapid transport is weak. The golden hour is the goal of getting a trauma patient to a trauma center within one hour of injury (Berger, 2010, p. 17A). Berger (2010) stated that the concept of the golden hour was developed in the 1960s and was never based on scientific research and newer research does not support the mandate (p. 17A). Newgard et al. (2010) studied the association between mortality and amount of time EMS spent with trauma patients and found no association between total EMS time and mortality (p. 239). Further, the study found no association between increasing on-scene times and increased mortality (p. 239).

Given the lack of evidence supporting the four and eight-minute response time standards, McCallion (2012) encouraged agencies to review their data and develop refined response goals (para. 7). Blackwell, Clawson, Eckstein, Miramonti, and Wang (2011) stated many EMS systems had increased their response time standard to 10:59 for emergent life-threatening calls and 12:59 for non-emergent calls without any adverse patient outcomes (p. 14). Blackwell et al. (2011) believed EMS systems need to look beyond response times as a measure of success, as focusing solely on response time creates an expensive and inefficient system (p. 36). Pons et al. (2005) echoed this sentiment stating the financial implications of decreasing response times could be overwhelming (p. 599). Al-Shaqsi (2010) also believed it would be expensive to try and meet the four and eight-minute response time standards and doing so increases the risk of crashes and unnecessarily endangering crews, other drivers, and pedestrians (p. 4). A final consideration of the eight-minute response time standard is how it affects the ambulance crew's behavior. Kupas (2017) and Slattery and Silver (2009) wrote they believed using L&S, combined with the eight-

minute response standard, encourages drivers to take additional risks to get to the scene at all costs (Kupas, 2017, p. 38; Slattery & Silver, 2009, p. 390).

The benefits of using L&S to reduce travel times must be weighed against the risks associated with using L&S. A United States Fire Administration (2014b) report stated personnel are most at risk when traveling with L&S (p. 77). Berger (2010) quoted an interview with Dr. Nadine Levick, an EMS researcher, who stated "ambulances are the most lethal vehicles on the road both per mile traveled and per vehicle. They are exempt from federal commercial fleet safety oversight and exempt from most federal motor vehicle safety standards" (p. 19A). This quote is supported by a United States Fire Administration (2014b) report which stated ambulances, specifically the rear compartment, are mostly exempt from federal motor vehicle safety standards and EMS is not regulated by any national transportation safety oversight (p. 54).

Collisions are the most common risk ambulance crews are exposed to, and using L&S increases the risk of a crash (Al-Shaqsi, 2010, p. 4; Clawson, Martin, Cady, Maio, 1997, p. 43; Saunders & Heye, 1994, p. 122; Watanabe, Patterson, Kempema, Magallanes, & Brown, 2019). Watanabe, Patterson, Kempema, Magallanes, and Brown (2019) analyzed data from 19 million EMS calls and found a crash rate of 4.6 per 100,000 responses without L&S and 5.4 per 100,000 responses with L&S. During transport they found the crash rate to be 7.0 per 100,000 transports without L&S and 17.1 per 100,000 transports with L&S (Watanabe, Patterson, Kempema, Magallanes, & Brown, 2019). Saunders and Heye (1994) reviewed ambulance crashes in an urban EMS system and found there were 45.9 collisions per 100,000 miles of L&S driving compared to 27.0 collisions per 100,000 miles of driving without L&S (p. 122). The authors also found a higher injury rate for collisions occurring during L&S travel (Saunders & Heye, 1994, p.122). Kahn, Pirrallo, and Kuhn (2001) analyzed fatal ambulances crashes over 11 years and

found 60% of collisions and 58% of crash fatalities occurred while the ambulance was operating with L&S (p. 262). Heick, Young, and Peek-Asa (2009) found crashes where the ambulance was using L&S were more likely to result in an injury (p. 966). Sanddal, Sanddal, Ward, and Stanley (2010) analyzed two years' worth of ambulances crashes which were reported in the press and found 80% of the crashes involved an ambulance utilizing L&S (p. 2). In addition to the potential for an ambulance to be involved in a crash, Clawson, Martin, Cady, and Maio (1997) found there are potentially up to four or five times more collisions that do not involve an ambulance but are caused by the wake-effect of other vehicles yielding the right of way to an emergency vehicle (p. 43).

If an ambulance is involved in a collision, the occupants in the ambulance, in other vehicles, and pedestrians are all at risk for injury or death. Smith (2015) reported that each year there is an average of 29 fatal ambulance crashes resulting in 33 fatalities and 1,500 non-fatal but injury causing ambulance crashes (p. 92). Sanddal, Sanddal, Ward, and Stanley (2010) reported ambulance personnel were the most commonly injured in a collision involving an ambulance and also accounted for 14% of the deaths reported in fatal ambulance crashes (p. 4). Compared to police and fire truck crashes, an ambulance crash is more likely to result in a fatality to the occupants (Becker, Zaloshnja, Levick, Li, & Miller, 2003, p. 943; Bona & Friedman, 2018, para. 2). This data is supported by Reichard, Marsh, and Moore (2011) who reported the most common cause of death for a paid EMT was from a highway incident, of which the most common incident was a vehicle collision with the use of L&S being a factor in those collisions (p. 513).

There are several reasons for the increased likelihood of a fatality in an ambulance crash compared to other emergency vehicles. The most significant reason for the disparity is the rear

compartment of an ambulance. The patient compartment has poor safety design and standards, does not have a crashworthy structure, has head strike zones, and frequently has unrestrained equipment that can become a projectile during a collision (Slattery & Silver, 2009, pp. 388-390). Further, the side facing seats, a common feature in ambulances, are unsafe and often have poorly designed safety restraint systems (Slattery & Silver, 2009, p. 390). These issues make the rear compartment the most common location for incapacitating and fatal injuries in an ambulance, with 58.5% of deaths from a collision occurring in the rear compartment (Centers for Disease Control and Prevention, 2003, Table section; Kahn, Pirrallo, Kuhn, 2001, p. 263).

In addition to the poor design of the patient compartment, unrestrained or improperly restrained occupants contribute to the unbalanced distribution of injuries and deaths in the rear compartment (Kahn, Pirrallo & Kuhn, 2001, p. 263; Slattery & Silver, 2009, p. 388). Becker, Zaloshnja, Levick, Li, and Miller (2003) reported over half (52.11%) of the fatalities in the rear compartment were unrestrained at the time of the collision, and 43.6% of incapacitating injuries occurring in the rear compartment were to unrestrained occupants (p. 944). Smith (2015) reported that four out of five providers involved in a serious crash were not wearing a seatbelt at the time of the collision (p. 92). Larmon, LeGassick, and Schringer (1993) studied the difference in seatbelt usage between the front and rear compartments. The authors found providers rarely used a seatbelt in the rear compartment, and usage was even worse if the ambulance was operating with L&S (Larmon, LeGassick, & Schringer, 1993, p. 597). The primary reasons for not wearing a seatbelt were (a) they inhibited patient care, (b) restricted provider movement, (c) were inconvenient, and (d) lacked efficacy (Larmon, LeGassick, & Schringer, 1993, p. 595).

Beyond not wearing seatbelts themselves; EMS providers increase the risk of injury or death to their patients by routinely failing to secure their patients to the gurney properly. Smith

(2015) stated only a third of patients are correctly restrained, meaning providers secure the patient with all three lateral belts and both shoulder belts (p. 92). Improperly restrained patients can be ejected from the gurney in a collision, causing serious or fatal injuries (Smith, 2015, p. 92; United States Fire Administration, 2014b, p. 55). Sanddal, Sanddal, Ward, and Stanley (2010) found that patients being transported accounted for 19% of the deaths reported in fatal ambulance collisions (p. 4).

The occupants of the ambulance are not the only people injured or killed when an ambulance is involved in a collision. Smith (2015) stated only a quarter of the fatalities resulting from an ambulance collision occur within the ambulance, leaving a majority of the victims in other cars or on the street (p. 92). The occupants of other vehicles involved in a collision with an ambulance are the most commonly killed (Kahn, Pirrallo, & Kuhn, 2001, p. 263; Sanddal, Sanddal, Ward, Stanley, 2010; p. 4). Sanddal, Sanddal, Ward, and Stanley (2010) found the driver of the other vehicle was the second most commonly injured in an accident behind ambulance personnel (p. 4). When an ambulance collision does not involve another vehicle the most common fatality is to a pedestrian (Pirrallo & Swor, 1994, p. 128).

One approach to decreasing the risks associated with using L&S is to reduce how often they are used. Wolfberg (2016) suggested L&S should be the exception, not the rule for response and transport (para. 29). The National Association of Emergency Medical Services Physicians and National Association of State EMS Directors (1994) advocated for a standard protocol prescribing when to use L&S during response and transport as a way to reduce the usage of L&S (p. 133). Blackwell, Clawson, Eckstein, Miramonti, and Wang (2011) indicated that most agencies respond with L&S to Charlie determinants when it is unnecessary to do so (p. 14). Blackwell et al. (2011) stated except for the not alert and altered level of consciousness

determinant descriptors; agencies could stop responding with L&S to Charlie determinants without impacting patient outcomes (p. 14). Agencies can further reduce their L&S responses by only responding with L&S to calls where saving time is likely to improve patient survival. Examples of these types of calls include: (a) cardiac or respiratory arrest, (b) airway obstruction, (c) extreme shortness of breath, (d) childbirth or pregnancy complications, (e) heart attack, (f) stroke, (g) trauma with significant or uncontrolled bleeding, and (h) unconsciousness (Bona & Friedman, 2018, para. 8; Blackwell, Clawson, Eckstein, Miramonti, & Wang, 2011, p. 27; Kupas, 2017, p. 36; Murray & Kue, 2017, p. 210; National Association of Emergency Medical Services Physicians & National Association of State EMS Directors, 1994, p. 135). Kupas (2017) suggested providers be given the flexibility to downgrade to no L&S if additional patient information becomes available which indicates the patient may not be as serious as first thought and would not benefit from the time savings (p. 50). Finally, agencies should discontinue the practice of responding with L&S to requests to stage or standby and should consider responding without L&S to any doctor's office or skilled nursing facility where trained medical staff are already on hand (Kupas, 2017, p. 38; National Association of Emergency Medical Services Physicians & National Association of State EMS Directors, 1994, p. 134).

When determining whether to use L&S during transport, the International Association of Fire Chief's (n.d.) recommended providers consider the medical necessity, traffic, the distance to the hospital, and weather (p. 4). Dami, Pasquier, and Carron (2013) recommended EMS systems have specific regulations that consider physiological criteria and time of day for the use of L&S during transport and suggested L&S transport criteria based on the need for immediate life-saving interventions upon arrival to the hospital (p. 56). Using a standardized protocol may be an option for reducing L&S usage during transport. Two studies have been conducted to test a

protocol designed to limit the number of patients transported with L&S. Kupas, Dula, and Pino (1994) developed a protocol of medical criteria which warranted L&S transport; all of the criteria in the protocol were objective except one (p. 227). The single subjective criterion was "emergent transport should be used in any situation in which the most highly trained EMS provider believes that the patient's condition could be worsened by a delay equivalent to the time that could be gained by emergent transport" (p. 227). During the study period using the protocol, only eight percent of patients were transported with L&S (p. 227). Thirty-two percent of the L&S transports were justified by providers using the subjective criterion rather than the objective criteria (p. 228). The most common reason providers used the subjective criterion was based on the mechanism of injury from trauma, a reason the authors questioned if there were no concurrent clinical findings (p. 229). The authors believed it would be possible to further reduce the number of L&S transports by improving the subjective criterion of the protocol, but also recognized it would be impossible to have objective criteria for every type of patient (p. 229).

The second study of an L&S transport protocol was completed by Merlin et al. (2012). The authors used a prospective study to compare the usage of L&S in an EMS system using a protocol to a system which was not using a protocol (p. 520). In the system trained on the protocol, 29% of transports used L&S versus 49.6% in the non-protocol system, leaving the non-protocol system 5.6 times more likely to transport a patient with L&S (p. 523). The authors concluded agencies should implement a protocol for when to use L&S during transport (p. 523). As a final step to continue to decrease L&S usage or improve an implemented L&S transport protocol, all L&S transports should be subject to a mandatory review (Wang et al., 2008, p. 260; Wolfberg, 2016, para. 31).

There are actions which agencies and providers can take to both reduce the risk of a

collision and reduce the potential for injury or death if an ambulance is involved in a collision. The literature recommended the following actions: (a) improve driver selection and training; (b) develop and enforce policies regarding intersection safety, seatbelt usage, and equipment storage; and (c) improve the design of future ambulances (Kahn, Pirrallo, & Kuhn, 2001; International Association of Fire Chiefs, n.d.; Lacroix, 2015; Slattery & Silber, 2009; Smith, 2015). Kahn, Pirrallo, and Kuhn (2001) believed EMS systems should require a higher level of competency for drivers than the general public after they found 41% of ambulance operators who were involved in a crash had a record of a previous crash, suspension, and/or citation (pp. 263-266). Improved driver training should include the aeronautical concept of a sterile cockpit, where crew members only speak mission-critical information to minimize distractions when traveling L&S (Slattery & Silver, 2009, p. 390). Training should also focus on intersection safety, as intersections are the most common location for a collision (Kahn, Pirrallo, & Kuhn, 2001, p. 265; Kupas, 2017, p. 47; Pirrallo & Swor, 1994, p. 128; Sanddal, Sanddal, Ward, & Stanley, 2010, p. 3). Agencies must also have up to date and enforced policies on intersection safety and seatbelt usage, specifically stating the requirement to stop and clear an intersection prior to proceeding and wearing a seatbelt in the rear compartment unless a critical intervention is needed (International Association of Fire Chiefs, n.d., p. 3; Kupas, 2017, p. 47). Lacroix (2015) and Smith (2015) emphasized the need for the “three S’s” in the rear compartment: (a) secure the patient, (b) secure the equipment, and (c) secure yourself (Lacroix, 2018, p. 89; Smith, 2018, p. 94). If family members are transported with a patient, they should ride in the front of the ambulance unless specifically needed to communicate with the patient (Becker, Zaloshnja, Levick, Li, & Miller, 2003, p. 946). Finally, when purchasing a new ambulance, agencies should design the rear compartment with patient and provider safety in mind, attempting to remove

barriers to providing care while remaining restrained (Slattery & Silver, 2009, p. 393).

In summary, L&S needs to be thought of as a medical treatment that has both benefits and risks (Bona & Friedman, 2008; Dami, Pasquier, & Carron, 2013; Kupas, 2017). The primary purpose of using L&S is to reduce travel times to reach patients quicker (Kupas, 2017). The time savings benefit of using L&S is well documented, showing 0.7 to 3.8 minutes saved when responding to a scene and 1.7 to 3.6 minutes when transporting to the hospital (Kupas, 2017). Many EMS systems use L&S to help reduce response times to meet a mandated response time goal of reaching the scene in under eight minutes, 90% of the time (Bona & Friedman, 2018, para. 2; Kupas, 2017, p. 9; McCallion, 2012, para. 4). The eight-minute response time goal came into existence after a study in 1979 showed improved cardiac arrest survival if a patient received ALS care within eight minutes (Al-Shaqsi, 2010; Kupas, 2017; Pons & Markovchik, 2002). Since then, agencies have stretched the eight-minute goal to nearly every type of call rather than just the most serious calls like cardiac arrest (Al-Shaqsi, 2010; Kupas, 2017; Pons & Markovchik, 2002). As a result, agencies now respond to over 75% of their calls with L&S and transport over 22% to the hospital with L&S (Kupas, 2017).

What is missing from the literature is documentation that meeting the response time goal of eight minutes, or even saving a few minutes during response or transport improves patient outcomes. The authors of studies showing time savings using L&S commented on how the time saved often was not of any clinical significance (Brown, Whitney, Hunt, Addario, & Hogue, 2000; Dami, Pasquier, & Carron, 2013; Marques-Baptista, Ohman-Strickland, Baldino, Prasto, & Merlin, 2010; O'Brien, Price, & Adams, 1999). Compared with the benefit of using L&S, the literature showed significant risks associated with using L&S. Ambulance collisions are common, and the use of L&S increases the risk of a collision (Al-Shaqsi, 2010; Clawson, Martin,

Cady, & Maio, 1997; Saunders & Heye, 1994; Wantanabe, Patterson, Kempema, Magallanes, & Brown, 2019). Ambulance collisions expose the occupants in the rear compartment of the ambulance to a significant risk of injury or death (Kahn, Pirrallo, & Kuhn, 2001; Slattery & Silver, 2009). Outside the ambulance, occupants of other vehicles and pedestrians are potential victims when an ambulance collision occurs (Kahn, Pirralo, & Kuhn, 2001; Pirrallo & Swor, 1994).

The literature showed several ways to reduce the usage of L&S. Multiple authors urged only using L&S when there is a time-sensitive emergency where the time saved with L&S will have a benefit to the patient and outweigh the risks (Bona & Friedman, 2008; Blackwell, Clawson, Eckstein, Miramonti, & Wang, 2011; Kupas, 2017; Muray & Kue, 2017). The use of a standardized protocol was shown to reduce the usage of L&S during transport (Kupas, Dula, & Pino, 1994; Merlin et al., 2012). An L&S transport protocol should be as objective as possible, taking into consideration the patient's condition, time of day, traffic and weather to help guide a provider's decision to use L&S (International Association of Fire Chiefs, n.d.; Kupas, Dula, & Pino, 1994; Merlin et al., 2012). Beyond reducing the usage of L&S, the literature also showed some steps agencies and providers could take to reduce both the risk of a collision and the risk of injury or death if an ambulance is involved in a crash. Agencies and providers should focus on (a) driver training, (b) developing and enforcing policies on intersection safety and seatbelt usage, and (c) improve the design of future ambulance purchases to improve the safety in rear compartments (Kahn, Pirrallo, & Kuhn, 2001; International Association of Fire Chiefs, n.d.; Lacroix, 2015; Slattery & Silber, 2009; Smith, 2015).

The findings of the literature review had a significant influence on this project. It guided the development of survey and interview questions, established a base of data to compare the

results of this research against, and revealed goals and recommendations for RF&R to use to reduce L&S usage as well reduce as the risks associated with using L&S.

Procedures

This research used descriptive methodology to collect and analyze data. Data for this research was exported from RF&R's electronic patient care records (PCR) system, HealthEMS by Stryker. This research analyzed L&S and no L&S EMS scene responses between 06/1/2017 to 09/30/2017. The L&S scene responses were Charlie, Delta, and Echo MPDS determinants responded to by RF&R's downtown ALS ambulance. The no L&S scene responses were Alpha and Bravo MPDS determinants responded to by RF&R's downtown BLS ambulance.

To determine the response time difference between L&S and no L&S responses, the following data fields were exported from HealthEMS into a Microsoft Excel spreadsheet: (a) call number, (b) en-route time, (c) on-scene time, (d) vehicle #, (e) lights to scene, (f) upgraded to scene, (g) downgraded to scene, (h) dispatch reason, (i) dispatch code, and (h) incident address. A total of 333 L&S responses and 374 no L&S responses exported.

The exported data was examined for validity and any calls with missing or incomplete time data were removed. To ensure only scene calls, responded to entirely with or without L&S, and within the same geographic region were being compared, the following types of calls were removed from the data: (a) calls outside the downtown station's first due area, (b) interfacility transfers, and (c) responses which the PCR indicated were upgraded or downgraded. Finally, on incidents with multiple patients, only the data for the first patient was kept for analysis.

Response times were computed by calculating the time difference between a unit's en-route time and on-scene time. Response times less than one minute were removed because they likely would not have benefited from the use of L&S. Any response time over eight minutes was

flagged for review, resulting in the removal of any call with the high likelihood of invalid data entry (e.g., an over two-hour response to an address four miles from the station). The final number of calls analyzed for response time differences was 278 L&S responses and 286 no L&S responses. Microsoft Excel functions were utilized to calculate the mean, standard deviation, 95% confidence intervals, and 90th percentile for each data set.

This research also exported EMS transports without L&S to SCMC-Redmond between 06/1/2017 and 09/30/2017, all transports without L&S to SCMC-Bend between 01/01/2017 and 12/31/2017, and all L&S transports to SCMC-Redmond and SCMC-Bend between 01/1/2017 and 12/31/2017. The entire year of L&S transports to both hospitals and no L&S transports to SCMC-Bend were exported due to the small sample size of L&S transports during the study period of 06/1/2017 to 09/30/2017. The transports without L&S to SCMC-Redmond were completed by RF&R's downtown ALS and BLS ambulances. The transports with L&S to SCMC-Redmond were completed by RF&R's downtown ALS ambulance. The transports to SCMC-Bend (with and without L&S) were completed by RF&R's downtown ALS ambulance.

To determine the transport time difference between L&S and no L&S transports, the following data fields were exported from HealthEMS into a Microsoft Excel spreadsheet: (a) call number, (b) left scene time, (c) at destination time, (d) vehicle #, (e) lights to destination, (f) upgraded to destination, (g) downgraded to destination, (h) run disposition, (i) dispatch reason, (j) dispatch code, (k) transport to description, (l) chief complaint, (m) incident address, and (n) transport mileage. A total of 489 no L&S transports to SCMC-Redmond, 261 by the ALS ambulance and 228 by the BLS ambulance were exported. For 2017, there were 39 no L&S transports to SCMC-Bend and 91 total (to both hospitals) L&S transports exported.

The exported data was examined for validity and any calls with missing or incomplete

time data were removed. To ensure only scene calls, transported entirely with or without L&S, and within the same geographic region were being compared, the following types of calls were removed from the data: (a) calls outside the downtown station's first due area, (b) interfacility transfers, and (c) transports which the PCR indicated were upgraded or downgraded. Finally, on incidents with multiple patients, only the data for the first patient was kept for analysis.

Transport times were computed by calculating the time difference between a unit's left scene time, and its at destination time. Calls with transport mileage less than one mile were removed because they likely would not have benefited from the use of L&S. Any transport time over eight minutes was flagged for review, resulting in the removal of any call with the high likelihood of invalid data entry. After these procedures, the remaining number of calls analyzed was 187 no L&S transports to SCMC-Redmond for the ALS ambulance, 150 no L&S transports to SCMC-Redmond for the BLS ambulance, 24 no L&S transports to SCMC-Bend, and 56 L&S transports (42 to SCMC-Redmond, 14 to SCMC-Bend). Microsoft Excel functions were utilized to calculate the mean, standard deviation, and 95% confidence intervals for each data set.

To determine the percentage of calls responded to with L&S, the total number of scene calls for all of RF&R's ambulances (471, 472, 473, 474) during the study period where the PCR indicated L&S was used to the scene was divided by the total number of scene calls in the study period. To determine the percentage of calls transported with L&S, the total number of transports for all of RF&R's ambulances (471, 472, 473, 474) during the study period where the PCR indicated L&S was used during transport was divided by the total number of transports in the study period.

This research also collected data through a survey given to RF&R's front-line paramedics. The survey (Appendix A) was developed using Google Forms. An electronic link to

take the survey was emailed to 11 paramedics. These paramedics were chosen because they respond to the majority of RF&R's medical calls and are the providers who most frequently decide to use L&S. Eight surveys were completed, giving a 72% completion rate. This research also relied on interviews with RF&R's Division Chief of EMS, Doug Kelly (personal communication, November 28, 2018; Appendix B) and RF&R's medical director, Dr. William Reed (personal communication, December 19, 2018; Appendix C). Chief Kelly was selected because of his role in overseeing the EMS program for RF&R. Dr. Reed was selected for an interview because of his experience as an emergency physician and medical director.

Several limitations to this research were identified. The first limitation was the study period (06/1/2017 – 09/30/2017); meaning this research was retrospective. This could mean present-day response data may differ from the study data due to different traffic patterns or other conditions which existed during the study period, but no longer does (e.g., road construction, seasonal trafficetc.). The study period was also during the summer when road conditions are typically not an issue, compared to the winter months when ice and snow are common, causing longer response and transport times. The second limitation of this research was the assumption PCR data was correct. The lights to scene and lights to destination fields of a PCR were not required fields. It is possible more patients were responded to and transported with L&S, but the PCR author did not indicate such since it was not a required field. The third limitation is this study was not a statistical evaluation comparing L&S to no L&S. Instead, this research aggregated all calls into either L&S or no L&S and used averages and confidence intervals to compare L&S to no L&S for the first due area of RF&R's downtown fire station. The fourth limitation was the BLS ambulance studied in this research was a new resource for RF&R. Most of the employees staffing this ambulance had less than a year of experience compared to the staff

on the ALS ambulance who had several years of experience. The lack of experience could have led to increased response times from slower driving due to unfamiliarity with the area and inefficient route selection.

Results

Research question one asked: What percentage of Redmond Fire & Rescue's EMS calls are responded to with lights and siren? There were 1374 EMS calls responded to by RF&R's four ambulances during the study period. Five hundred eleven calls were responded to with L&S, 863 were responded to without L&S. The percentage of EMS calls responded to by RF&R with L&S during the study period was 37.19%.

Research question two asked: How much time, if any, does utilizing lights and siren reduce response times? To answer this question, 278 calls where the ALS ambulance responded with L&S was compared to 286 calls where the BLS ambulance responded without L&S. The results showed that the average response time using L&S was 5:15 (SD 2:09) with a 95% confidence interval of 0:15 [5:00, 5:30]. The 90% percentile for this sample was 7:54. The 286 no L&S calls had an average response time of 6:36 (SD 3:02) with a 95% confidence interval of 0:21 [6:15, 6:57]. The 90% percentile for this sample was 9:29. The difference between the average L&S response and the average no L&S response was 1:21. The confidence intervals show a potential time saving between 0:45 and 1:57.

Table 1

Research Question Two Results

Response Mode	n	M (SD)	95% CI	90th Percentile
L&S	278	5:15 (2:09)	[5:00, 5:30]	7:54
Non-L&S	286	6:36 (3:02)	[6:15, 6:57]	9:29

Note. CI = confidence interval.

Research question three asked: What types of patients potentially benefit from the time savings of responding with lights and siren? Chief Doug Kelly (personal communication, November 28, 2018; Appendix B) indicated he believed the following types of patients would benefit from the time savings of using L&S: (a) stroke, (b) chest pain or heart problems, (c) cardiac or respiratory arrest, and (d) trauma. Dr. William Reed (personal communication, December 19, 2018; Appendix C) believed the following patients might benefit from a quicker response: (a) airway or breathing problems, (b) cardiac arrest, (c) acute stroke, (d) penetrating trauma, (e) chest pain, and (f) anaphylaxis with any airway involvement.

Survey question one was asked to help answer research question three. The survey question asked: Describe the types of patients (e.g., trauma, stroke, chest pain, etc.) you believe benefit from the time savings of responding with lights and siren? Answers to this question were free text (Appendix D). The most common answer was chest pain, followed by (a) trauma, (b) respiratory or breathing problems, (c) pregnancy problems, (d) cardiac arrest, and (e) stroke. There was one mention each of (a) seizure, (b) unconscious, (c) dispatch describing a situation as needing immediate help, (d) at risk or unstable patient, (e) drowning, (f) nausea and vomiting, (g) dizziness, and (h) paramedic discretion for situations when tissue damage or long-term outcomes are improved.

Research question four asked: What percentage of EMS calls and types of patients are transported with lights and siren? There were 1008 transports by RF&R's four ambulances during the study period. Sixty-five transports were with L&S, 943 were transported without L&S. The percentage of transports which utilized L&S during the study period was 6.45%.

This research analyzed 56 L&S transports by RFR's downtown ALS ambulance in 2017 to determine the types of patients which were transported with L&S. Nine (16%) were

dispatched as chest pain. Eight (14%) were dispatched as cardiac arrest, and another eight (14%) dispatched as unconscious. Calls dispatched as stroke and breathing problems both accounted for five (9%) of the L&S transports. Four (7%) of the L&S transports were dispatched as a fall. These six call types made up 69% of the types of patients transported with L&S. All of the L&S transports were dispatched as either a Charlie, Delta, or Echo MPDS determinant. Delta and Echo determinants were the most common, with the Charlie determinant accounting for only 12 of the 56 transports (21.43%). The most common Charlie response to be transported L&S was stroke, making up five of the 12 (41.67%). Chest pain was the next most common Charlie response to be transported L&S with three (25%). Two of the remaining four non-stroke, non-chest pain Charlie responses transported L&S had the MPDS "not alert" determinant descriptor.

Research question five asked: How much time, if any, does transporting lights and siren reduce transport times? Forty-two L&S transports showed the average L&S transport time to SCMC-Redmond was 5:52 (SD 2:42) with a 95% confidence interval of 0:49 [5:03, 6:41]. The average transport distance was 2.57 miles.

The ALS ambulance's 187 no L&S transports to SCMC-Redmond during the study period showed the average transport time without L&S was 8:39 (SD 3:36) with a 95% confidence interval of 0:31 [8:08, 9:10]. The average transport distance was 2.86 miles. The BLS ambulance's 150 no L&S transports to SCMC-Redmond showed an average transport time of 8:07 (SD 2:55) with a 95% confidence interval of 0:28 [7:39, 8:35]. The average transport distance was 2.74 miles.

The time difference between the ALS ambulance's average L&S and no L&S transport time was 2:47. The confidence intervals show a potential time savings of 1:27 to 4:07. The time difference between the ALS ambulance's L&S average to the BLS ambulance's no L&S average

was 2:15, with the confidence interval showing a potential time saving between 0:58 and 3:32.

Table 2

SCMC-Redmond Transport Times

Transport Mode	n	M (SD)	95% CI
L&S	42	5:52 (2:42)	[5:03, 6:41]
ALS Non-L&S	187	8:39 (3:36)	[8:08, 9:10]
BLS Non-L&S	150	8:07 (2:55)	[7:39, 8:35]

Note. CI = confidence interval.

Fourteen L&S transports to SCMC-Bend showed the average transport time was 21:42 (SD 3:18) with a 95% confidence interval of 1:44 [19:58, 23:26]. The average transport distance was 16.26 miles. Twenty-four no L&S transports to SCMC–Bend showed the average transport time was 28:21 (SD 5:39) with a 95% confidence interval of 2:16 [26:05, 30:37]. The average transport distance was 16.89. The time difference between the average L&S and the average no L&S transport time was 6:39. The confidence intervals show a potential time saving between 2:39 and 10:39.

Table 3

SCMC-Bend Transport Times

Transport Mode	n	M (SD)	95% CI
L&S	14	21:42 (3:18)	[19:58, 23:26]
Non-L&S	24	28:21 (5:39)	[26:05, 30:37]

Note. CI = confidence interval.

Research question six asked: What criteria should providers consider when deciding to transport lights and siren? Chief Kelly (personal communication, November 28, 2018; Appendix B) stated he believed providers should consider transporting L&S when they have a patient with

(a) a compromised airway, (b) multi-system trauma, and (c) a systolic blood pressure less than 90mmHg as compared to their normal blood pressure, but especially in geriatric patients. He also believed providers should use their discretion to transport with L&S when they have a complicated patient that is beyond their ability to treat with the equipment or personnel available.

Dr. Reed (personal communication, December 19, 2018; Appendix C) believed that providers should transport the following types of patients L&S: (a) ST-elevation myocardial infarction, (b) acute stroke, (c) trauma patients meeting physiologic or anatomic trauma system entry criteria, and (d) cardiac arrest patients who have a return of spontaneous circulation. Dr. Reed (personal communication, December 19, 2018; Appendix C) also believed if a patient was unstable as evidenced by their (a) mentation, (b) Glasgow Coma Score, (c) blood pressure, (d) heart rate, (e) respiratory rate, and/or (f) oxygen saturation, the provider should seriously consider transporting them with L&S.

Survey question two and three were asked to help answer research question six. Survey question two asked: Describe the types of patients (e.g., trauma system entry, stroke, STEMI, etc.) you decide to transport code three and why. Answers to this question were free text (Appendix D). The most common answers were: (a) trauma (with internal bleeding, head injury, or the need for immediate surgery), (b) pregnancy problem or birth, (c) ST-elevation myocardial infarction, (d) return of spontaneous circulation, (e) stroke, and (f) life-saving intervention needed that cannot be performed in the field. The following answers were all mentioned once: (a) the serious ones, (b) decreasing airway, heart, or blood pressure, (c) paramedic discretion on critical patients or the need for definitive care to correct a problem, (d) at risk or unstable, (e) unprotected airway, and (f) rapid sequence intubation.

Survey question three asked: Describe the factors (e.g., weather, traffic, patient condition,

etc.) you consider when deciding to transport a patient code three and why. Answers to this question were free text (Appendix D). The most common answer to this question revolved around weather, with multiple responses indicating snow or bad weather were serious factors in deciding not to use L&S. The next most common response involved patient condition. The third most common response was traffic. Lastly, one response mentioned they considered the resources available on-scene as a deciding factor in whether they transport with L&S or not.

Discussion

The purpose of this research was to conduct a risk/benefit analysis on the usage of L&S on EMS incidents. The literature review showed that driving with L&S is not benign, and there are significant risks associated with doing so. Multiple authors showed operating with L&S increased the risk of a collision and collisions involving ambulances often lead to injuries or death to providers, pedestrians, and occupants of other vehicles (Clawson, Martin, Cady, & Maio, 1997; Heick, Young, & Peek-Asa, 2009; Sanddal, Sanddal, Ward & Stanley, 2010; Watanabe, Patterson, Kempema, Magallanes, & Brown, 2019). These risks must be given serious consideration when an organization sets response policies, and providers decide to transport with L&S.

The results of this research (Appendix E) found RF&R used L&S during response (37.19%) below the national average (76% – 77.5%) (Kupas, 2017, p. 9). This result was also below the 50% goal found in the literature (Kupas, 2017, p. 37). These results are encouraging and show RF&R used L&S more judiciously than many agencies. However, the literature review revealed additional opportunities for reducing L&S responses. Reducing the number of L&S responses is an effective method of reducing risk (Wolfberg, 2016). Because RF&R's current practice is to respond L&S on all MPDS Charlie determinants, one opportunity worth

consideration was mentioned by Blackwell, Clawson, Eckstein, Miramonti, and Wang (2011). These authors indicated most agencies could stop responding L&S to MPDS Charlie determinants, except for the not alert and altered level of consciousness determinant descriptors, without any impact on patient outcomes (Blackwell, Clawson, Eckstein, Miramonti, & Wang, 2011, p. 14). The results of this research suggest there may be a benefit in also continuing to respond L&S to stroke and chest pain Charlie determinants, as they made up 66.6% of L&S transports dispatched as a Charlie response and were mentioned in the interviews and survey responses (Appendices B, C, D, & E).

This research also showed the time-saving benefit of L&S to be an average of 1:21 during response (Appendix E). This result was on the low end of what Kupas (2017) found (1.7 minutes to 3.6 minutes) in a review of previous L&S studies (p. 32). These results are also lower than what Brown, Whitney, Hunt, Addario, and Hogue (2000) (1:46) and Ho and Lindquist (2001) (3.63 minutes) found in their studies of response times. These differences are likely from the methods used to determine the time differences; the previous studies used a chase car or other method of retracing an L&S ambulance's route along with statistical analysis, where this research compared response times in a generalized aggregate method. Other reasons for the discrepancy could be from study setting differences, i.e., travel distances, urban vs. suburban vs. rural, traffic congestionetc.

The 1:21 time benefit needs to be weighed against existing research which showed response times had little benefit on patient outcomes. The literature review referenced several studies which did not find an association between faster response time and improved patient outcomes. Blackwell, Kline, Willis, and Hicks (2009), Pons et al. (2005), Pons and Markovchick (2002) all reported there was no either no improvement in patient outcome with a quicker

response, or patients were not harmed when response times were longer. A common thread among the authors was a response time less than five minutes can improve survivability in cardiac arrest and responding with L&S should only be done when the patient needs an immediate intervention for a life-threatening condition (Blackwell, Kline, Willis, & Hicks, 2009; Pons et al. 2005; Pons and Markovchick, 2002).

In conditions such as cardiac or respiratory arrest, or airway obstruction, the patient needs immediate intervention, and responding with L&S may have clinical benefits which outweigh the risks (Brown, Whitney, Hunt, & Hogue, 2000). Other authors have suggested there is benefit in a quicker response to (a) extreme shortness of breath, (b) childbirth or pregnancy complications, (c) heart attack, (d) stroke, (e) trauma with significant or uncontrolled bleeding, and (f) unconsciousness (Bona & Friedman, 2018, para. 8; Blackwell, Clawson, Eckstein, Miramonti, & Wang, 2011, p. 27; Kupas, 2017, p. 36; Murray & Kue, 2017, p. 210; National Association of Emergency Medical Services Physicians & National Association of State EMS Directors, 1994, p. 135). The results of the interviews and surveys from this research showed that many providers consider those conditions as benefiting from a faster response as well (Appendices B, C, & D). It seems reasonable that in these conditions, a quicker response by paramedics will mean an earlier evaluation and if needed, intervention, potentially improving the patient's condition or at least slowing their decline.

The results (Appendix E) also showed RF&R used L&S during transport (6.45%) less than the national average (22.7%) (Kupas, 2017, p. 10). RF&R's current practice allows paramedics to use their discretion for when to transport L&S. These results are a little higher than what Garza, Gratton, McElroy, Lindholm, & Glass (2008) reported (5.4%) from an EMS system which also left L&S transport up to paramedic discretion (p. 26). Interestingly, RF&R's

results are lower than those reported by Kupas, Dula, and Pino (1994) (8%) and Merlin et al. (2012) (29%), both of whom studied EMS systems using a protocol designed to guide and reduce L&S usage during transport (Kupas, Dula, & Pino, 1994, p. 227; Merlin et al., 2012, p. 523). These comparisons do not immediately invalidate the need or usefulness of an L&S transport protocol. Both Kupas, Dula, and Pino (1994) and Merlin et al. (2010) showed a decline in the number of L&S transports by implementing a protocol. Developing and implementing a protocol may help RF&R reduce the of number L&S transports and get the percentage of L&S transports below the five percent recommendation found in the literature (Kupas, 2017, p. 43).

The results of this research showed transporting with L&S is quicker than without L&S. During transport to the local hospital, SCMC-Redmond, the average time savings from using L&S was 2:15 when compared to no L&S BLS transport and 2:47 for no L&S ALS transport (Appendix E). Those results are within the results Kupas (2017) reported as the average time saved using L&S in previous studies (0.7 minutes to 3.8 minutes) (p. 32). The results (Appendix E) showed the average time saved transporting to SCMC-Bend was 6:39, a surprising and potentially beneficial amount of time for some patients.

These results need to be looked at through the lens of clinical significance to determine if there is a true benefit in transporting with L&S. Previous research also showed transporting L&S saved time. However, the authors often concluded the time saved had no clinical significance (Dami, Pasquier, & Carron, 2013; Marques-Baptista, Ohman-Strickland, Baldino, Prasto, & Merlin, 2010; O'Brien, Price, & Adams, 1999). The authors primarily gauged clinical significance on whether a patient received a critical intervention in the amount of time saved by transporting L&S (Dami, Pasquier, & Carron, 2013; Marques-Baptista, Ohman-Strickland, Baldino, Prasto, & Merlin, 2010; O'Brien, Price, & Adams, 1999). It is difficult to base all of the

benefits of L&S transport on whether a patient received an intervention within the time saved. Defining clinical significance in that way seems to be an overly simplistic measurement which disregards the fact patients may still be evaluated and receive treatment quicker.

The results of this research offered a useful description of when L&S transport may benefit the patient. The survey results showed paramedics see a value in L&S transport for patients who need an intervention they are unable to provide in the field (Appendix D). This may include interventions paramedics attempted, but were unsuccessfully completed, or were unable to attempt due to limited resources (personnel, equipment, training). This description provides some assistance in identifying the types of patients who may benefit from L&S transport: (a) ST-elevation myocardial infarction needing cardiac catheterization, (b) acute stroke who may be eligible for clot-dissolving drugs or clot retrieval surgery, (c) trauma needing surgical intervention, (d) compromised airway, (e) cardiac arrest with a return of spontaneous circulation who is at risk for re-arrest during transport, and (f) pregnancy complications beyond a provider's level of training (Appendices B, C, & D).

Transporting these patients L&S may not mean they receive an intervention during the time saved. However, these patients are vulnerable to a rapid decline during transport and the care provided in a moving ambulance is often limited due to the personnel available, difficult to provide due to movement, and exposes providers to further risk by requiring them to be unrestrained (Slattery & Silver, 2009). In these cases, it appears reasonable to accept the risks of transporting with L&S to get a patient to definitive care sooner.

An important component to increase the clinical significance of transporting with L&S which was discovered during this research was to give the receiving facility early notification (Clawson & Dernocoeur, 2001, p. 3.33; Kupas, 2017, p. 41; William Reed, personal

communication, December 19, 2018; Appendix C). Reducing transport time by using L&S is unlikely to benefit the patient if the facility did not receive adequate notice to begin preparation for the patient. A consideration for providers electing to transport L&S is to give the receiving facility an early notification, especially in cases where special resources may be needed to manage the patient. Locally, "heart one," "stroke one," and "trauma system entry" notifications activate specialty resources at receiving hospitals (William Reed, personal communication, December 19, 2018; Appendix C). Providers who are transporting these types of patients should send their notification as early as possible, so resources are mobilized and ready to treat the patient when they arrive, making the most of the time saved using L&S.

A final point of discussion from the results are the environmental factors providers should consider when deciding to transport with L&S. The patient's condition is one of the major deciding factors of using L&S. However, providers must also consider the environmental factors to ensure they are not exposing themselves or other drivers to additional risk. Survey results (Appendix D) indicated that providers consider the weather (snow or fogetc.) and road condition (ice or snow buildup) when determining the usefulness of transporting with L&S. These results are supported by the recommendations of the International Association of Fire Chiefs (n.d.) who urge providers to consider weather in addition to traffic and the patient's condition.

Overall, the results from this study provided insight into the time-saving benefit of using L&S and helped narrow down the types of patients who may clinically benefit from those time savings, both during response and transport. The implication for the organization is the opportunity to review and change L&S practices based on objective data and take action to limit the use of L&S to medical conditions where the benefit to the patient outweighs the risk of a collision.

Recommendations

This research measured the time-saving benefit of using L&S on EMS calls to compare it to the risks of using L&S. The results showed that responding with L&S potentially saves around a minute and a half while transporting with L&S potentially saves a few minutes. Through the literature review, this research showed there are significant risks associated with operating an ambulance with L&S. Given the minimal time savings compared to the substantial risk, there are opportunities for RF&R to decrease L&S usage and reduce the risk of injury if an ambulance is involved in a crash.

The first recommendation to reduce L&S usage was: Stop responding L&S to MPDS Charlie determinants except for (a) chest pain, (b) stroke, (c) not alert determinant descriptors, and (d) altered level of consciousness determinant descriptors. The second recommendation was: Review the MPDS Delta determinant call types and determinant descriptors to determine which are potentially life-threatening and warrant an L&S response and stop responding L&S to any Delta determinants which are not potentially life-threatening. The third recommendation was: Update the response plan and emergency driving policy to include criteria for when providers can downgrade a response based on dispatch information or environmental conditions (e.g., weather, icy roads etc.).

The fourth recommendation was: Develop a protocol for providers to use to help determine what patients may benefit from L&S transport. This protocol should include specific patient conditions, physiologic criteria, and provide a subjective criterion for providers to use their discretion. The fifth recommendation was: Review any patient care report where the patient was transported L&S for medical necessity. Reviewing all L&S transports allows for continuous quality improvement by identifying trends in L&S transports. This information allows the L&S

transport protocol to be fine-tuned over time and identifies the need for ongoing training. The sixth recommendation was: Update policies and provide training to ensure providers properly secure equipment, patients, and themselves during transport. This recommendation includes ensuring patient family members are transported in the front compartment unless needed for patient communication. Finally, the seventh recommendation was: Before ordering any additional ambulances, form a committee to develop a specification which incorporates design best practices for patient compartment safety.

For future readers and researchers looking to address this issue in their organization, two recommendations should be considered. First, consider expanding the scope to ask a research question about EMS provider's current practices of securing equipment, patients, and themselves during transport. Finally, consider breaking down response data by time of day to determine what time of day using L&S saves the most amount of time.

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Appendix A

Lights & Siren Survey

Lights & Siren Survey

Please answer the following questions, all responses are anonymous. The data collected is being used to understand the risks associated with a motor vehicle collision involving an ambulance.

* Required

1. Describe the types of patients (e.g., trauma, stroke, chest pain, etc.) you believe benefit from the time savings of responding with lights and siren? *

Your answer

2. Describe the types of patients (e.g., trauma system entry, stroke, STEMI, etc.) you decide to transport code three and why: *

Your answer

3. Describe the factors (e.g., weather, traffic, patient condition, etc.) you consider when deciding to transport a patient code three and why: *

Your answer

SUBMIT

Appendix B

Chief Kelly Interview Documentation

11/28/18 08:00

Chief Doug Kelly

EMS Division Chief

Redmond Fire & Rescue

Q: Where did the 8:00 minute response time requirement in the standard of cover document come from?

A: The primary source is the oxygen disassociation curve and need to get to the scene to provide oxygen to patients in need.

Q: What is the definition of an emergency for our standard of cover?

A: We classify Charlie, Delta, and Echo responses as emergencies.

Q: What are the Deschutes County Ambulance Service Area (ASA) response time requirements?

A: The county uses an 8:00 for urban, 13:00 for rural, and 43:00 for super-rural response time requirement. The urban, rural, and super-rural classifications are from the Federal Government. Most of the territory served by RF&R is classified as rural.

Q: Why does RF&R use lights and siren on MPDS Charlie determinants when the standard is no lights and siren?

A: The region has always considered a Charlie response to be an emergency due to the need to get a resource to the scene quickly to provide an assessment to the patient.

Q: What are the potential repercussions for not using lights and siren to Charlie responses?
A: Potential litigation by a patient or family for a delayed response, when in the past they received a quicker response. The process to make this change would be to notify the ASA committee that RF&R will be making the change based on our data and to educate the county commissioners who have the ability to veto the change.

Q: Our data shows that we save a minimum of 45 seconds using lights and siren responding to scene calls, what patients potentially medically benefit from this time savings?
A: Stroke, chest pain or heart problems, cardiac/respiratory arrest, and trauma.

Q: Our data shows that we save a minimum of 1.5 minutes using lights and siren transporting to SCMC-Redmond, what patients potentially medically benefit from this time savings?
A: Compromised airway – not secured, but needs to be. Stroke. Cardiac arrest where a lot is going on and the providers are overwhelmed. Provider discretion with an emphasis on them not using lights and siren.

Q: Our data shows that we save a minimum of 3 minutes using lights and siren transporting to SCMC-B, what patients potentially medically benefit from this time savings?
A: Multi-system trauma, STEMI, LVO stroke, and maybe sepsis.

Q: What physiologic patient criteria do you think providers should consider when deciding to transport a patient lights and siren?

A: Compromised airway; SBP < 90 relative to patient norm, especially in a geriatric population; multi-system trauma; provider discretion for a complicated patient.

Q: What environmental factors should providers consider when deciding to transport with lights and siren?

A: Providers should opt to not use lights and siren when road conditions are bad (such as ice or snow), in bad weather, with limited visibility, and when there is construction or heavy traffic when there is no safe route around the traffic.

Appendix C

Dr. Reed Interview Documentation

12/19/18 10:00

Dr. William Reed

Emergency Physician & Medical Director

St. Charles Medical Center – Bend & Redmond Fire & Rescue

Q: Which patients clinically benefit from a quicker response using L&S?

A: Airway issues, difficulty breathing, cardiac arrest, acute stroke, penetrating trauma, chest pain, and anaphylaxis with breathing or airway compromise.

Q: Which patients clinically benefit from a quicker transport using L&S?

A: STEMI, stroke, trauma system entry meeting physiologic or anatomic entry requirements, cardiac arrest with ROSC. It is important trauma patients go to a trauma center, not just the closest facility, even if the transport takes longer. Early notification to the receiving center for STEMI, trauma, and stroke patients would best utilize the time saving from L&S transport.

Q: What physiologic criteria should providers consider when deciding to transport with L&S?

A: Unstable vitals ("serious signs and symptoms") – tachycardia, decreased mentation, hypotension, abnormal respiratory rate, and hypoxia, unsecured airway, declining GCS

Q: What environmental factors should providers consider when deciding to use L&S?

A: traffic congestion ("will L&S actually save any time?"), road conditions, weather conditions

Appendix D

Survey Question Results

1. Describe the types of patients (e.g., trauma, stroke, chest pain, etc.) you believe benefit from the time savings of responding with lights and siren?

Depending on the notes from dispatch, the type of patients that benefit the most from responding code 3 are chest pn., trauma, pregnancy problems and cardiac arrest.
Trauma system and heart one activations to Bend during rush hours.
Trauma, stroke, STEMI, respiratory distress
trauma, stemi, eminent child birth
Critical patients that will benefit from time saving response of EMS that they cannot improve upon themselves. Airway/breathing, major trauma, chest pain. Pt's that Dispatch describes to be in need of immediate help.
Any patient that the paramedics discretion deems that tissue damage or long term out comes are improved by arriving at definitive care in a timely manner. Examples being HEART 1 patient were heart tissue is being lost or Breathing difficulty patients that are not easily rectified by equipment or medications carried by EMS.
Any at-risk or unstable patients
trauma with major mechanisms of injury, chest pain with SOB, dizziness, nausea/vomiting, any unconscious pts, active labor/bleeding with pregnancy, difficulty breathing, active Seizure, cardiac/respiratory arrest, drowning and stroke.

2. Describe the types of patients (e.g., trauma system entry, stroke, STEMI, etc.) you decide to transport code three and why:

The type of patients that I decide to transport code 3 is trauma system entries (time sensitive especially if I believe there is any internal bleeding or head trauma), STEMI, ROSC, RSI, and pregnancy with significant bleeding or birth. Stroke would depend if the patient has an airway issue.
Trauma system activations due to Oregon law. Stroke one and heart one due to protocol. OB emergencies I treat like a trauma.
Same as above, any patient where time is of the essence for live saving interventions that I cannot perform in the field. i.e., surgery, cath lab, chest tube
the ones that appear serious
Critical patients that will benefit from time saving transport to a hospital with a problem that EMS cannot fix or improve on; trauma that needs an immediate surgeon, heart 1 (time is tissue), other critical patients with decreasing airway/heart/blood pressure (etc.) that need higher level of care to stabilize.
In reference to the previous answer. I will repeat that any patient I deem critical or that needs definitive care to correct the medical problem i will use my discretion to upgrade to code three.
Any at-risk or unstable patients
Multisystem/major trauma with the following- airway issues, head injury, possible internal/uncontrolled bleeding (Immediate life threats EMS cannot reverse). A pt. with an unprotected airway, STEMI, child birth especially a child birth with complications. ROSC pts. All of these issues' EMS cannot effectively control/treat and emergency transport is needed to get these pts to definitive care.

3. Describe the factors (e.g., weather, traffic, patient condition, etc.) you consider when deciding to transport a patient code three and why:

The factors I consider most is weather and patient condition. If it is snowing and driving code 3 will put myself and others more at risk, then I will not drive code 3. If the patient condition does not get better and the pt. starts deteriorating, then I will drive code 3.
I agree with the examples stated above and here is why. Weather condition is a huge factor because no one wins if you overdrive the conditions and end up crashing. Traffic; most of the time you don't need your lights for example whenever on HWY 97 going to Bend, but I believe they are beneficial once traffic slows in the city limits of Bend. Patient condition is fairly simple, if they are bad sick then they are going to be transported code 3 and if they are stable then we are going code 1.
Unstable pt., heavy traffic
Pt condition, traffic, weather. its only useful for getting through traffic lights, code 3 in bad weather is no good, more dangerous.
Comparing the stability of the patient to the benefits of driving code three with weather (fog, ice, etc.) and traffic. Dangerous weather prohibits some advantages of driving code three by making it more dangerous to EMS or other drivers around them (distractions, stopping fast, etc.). If traffic is light; code three may not get you to the destination any faster than driving code 1. Heavy traffic on a true emergency, driving code three has the advantages of getting past lines of traffic and stop lights without delaying pt. response or transport. If patient condition is deteriorating with advanced treatment from EMS, pt. condition may require code three transport.
My decision to go code three is primarily directed by the patient's condition and need for rapid interventions that I cannot perform. Weather, traffic, road conditions affect my style of drive i.e., speed, breaking distance, following distance, rout to my destination. All of those factors attribute to driving style regardless of code three or not. Driving with the lights and sirens still requires us to drive with due regard.
Everything. Code 3 does not have to be faster than Code 1
Only transport code three during optimal weather conditions. (No code three if snowing, icy, poor visibility). If the pt. does not meet criteria in question 2 there is no need to transport code three. We can wait in traffic. Also consider resources available. EMT B paired with a Paramedic and no other resources available.

Appendix E

Results Tally

LS Scene									
Unit	Beginning	Removed	Sample	Average	Std	CI	Lower	Upper	90th Percentile
471 (ALS)	333	55	278	0:05:15	0:02:09	0:00:15	0:05:00	0:05:30	0:07:54
No LS Scene									
Unit	Beginning	Removed	Sample	Average	Std	CI	Lower	Upper	90th Percentile
473 (BLS)	374	88	286	0:06:36	0:03:02	0:00:21	0:06:15	0:06:57	0:09:29
No LS SCMC-Redmond									
Unit	Beginning	Removed	Sample	Average	Std	CI	Lower	Upper	Ave. Miles
471 (ALS)	261	74	187	0:08:39	0:03:36	0:00:31	0:08:08	0:09:10	2.86
473 (BLS)	228	77	150	0:08:07	0:02:55	0:00:28	0:07:39	0:08:35	2.74
2017 LS SCMC-Redmond									
Unit	Beginning	Removed	Sample	Average	Std	CI	Lower	Upper	Ave. Miles
471 (ALS)	75	33	42	0:05:52	0:02:42	0:00:49	0:05:03	0:06:41	2.57
2017 No LS SCMC-Bend									
Unit	Beginning	Removed	Sample	Average	Std	CI	Lower	Upper	Ave. Miles
471 (ALS)	39	15	24	0:28:21	0:05:39	0:02:16	0:26:05	0:30:37	16.89
2017 LS SCMC-Bend									
Unit	Beginning	Removed	Sample	Average	Std	CI	Lower	Upper	Ave. Miles
471 (ALS)	17	3	14	0:21:42	0:03:18	0:01:44	0:19:58	0:23:26	16.26

To Scene		
471, 472, 473, 474		
1374 Total calls		
511 LS to Scene		
863 No LS to Scene		
37.19%		
Transport		
1008 total calls (treated/transported)		
65 LS to Destination		
943 No LS to Destination		
6.45%		

2017 LS Transports			
Dispatch Reason	**Dispatch Code**	**Chief Complaint**	
Chest Pain - Breathing normally > 35	10C3	Chest Pain	
Chest Pain - Breathing normally > 35	10C3	Chest Pain	
Chest Pain - Breathing normally > 35	10C3	Chest Pain	
Chest Pain - Patient NOT alert	10D1	Dyspnea-SOB	
Chest Pain - DIFFICULTY SPEAKING BETWEEN BREATHS	10D2	General weakness	16.07%
Chest Pain - DIFFICULTY SPEAKING BETWEEN BREATHS	10D2	Shortness of breath.	
Chest Pain - DIFFICULTY SPEAKING BETWEEN BREATHS	10D2	Chest Pain	
Chest Pain - Patient Clammy/Cold Sweats	10D4	Chest Pain	
Chest Pain - Heart attack or angina history	10D5	Chest Pain	
Choking - Abnormal breathing - PARTIAL obstruction	**11D1U**	**Choking**	
Seizure - CONTINUOUS or MULTIPLE seizures	**12D2**	**Seizure**	
Diabetic Problem - NOT alert - Combative or aggressive	**13C1C**	**Alt. Level Conscious**	
Fall - EXTREME FALL (>30ft)	17D1	Fall 2X height	
Fall - Patient NOT alert - On the ground or floor	17D4G		
Fall - Patient NOT alert - On the ground or floor	17D4G	Alt. Level Conscious	7.14%
Fall - Patient NOT alert - On the ground or floor	17D4G	Fall	
Heat Exposure - Patient NOT alert	**20D1H**	**Syncope/Fainting**	
Overdose/Poisoning - NOT alert	**23C1**	**Overdose**	
Overdose/Poisoning - Intentional - Unknown status	**23C7I**	**Alt. Level Conscious**	
Pregnancy/Childbirth - 3rd TRIMESTER hemorrhage	**24D4**	**Labor contractions**	
Sick Person - Abnormal breathing	**26C2**	**Diabetic Symptoms**	
Sick Person - Not alert	**26D1**	**General weakness**	
Stroke - Patient NOT alert - Clear evidence of stroke	28C1J	CVA/Stroke	
Stroke - Patient NOT alert - Clear evidence of stroke	28C1J	CVA/Stroke	
Stroke - Patient NOT alert - Clear evidence of stroke	28C1K	CVA/Stroke	8.93%
Stroke - Sudden speech problems - Clear evidence of stroke	28C3J	STROKE-1	
Stroke - Sudden paralysis or facial droop	28C5L	STROKE-1	
Traffic Accident - Auto-Bicycle/Motorcycle (HIGH MECHANISM)	29D2I	MVA To Fixed Object	
Traffic Accident - Auto-Bicycle/Motorcycle (HIGH MECHANISM)	29D2I	MVA To MV	5.36%
Traffic Accident - Entrapment - Unknown number of patients	29D5U	MVA To MV	
Allergies/Envenomations w/ SEVERE RESPIRATORY DISTRESS	**2D2**	**Allergic Reaction**	
Unconscious - AGONAL/INEFFECTIVE BREATHING	31D1	Unconscious	
Unconscious/Fainting - Effective breathing	31D2	Alt. Level Conscious	
Unconscious/Fainting - Effective breathing	31D2	Unconscious	
Unconscious/Fainting - Patient NOT alert	31D3	Syncope/Fainting	14.29%
Unconscious/Fainting - Patient NOT alert	31D3	Altered LOC	
Unconscious/Fainting - Patient NOT alert	31D3	Cardiac Arrest	
Unconscious/Fainting - Patient NOT alert	31D3	Syncope/Fainting	
Unconscious/Fainting - Patient NOT alert	31D3	Seizure	
Unknown Medical Problem - LIFE STATUS QUESTIONABLE	**32D1**	**Unconscious**	
Animal Bites/Attacks - Patient NOT alert	**3D3**	**Animal Bite**	
Mobile Home Fire	**69D10**	**BurnS**	
Breathing Problem - Patient NOT alert	6D1	Dyspnea-SOB	
Breathing Problem - Patient NOT alert	6D1	Unconscious	
Breathing Problem - DIFFICULTY SPEAKING BETWEEN BREATHS	6D2	Short of breath	8.93%
Breathing Problem - DIFFICULTY SPEAKING BETWEEN BREATHS	6D2	Dyspnea-SOB	
Breathing Problem - DIFFICULTY SPEAKING BETWEEN BREATHS	6D2O	Dyspnea-SOB	
Fire with persons reported inside	**7C1F**		
Cardiac/Respiratory Arrest - INEFFECTIVE BREATHING	9D1	Cardiac Arrest	
Cardiac/Respiratory Arrest - INEFFECTIVE BREATHING	9D1	Cardiac Arrest	
Cardiac/Respiratory Arrest - Death	9E0z	Alt. Level Conscious	
Cardiac/Respiratory Arrest - NOT BREATHING AT ALL	9E1	Overdose	14.29%
Cardiac/Respiratory Arrest - NOT BREATHING AT ALL	9E1	Cardiac Arrest	
Cardiac/Respiratory Arrest - NOT BREATHING AT ALL	9E1	Cardiac Arrest	
Cardiac/Respiratory Arrest - NOT BREATHING AT ALL	9E1	Cardiac Arrest	
Cardiac/Respiratory Arrest - Hanging	9E3		