

RESEARCH REPORT

# ADVANCED INTERVENTIONS DURING PREHOSPITAL TRANSPORT OF PATIENTS WITH CHEST PAIN AND SUSPECTED ACUTE CORONARY SYNDROME

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## ABSTRACT

**Objective:** This study aims to describe the frequency and type of advanced (ALS) interventions performed by emergency medical services (EMS) providers while caring for undifferentiated chest pain patients.

**Methods:** This pilot study is a retrospective review of advanced interventions performed on consecutive adult patients transported by EMS with a provider impression of non-traumatic chest pain and treated under the suspected acute coronary syndrome statewide protocol from July 2013 through January 2022. The EMS system studied is a hospital-based agency serving a large suburban to rural population in central Pennsylvania. Advanced interventions were defined a priori and included STEMI activation.

**Results:** During the study period, 2,456 EMS transports out of 97,877 met study inclusion criteria. A total of 121 advanced interventions were performed on 101 (4.1%) of these patients, the majority 79 (3.2%) of which were prehospital notifications of STEMI activations. Intravenous medications were administered 25 times to 22 (0.9%) patients and advanced procedures were performed 17 times on 7 (0.3%) patients. Several patients received more than one intervention or medication. Patients between 60 and 65 years of age accounted for the highest number of activations (283, 11.5%) and received the largest number of interventions (28, 9.9%). Only eight patients were below the age of 45, and all were STEMI activations only.

**Conclusion:** We found that less than 5% of included patients transported by EMS required advanced interventions, most of which were STEMI activations not requiring any additional interventions. Further investigation is required to determine if certain characteristics or risk factors predict the need for out-of-hospital advanced interventions and ALS transport.

## INTRODUCTION

Chest pain is one of the most frequent symptoms experienced by patients seeking emergency care (Mokel, 2013). It is estimated that over 6.5 million patients presented to emergency departments throughout the United States for evaluation of chest pain

in 2017 alone (Rui, 2017). Many of them arrive by emergency medical services (EMS). Studies show that as many as 10% to 15% of EMS calls are for individuals experiencing chest pain (Clawson, 2008; Wilbring 2021). Potential causes of chest pain range from relatively benign disorders, such as muscle strain or gastritis, to imminently life-threatening conditions, including pulmonary embolism, aortic dissection, and myocardial infarction.

While serious medical conditions may cause chest pain, the majority of the patients transported by EMS with chest pain are ultimately diagnosed with self-limiting, non-cardiac causes for their symptoms (Alotaibi, 2021). A study by Saddichha and Saxena (2009) found that less than 10% of patients presenting with chest pain were found to have ischemic cardiac events. This estimate increases to 15% when any potentially life-threatening condition is considered (Rawshani, 2014). Regardless of final ED diagnosis and disposition, what is important and unknown is how many actually require or receive advanced life support (ALS) intervention due to their complaint.

Because of the potential seriousness of the complaint, most chest pain patients are traditionally transported by ALS units staffed with paramedics or physicians in countries that deploy doctors on ambulances. This is a practice that may be unnecessary for many of these patients.

While studies have attempted to correlate prehospital factors of undifferentiated chest pain patients with traditional outcomes, such as major adverse cardiac events at 30 days or the need for coronary intervention, little is known about the care they receive in the out-of-hospital phase (Stopyra, 2018). This study aims to describe the frequency of advanced interventions performed by EMS providers while caring for undifferentiated patients with chest pain/suspected acute coronary syndrome. We hypothesize that few patients will require advanced interventions during transportation to the hospital. This knowledge could be used to develop more resource-appropriate transportation decisions based on the predicted immediate needs of the patient, irrespective of final disposition from the emergency department.

## **METHODS**

### **STUDY DESIGN**

This pilot study is a retrospective review of consecutive adult patients transported by EMS with a provider impression of chest pain and treated using the suspected acute coronary syndrome statewide protocol. This study was deemed exempt from full IRB review by the Human Subjects Protection Office of Penn State University (Study #00015252).

### **STUDY SETTING AND POPULATION**

The EMS system studied is a hospital-based agency that serves a large suburban to rural population in central Pennsylvania. The Commonwealth of Pennsylvania utilizes a system of statewide protocols for basic and advanced life support. These protocols are

universally applied with few exceptions for optional or pilot protocol adaptation. The electronic medical record allows for documentation of the particular treatment protocol being followed for each individual case or intervention. Furthermore, a field for provider impression is required, and a selection is made from a dropdown menu.

*STUDY PROTOCOL*

The reporting function of the electronic medical record (emsCharts, ZOLL Medical, Chelmsford, MA) was queried for patients transported from 7/1/2013 to 1/5/2022 who met inclusion criteria. Inclusion criteria included adults 18 or older with an EMS provider impression of non-traumatic chest pain or discomfort and treatment under the Suspected Acute Coronary Syndrome Statewide Protocol. Exclusion criteria included individuals less than 18 and those with unknown ages. Investigators reviewed records for advanced interventions for individuals included in the study. Advanced interventions were pre-defined as defibrillation or cardioversion, transcutaneous pacing, IV medications for the treatment of arrhythmia, bradycardia, hypotension or shock, or identification of an ST-elevation myocardial infarction (STEMI). In the Commonwealth of Pennsylvania and many other states, the administration of aspirin is included in the basic life support protocols. Acquiring a 12-lead electrocardiogram and transmitting it is also part of the BLS protocols. Administration of nitroglycerine and opioids was not included in the definition of advanced interventions as they have not been shown to improve outcomes in patients with ACS (Savino, 2015). The authors do acknowledge that pain management is a consideration in such cases and could be a benefit of advanced care in resource-rich settings.

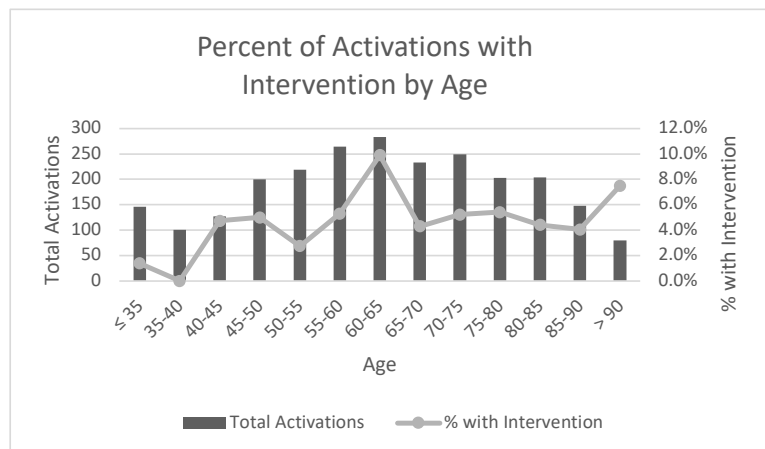
*DATA ANALYSIS*

Interventions were reported as a percentage of included patients. Continuous variables were reported using the median and interquartile range. Simple descriptive statistics were performed (Excel 2013, Microsoft Corporation, Redmond, WA).

**RESULTS**

There were 97,877 total EMS activations from the study period. 2,456 (2.5%) of these activations met the study inclusion criteria. The median age was 64 [IQR 51-76] and ranged from 18 to 100. Almost half (48.6%) of the participants were female.

121 advanced interventions were performed on 101 (4.1%) patients. The median age of those who received advanced interventions was 65 [IQR 58-



**Figure 1** - Percentage of calls with advanced interventions by age. Represents the total number of activations and percent of activations with advanced intervention for each corresponding age group.

76]. All but eight interventions were performed on patients over 45, and these were all STEMI activations that did not require additional advanced care. Patients between 60 and 65 accounted for the highest number of activations (283, 11.5%) and received the largest number of interventions (28, 9.9%). Twenty-three percent of all interventions performed were in this age range (Figures 1, 2). Overall, intravenous medications were administered 25 times to 22 (0.9%) separate patients during the study period. These medications included adenosine, amiodarone, atropine, diltiazem, epinephrine and normal saline. Prehospital alerts for STEMI were activated for 79 (3.2%) patients and several interventions occurred in these patients. Advanced procedures, which included cardiopulmonary resuscitation (CPR), defibrillation or electrical

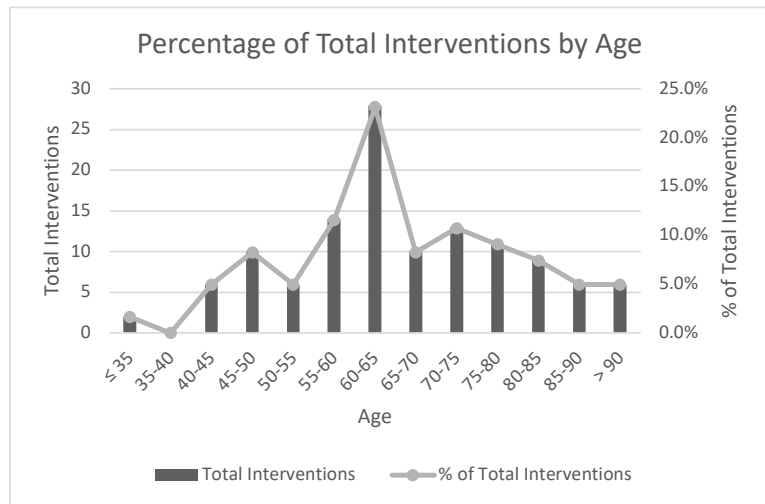


Figure 2 - Percentage of total interventions by age. Represents the total number of interventions and the percentage of total interventions for each corresponding age group.

cardioversion and transcutaneous pacing, were performed 17 times on 7 (0.3%) patients. Advanced interventions performed by EMS providers during this study period are summarized in Table 1.

Intervention	n	%
Any advanced intervention	101	4.1
Intravenous medication (total)	25	1.0
Adenosine	1	0.04
Amiodarone*	8	0.3
Atropine	1	0.04
Diltiazem	2	0.08
Epinephrine	1	0.04
Normal saline (for hypotension)**	12	0.5
STEMI activation	79	3.2
Advanced procedures	17	0.7
CPR*	5	0.2
Defibrillation or electrical cardioversion*	12	0.5
Transcutaneous pacing	0	0

\*One STEMI patient received defibrillation, CPR, and amiodarone  
 \*\*Two STEMI patients received normal saline for hypotension

Table 1 - Summary of advanced interventions performed (n = 2456 EMS activations)

pain patients, with only 2.1% of the study population ultimately diagnosed with an acute myocardial infarction during the index hospital admission. Given that advanced interventions are rarely required, further consideration should be given to how prehospital providers transport patients with chest pain.

## DISCUSSION

This study demonstrates that few EMS transports for chest pain with suspected acute coronary syndrome require or receive advanced interventions from prehospital providers. This is consistent with previous investigations demonstrating that most cases of chest pain are due to non-life-threatening causes. A study by Pedersen et al. (2019) found a high rate of over-triage for ambulance-transported chest

There is currently a limited body of literature that has attempted to identify patients at increased risk for major adverse cardiac events in the prehospital setting. Several studies have examined the relationship between data collected in the prehospital setting and conventional hospital-based outcomes such as mortality or 30-day major adverse cardiac events (Wilbring, 2016; Frisch 2018). Frisch et al. (2018) did find that advanced age, among other historical factors, was associated with abnormal cardiac catheterization, the performance of coronary artery bypass grafting, and death in the hospital. Indeed, in our study, the median age for requiring advanced intervention was 65 years. A total of 8 interventions were performed on patients under age 45. Interestingly, this is also the lower limit of risk stratification for age in the HEART pathway (Backus, 2010). It should be noted that all of the advanced interventions in this younger group were prehospital activation of STEMI, and none required advanced procedures or medications. Interventions were most commonly performed on patients between 60 and 65. A total of 9.9% of activations in this age range required interventions, and 23.1% of all interventions were performed on these patients. Further investigation should build on these findings to determine if certain patient characteristics or risk factors are associated with more frequent need for advanced interventions by prehospital providers.

There is no doubt that some chest pain patients will require advanced care, and it may be that it actually does make a difference in overall mortality outcomes, as suggested by the Ontario Prehospital Advanced Life Support (OPALS) Study Group in a recent paper (Stiell, 2022). Nonetheless, their findings also support our hypothesis. It was a minority of their chest pain patients received any advanced intervention. Only 7.4% of patients received some IV medication, most commonly morphine (4.2%) and intravenous fluid bolus (3.5%); 0.7% received adenosine, 0.3% atropine, and 0.25% lidocaine. Only 1 patient (0.02%) received dopamine. One study by Holmberg et al. (2018) found that increased chest pain severity did correlate with rates of hypotension and bradyarrhythmia requiring prehospital intervention. Overall, this study reported a complication rate of 2.9 to 3.1%, requiring prehospital intervention in patients suffering from chest pain of suspected cardiac origin.

Nonetheless, because of perceived increased seriousness, EMS calls for patients with chest pain are typically given a high triage level, and ALS resources, when available, are dispatched immediately. Such a response comes at an increased overall cost, greater equipment and supply need, and personnel expense compared to basic life support (BLS) resources (Bissell, 1998). This is particularly concerning when the data regarding ALS versus BLS care for patients with cardiovascular complaints are considered. Furthermore, evidence-based interventions for acute coronary syndrome and cardiac arrest, such as aspirin administration, high-quality CPR, and early defibrillation, are within the BLS scope of practice. A review by Isenberg and Bissell (2005) showed no difference in patient outcomes for myocardial infarction or cardiac arrest when ALS provided care compared to BLS providers. A separate study showed that patients receiving BLS care for out-of-hospital cardiac arrest actually had higher survival rates to hospital discharge and at 90 days as well as better neurologic functioning compared to those who received ALS (Sanghavi, 2015). Given the increased resources required and limited, if any, benefits, ALS transportation for every patient with chest pain does not appear to be a cost-effective approach when providing prehospital care.

The purpose of this study is not to diminish the utility of high dispatch priority or initial ALS response in patients requesting EMS resources for chest pain. As mentioned above and suggested by the OPALS study group, advanced interventions may indeed contribute to improved patient outcomes. Certainly, the ability to identify STEMI and activate appropriate hospital resources is beneficial to patients. The American Heart Association advocates for early identification of STEMI and transportation by EMS to decrease the time to treatment and improve the morbidity and mortality of patients suffering from STEMI (Antman, 2004). This was the most frequent advanced intervention observed in our study. Unlike the OPALS study, we did not examine outcomes in patients receiving advanced interventions and, therefore cannot comment on the impact of the interventions performed. While their work is critical to understanding the impact of ALS care, we aim to complement this research and provide commentary on the frequency of these interventions. A scenario may exist in which, after ALS assessment, including a screening 12-lead electrocardiogram, a subset of patients can safely be transported to the hospital via BLS. Advanced resource allocation would remain unchanged; however, their utilization may be dedicated to transporting patients more likely to require advanced intervention during transport. Further research will be needed to ensure that resources are utilized such that the maximal number of patients can be provided care that has been proven to improve their outcomes.

## LIMITATIONS

As this study was performed within a single EMS system, the generalizability of our results may be limited. For example, systems with longer transport times may be more likely to provide advanced interventions during transport. Our data were collected through retrospective chart review and therefore we were unable to assess for incomplete or inaccurate data. A total of 2.5% of patients met our inclusion criteria, less than the previously reported frequency of EMS activations for chest pain. Requiring documentation of specific treatment protocols and provider impressions likely contributed to underrepresenting the true number of patients presenting with non-traumatic chest pain. As we examined interventions performed, it is possible there were missed opportunities to intervene, and our results may underestimate the actual need for ALS intervention. In some systems, particularly internationally, further advanced interventions such as administering antiplatelet agents may be of value and not mentioned here—finally, not all patients with cardiac issues present with chest pain. However, the outcome of interest was not the accuracy of diagnosis but rather what happens to the patient that presents to EMS with chest pain and suspected acute coronary syndrome.

## CONCLUSION

Chest pain is a common symptom experienced by individuals seeking medical care. While providers must consider and screen for potentially life-threatening conditions when caring for these patients, most of these are likely due to relatively benign causes and do not require any immediate ALS care on scene or in the ambulance during transport. Our study suggests that it is a minority of chest pain patients receive an ALS intervention during transport to the hospital. A better understanding of this might

allow a more pragmatic use of ALS resources for these transports. This could be a benefit, especially in areas where paramedic or physician-level care is in short supply. Further investigation is required to determine if certain patient characteristics, such as the description of symptoms, presence of cardiovascular risk factors, or EKG abnormalities, may predict the need for out-of-hospital advanced interventions and, consequently, ALS transport.

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