

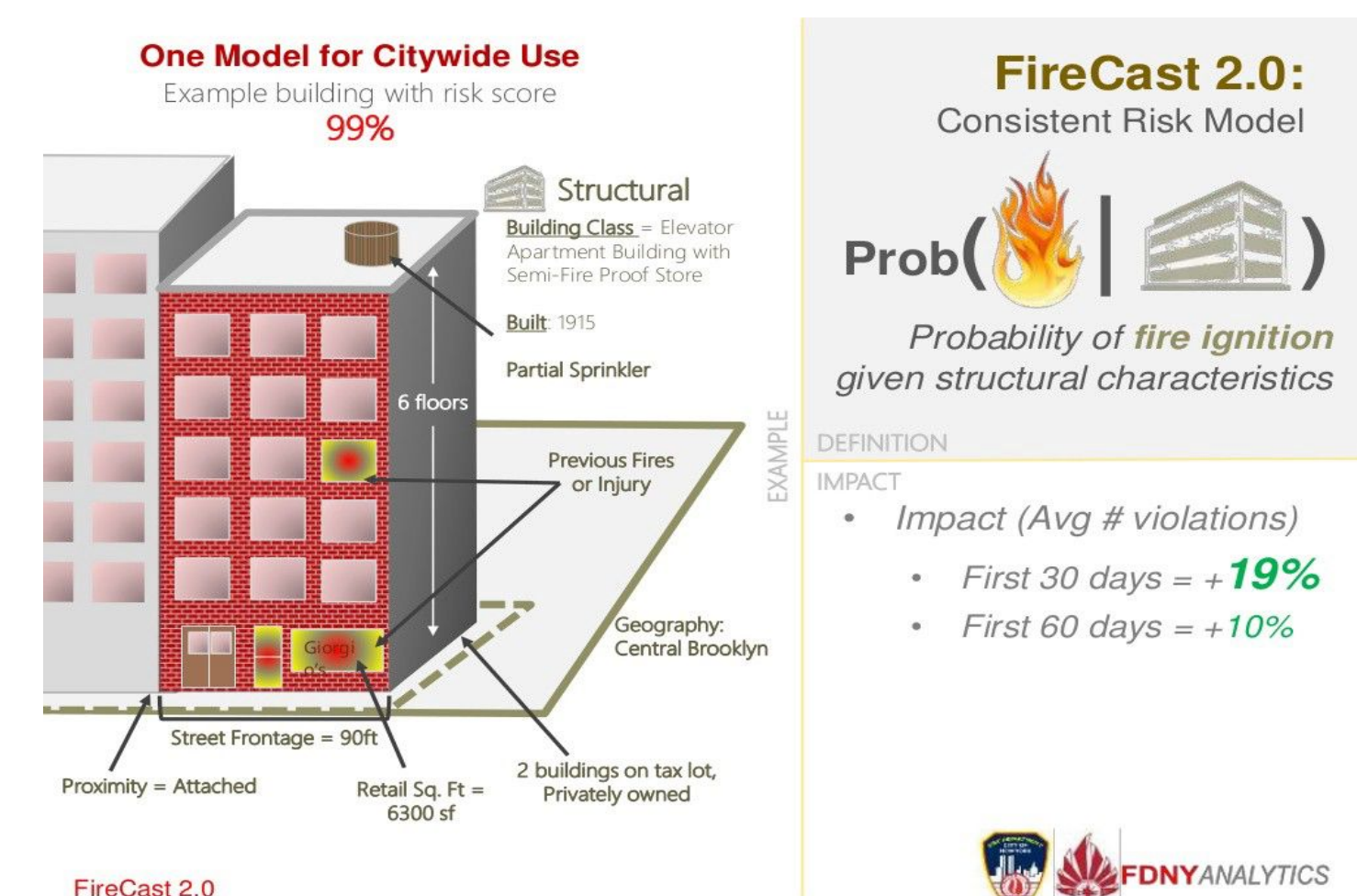
Community Risk Assessment for the Valparaiso Fire Department

Ashley Darnell

Introduction

This project is a collaboration between Valparaiso University and the Valparaiso Fire Department to perform a community risk assessment for the city of Valparaiso. In recent years there has been a push among the fire community towards the use of data science. Several large fire departments across the nation have employed the use of data scientists to create models to predict the location and types of fires that are most likely to occur. Historical attempts to predict fires include big projects like NYC FireCast, New Orleans Smoke Signal, and Atlanta FireBird. These projects have set precedents for predictive analytics within the fire community.

The main goals of this project are to organize and clean the data from the Valparaiso Fire Department and to conduct exploratory data analysis. In addition, we will be preparing for a future student to perform predictive analytics by finding additional sources of data and reviewing the literature on other fire prediction projects.



Data Collection and Cleaning

Data was given to us from the Valparaiso Fire Department for the years 2010-2020 in Excel files. In the raw data, there are several important variables that we used to create pivot tables and charts including incident ID, incident type, date, property value, property loss, and address.

We created a new variable of property saved by subtracting the property loss from the property value. The property saved variable was requested by the Fire Department in order to highlight the important impacts of their work. However, it became immediately apparent that some property values were missing or incorrect after creating the original pivot table, shown below on the left. There were obvious errors in the table such as extremely high values and negative values that led us to further investigate the property values and discover that many were missing or incorrect.

In order to locate the missing and correct property values, we utilized websites including Zillow, Realtor, and the Porter County Property Assessor's website. We attempted to match the year that we retrieved the property values to the year that the fires occurred. Overall, there were 245 fires in the data set, and 17% of the values were originally missing or incorrect. The pivot table below on the right displays the total property values, property loss, and property saved for each year in the clean data.

Original Data				Clean Data			
Years	Sum of Property Value	Sum of Property Loss	Sum of Property Saved	Years	Sum of Property Value	Sum of Property Loss	Sum of Property Saved
2010	\$824,000	\$365,750	\$458,250	2010	\$12,631,300	\$365,750	\$12,265,550
2011	\$637,924	\$807,900	\$169,976	2011	\$3,162,241	\$807,900	\$2,354,341
2012	\$2,506,754	\$2,113,600	\$393,154	2012	\$4,247,422	\$2,113,600	\$2,133,822
2013	\$1,957,000	\$1,521,000	\$436,000	2013	\$4,379,449	\$1,521,000	\$2,858,449
2014	\$1,555,000	\$1,085,000	\$470,000	2014	\$10,898,800	\$1,085,000	\$9,813,800
2015	\$4,070,100	\$411,100	\$3,659,000	2015	\$4,705,852	\$411,100	\$4,294,752
2016	\$30,275,002	\$1,075,002	\$29,200,000	2016	\$30,275,002	\$1,075,002	\$29,200,000
2017	\$1,017,293,219	\$2,320,350	\$1,014,972,869	2017	\$18,467,619	\$2,320,350	\$16,147,269
2018	\$106,232,980	\$1,635,130	\$104,597,850	2018	\$106,232,980	\$1,635,130	\$104,597,850
2019	\$5,343,779	\$1,679,650	\$3,664,129	2019	\$5,343,779	\$1,679,650	\$3,664,129
2020	\$10,384,625	\$601,325	\$9,783,300	2020	\$10,384,625	\$601,325	\$9,783,300
Grand Total	\$1,181,080,383	\$13,615,807	\$1,167,464,576	Grand Total	\$210,729,069	\$13,615,807	\$197,113,262

Analysis of Dispatch Complaints

While also attending to incidents of fires, another beneficial service provided by the Fire Department is dispatching Emergency Medical Services (EMS). The data collected from the EMS dispatches is separate from the fire incident data. With the EMS data provided for Valparaiso from 2016-2020, we were able to show the frequency of various EMS dispatch complaints, which are the reported reasons for why the EMS is being sent out.

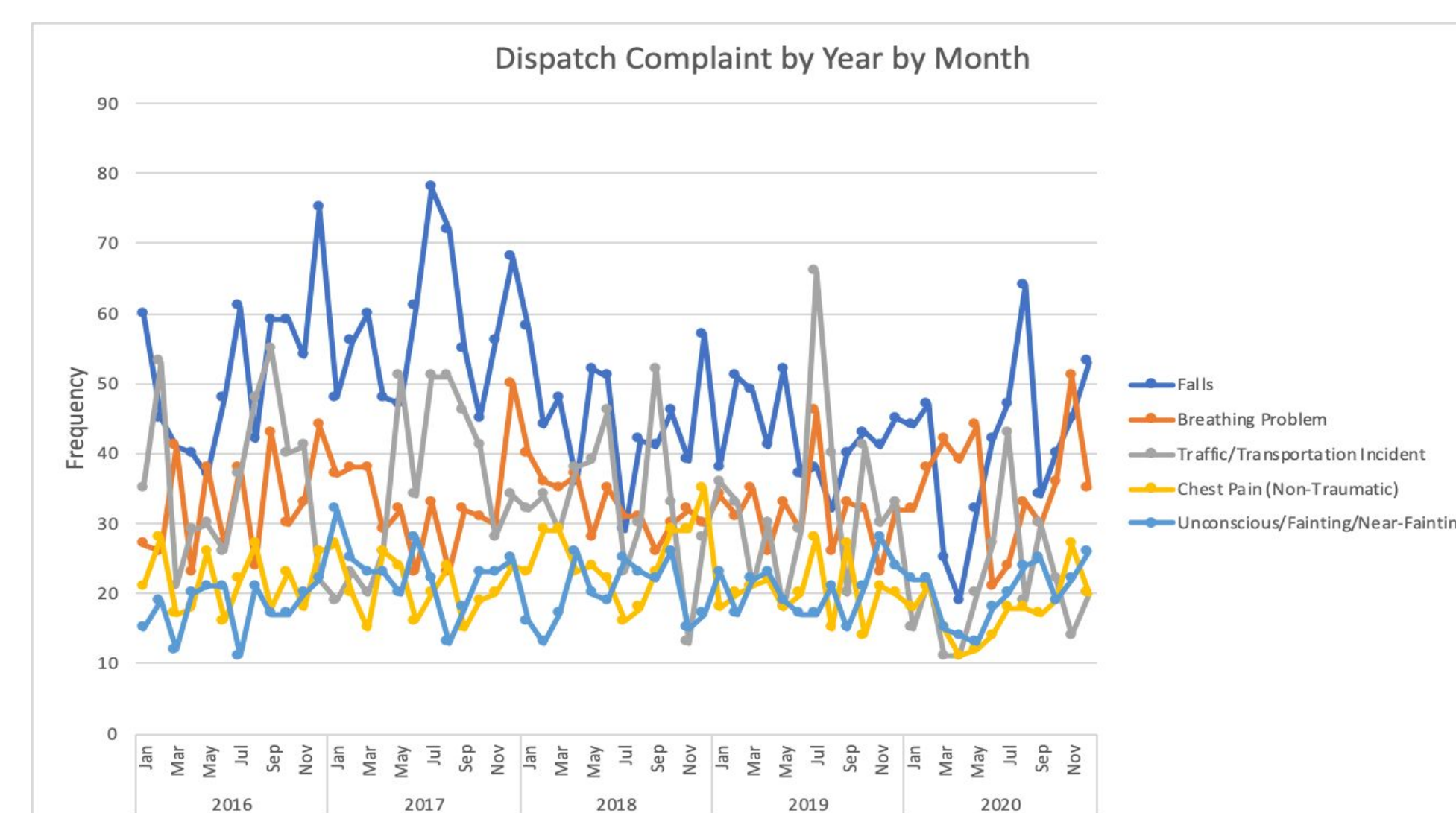
Dispatch complaint	Count
Sick Person	2997
Falls	2857
Breathing Problem	1986
Traffic/Transportation Incident	1909
Chest Pain (Non-Traumatic)	1264
Unconscious/Fainting/Near-Fainting	1217
No Other Appropriate Choice	657
Psychiatric Problem/Abnormal Behavior/Suicide Attempt	606
Convulsions/Seizure	583
Abdominal Pain/Problems	580
Hemorrhage/Laceration	486
Cardiac Arrest/Death	458
Unknown Problem/Person Down	454
Stroke/CVA	450
Overdose/Poisoning/Ingestion	440
Traumatic Injury	336
Diabetic Problem	327
Heart Problems/AICD	244
Back Pain (Non-Traumatic)	239
Assault	163
Allergic Reaction/Stings	146

While the EMS dispatch calls may seem unpredictable, there are certain types of calls that occur much more frequently than others. By indicating the most common types of dispatch complaints, the Fire Department can better prepare and train the EMS personnel.

The pivot table to the left is organized from most common type of dispatch complaint to least common. It is clear to see that six of the complaints occur much more frequently than others: sick person, falls, breathing problem, traffic/transportation incident, chest pain (non-traumatic), and unconscious/fainting/near-fainting.

Dispatch Complaints Over Time

In order to examine the trends occurring within the dispatch complaints across the span of the data, we extracted the top five most common dispatch complaints and graphed them across time. It should be noted that "sick person" was the most common reason for a dispatch complaint; however that was left out of the graph due to the vagueness of the term.

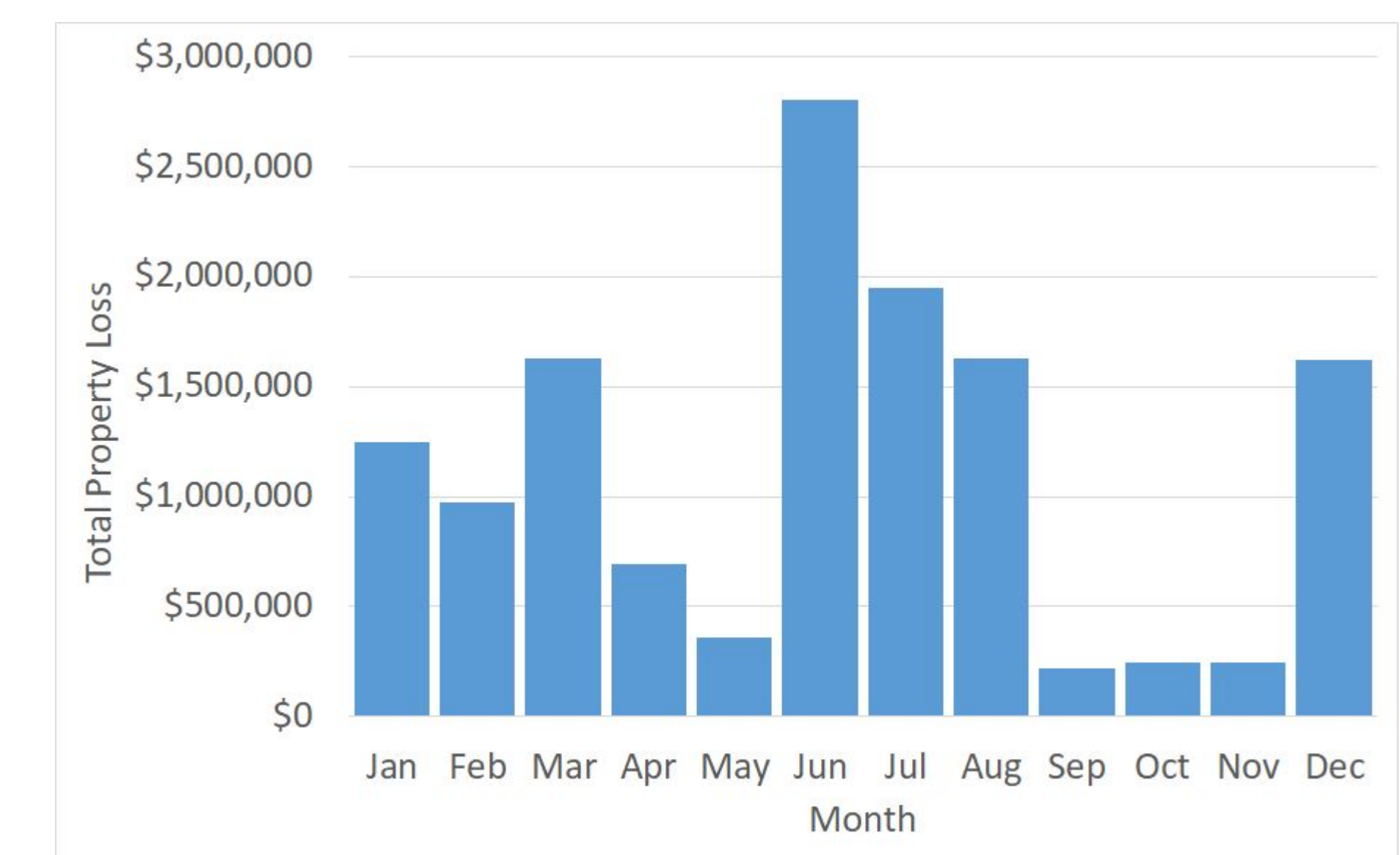


An interesting finding in this graph was in the year 2020. We can observe that while the complaints of falls, traffic/transportation incident, chest pain (non-traumatic), and unconscious/fainting/near-fainting all decrease in early 2020, breathing problem increases. This *may* be attributable to the fact that COVID-19 was heavily prevalent in this year. Therefore people may have been hesitant to call the EMS for reasons that did not mimic the symptoms of the disease, such as breathing problems.

Otherwise, there were no clear patterns present in analyzing the dispatch complaints over time. This information can still help the Fire Department understand that conditions are generally steady and that they should not expect any significant increases or decreases in the future.

Property Loss Over Time

The amount of property loss due to fires can be examined across time in order to find trends. The graph below displays the total property loss due to fires in Valparaiso from 2010-2020, broken down by month.



The expected result prior to creating this graph was that the winter months would have the highest reported property loss due to more fires caused by heating. However, it was actually the summer months that proved to have the highest reported property loss. This information can be used by the Fire Department to motivate further investigation into the underlying reason for higher property loss in the summer months. The Fire Department can then more efficiently allocate resources and training for fire prevention.

Future Work

As we move forward with this project, we would like to examine the effects of the LUCAS Device, which is a device used to perform automatic chest compressions on an individual in place of those done manually by EMS personnel. The Valparaiso Fire Department began using the LUCAS Device in May of 2017. While we are still waiting on data regarding the LUCAS device, we plan to perform a hypothesis test to investigate whether or not there is evidence of a significantly higher percentage of successful resuscitations after the implementation of the LUCAS device compared to before it was deployed.



Acknowledgements

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