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**ORIGINAL ARTICLE**

# Impact of COVID-19 Pandemic on acute cardiac emergencies: ST- Elevation Myocardial Infarction, Acute Aortic Dissection and Ventricular Septal Rupture

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## ABSTRACT

**Aim:** To evaluate the influence of the Covid- 19 pandemic on Acute Cardiac Emergencies, namely, ST-Elevation Myocardial Infarction (STEMI), Acute Aortic dissection (AAD) and Ventricular Septal Rupture (VSR) at a tertiary care hospital in India. **Methods:** A total of 880 acute cardiac emergencies patients presenting at the emergency department at a tertiary cardiac care centre, diagnosed with STEMI, VSR and AAD were included in the study. **Results:** A notable reduction in the number of STEMI, VSR and AAD patients presenting to the emergency department was observed coinciding with the COVID-19 pandemic. In STEMI patients the average time from onset of signs and symptoms to first medical contact changed from a central tendency of 5.5 hours pre Covid-19 to 6 hours post Covid-19 ; door to balloon time changed from a central tendency of 90 minutes pre Covid-19 to 82.5 minutes post Covid-19 ; a reduced ejection fraction of less than or equal to 40% was seen in 37.22% of patients pre Covid-19 to 50.7% of patients post Covid-19 ; Percentage of patients in Killip class-1 and Killip class-3 decreased from 84.09% to 69.85% and 1.13% to 0.73% respectively post pandemic. And the percentage of patients in Killip class-2 and Killip class-4 increased from 4.82% to 13.23%, and 9.94% to 16.17% respectively post-pandemic. We observed a sharp fall in acute cardiac emergency patients post Janta Curfew declared on March 22nd, 2020. There was also a rise in STEMI and VSR patients seen post Unlock 4 declared on September 1st, 2020. **Conclusion:** The COVID-19 pandemic has significantly decreased the presentations of acute cardiac emergencies at our tertiary care hospital. There was also a significant delay in time from onset of signs and symptoms to first medical contact. There was no impact on the quality of care given to patients, in fact a decrease in door to balloon time was seen post pandemic at our centre. However, patients presented with a lower ejection fraction and higher Killip's classification post pandemic. This indicates the possibility of increased mortality and morbidity of such patients, which is a matter of public health concern globally. It is important that we address this by increasing access to immediate healthcare facilities via tele-consultation.

**Keywords:** STEMI, Acute aortic emergency, Ventricular Septal rupture, COVID-19

## Introduction

The COVID-19 Pandemic has put tremendous strain on our medical care systems globally, causing many medical care organizations to disallow elective admissions for coronary angiograms.

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Several researchers across the globe have collated the incidence of acute coronary syndrome and outcome during the COVID period to that of the year before; Following analysis and comparison they have emerged with quite conflicting findings [1,2,3]. The standard for treatment of STEMI patients has been primary percutaneous coronary intervention (PPCI) during the pre-pandemic era. Fibrinolytic therapy was suggested rather than PPCI by the Chinese Cardiac Society during the pandemic to scale back the danger to health care workers[4]. However, the American College of Cardiology and Society for Cardiac Angiography and Interventions has since recommended PPCI should remain the standard for treatment of STEMI patients regardless of the ongoing pandemic[5].

The outbreak of the COVID-19 pandemic has forced us to rapidly adapt and change practices which we have long adhered to in the healthcare system. An overall shortage of personal protective equipment (PPE) for healthcare workers, a chronically exhausted hospital infrastructure and a significant lack of sanitization supplies were some of the major hurdles presented to healthcare facilities around the world on account of the pandemic. The pandemic has globally elicited hospitals to create new therapies and strategies to continue efficient operations.

In this paper, we will explore the impact of the COVID-19 pandemic on acute cardiac emergencies namely ST-Elevation Myocardial Infarction (STEMI), Ventricular Septal Rupture (VSR) and Acute Aortic Dissection (AAD). Many reports suggest that the pandemic has led to a decrease in patients presenting to hospitals with serious cardiovascular diseases[6]. Ventricular septal rupture is a lethal complication that occurs within the first week of acute myocardial infarction. With advancements in interventional treatment towards early reperfusion therapy VSR has become a rare complication, however it still has a high mortality rate[7]. Similarly, STEMI and AAD are both cardiac diseases which necessitate prompt treatment; delays in treatment of such cardiac emergencies can lead to unnecessary fatalities. In this paper we sought to measure the influence of the COVID-19 pandemic on the presentation and outcomes of STEMI, VSR and AAD patients admitted to a tertiary care centre in India during the COVID-19 pandemic.

## Materials and Methods

**Study design-** This is a retrospective record-based study conducted at one of India's largest cardiac centres.

**Participants-** All hospitalized patients diagnosed with STEMI, Acute aortic dissection (AAD) and Ventricular septal rupture (VSR) presenting at the emergency department at a high-volume tertiary care centre for cardiovascular diseases in India were included in this study, regardless of age group. A composite of 880 patients' data was collected, out of which 768 were STEMI patients from January 2019 to February 2021, 77 were AAD patients from January 2018 to March 2021, and 35 were VSR patients from January 2017 to March 2021. Data was retrieved from retrospectively maintained medical records which included time from signs and symptoms onset to first medical contact, Door to Balloon time, initial Left ventricular ejection fraction (LVEF) and Killips classification on admission. All the patients were above 18 years of age. By ECG criteria the definition of STEMI is left bundle branch block (new onset) or more than 1mm ST segment elevation in at least 2 consecutive leads lasting for half-hour at presentation to emergency department (ED). Ejection fraction (EF) was classified as reduced-less than or equal to 40%, borderline-41-49%, and Normal-50-70 [8]. The Killip classification was used for the purpose of risk stratification in patients presenting with acute MI, as follows:- Individuals in Killip class I included patients with no clinical signs of heart failure; Individuals with Killip class II included patients with an S3 gallop, crackles or rales in the lungs, and raised jugular venous pressure; Individuals with Killip class III included patients with frank acute pulmonary edema; Individuals with Killip class IV included patients in hypotension and signs/symptoms of decreased cardiac output (impaired mental status, oliguria or cyanosis) or in cardiogenic shock [9].

VSR (ventricular septal rupture) was defined as the appearance of a new ventricular septal defect (within 8 days from the onset of acute myocardial infarction) with a left to right shunt significant enough to cause volume overload of the pulmonary circulation and congestive heart failure.

AAD (acute aortic dissection) was defined as an intimal tear inside the aorta causing separation of its layers, within 14 days from the onset of symptoms (most notably pain). Intramural hematoma and penetrating atherosclerotic ulcers are different presentations of acute aorta syndromes and have been included in the study[10].

**Statistical methods:** Plots were generated using in-house Python and R scripts. The seaborn and matplotlib packages for python and the gg plot 2 package for R were used. We examined the counts data for all three cardiac emergencies by first generating statistical process control charts as seen in Fig 1.1, Fig 2.1, and Fig 3.1. Three-sigma control limits flank the plot of the actual monthly counts data; The upper control limit (UCL) is set three-sigma levels above the mean, and the lower control limit (LCL) is set three sigma levels below the mean, here we have kept this limit as 0 since that's the lowest number of patient visits which can occur. Since around 99.73% of a controlled process will occur within plus or minus three sigmas, the data from a process should approximate a general distribution around the mean and within the pre-defined limits.

The time of signs and symptoms to the point of first medical contact and the door to balloon time are particularly important measures when studying the STEMI data. Severity of STEMI patients was observed at the time of admission using the left ventricular ejection fraction and the Killips classification. We studied the differences in these process measures by creating histograms for each respective measure pre and post the Covid-19 pandemic.

Following this we analysed daily STEMI walk-in data pre and post Covid-19. For this we created scatter plots in order to juxtapose and deduce the general spread of the data. Box plots were then utilized to plot monthly data in order to observe the notable change in 5 number summaries pre and post the Janta curfew. Finally, a cumulative plot of all available counts data was employed to discern the jarring dislocation between the start of the new year and the announcement of the Janta Curfew.

Simple line plots were created of a more restrictive 10 week or 6-month period, giving a more focused perspective of the event which propelled the reduced walk-ins to take place- The Janta Curfew on 22nd March 2020.

Finally, for VSR and Acute Aortic Dissection we had discharge and death counts data for patients over the span of 3 and 4 years, respectively. We displayed the yearly data using simple line plots with trend lines. Then we overlaid the death and discharge line plots over one another in a singular graph and generated trend lines for both plots so we could understand the nature of the overall data better.

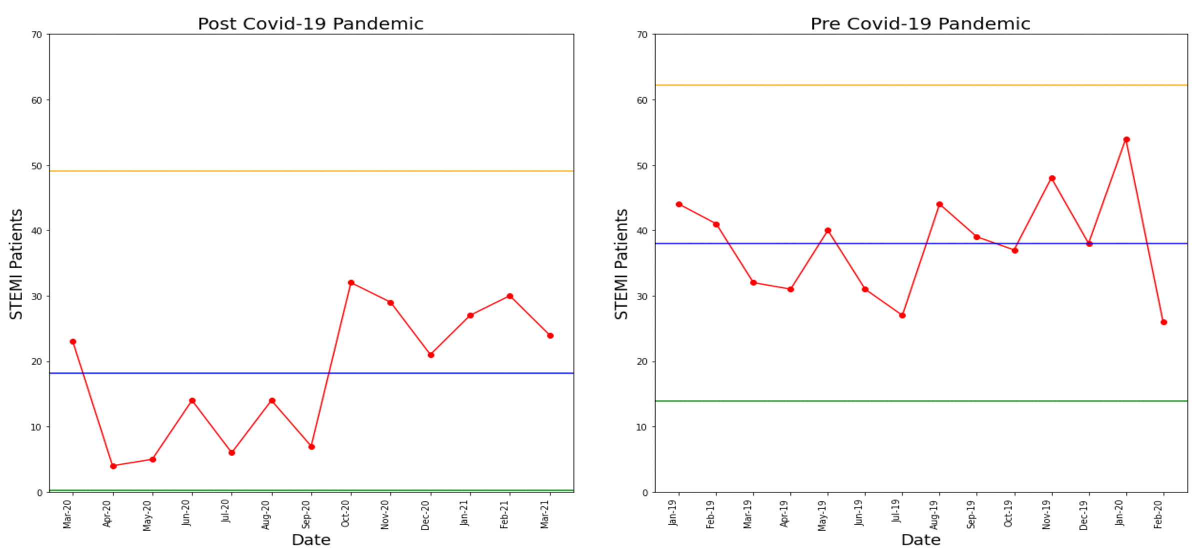
All patients included were followed up until death or discharge. The study protocol was approved by the hospital's ethics committee. Consent waiver was given in view of the study being retrospective in nature and complete patient confidentiality was maintained.

## Results

### ST- Elevation Myocardial Infarction (STEMI)

We began our analysis by creating a statistical process control chart for 768 STEMI walk-ins for January 2019 to February 2020 pre-pandemic, and another for walk-ins which took place from March 2020-March 2021 post-pandemic.

Fig 1.1, statistical process control charts Pre and Post Pandemic for STEMI. Depicted in red is the monthly counts data for STEMI walk-ins, and the blue line represents the mean. The green and yellow lines represent the upper and lower 3σ standard deviations.




**Post-Covid-19 Pandemic** **Pre-Covid-19 Pandemic**

**Fig.-1.1: Pre and Post Pandemic for STEMI**

Before the Covid-19 pandemic the mean number of STEMI walk-ins was 38 patients per month. The upper control limit was thus 62 patients per month, and the lower 14 patients per month. As can be seen in Fig 1.1 there was a significant change in walk-in data following the pandemic, the average becoming 18 patients per month; The upper and lower control limits became 49 and 0 patients per month, respectively. This indicates that there was a large decrease in STEMI Walk-Ins.

Out of the 768 STEMI patients, data for Time of signs and symptoms to first medical contact (FMC) and Door to balloon time was available for 471 patients. As seen in Fig 1.2. Before the Covid-19 pandemic the time it took from the first signs and symptoms of a STEMI to making medical contact had a central tendency of 5.5 hours, after the pandemic we saw this time increase to 6 hours. When we look at the 75th percentile of the data we see that pre Covid-19 the patient would wait 10.75 hours however after the pandemic this increased by 1.25 hours to 12 hours. In fact, looking at all the quantiles we see an overall increase in the time that patients waited before seeking medical attention. We believe this to be a by-product of the media induced fear during the COVID-19 pandemic, causing patients to be afraid of breaking social distancing norms even in the case of an emergency, as well as being excessively wary of infection[11].

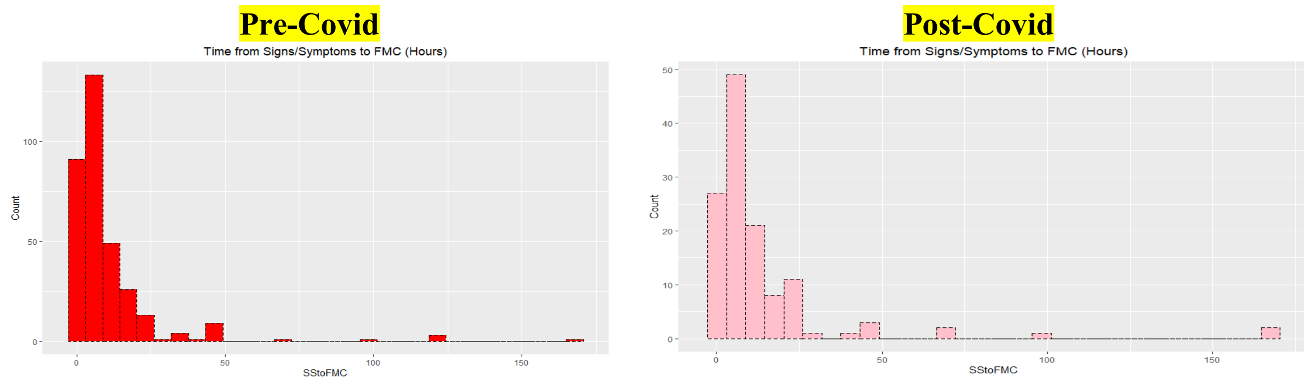



**Fig. 1.2.** These histograms show the time in hours from the time when the patient presented with the signs and symptoms of a STEMI to when the patient made first medical contact (FMC).

The tables below the histograms show the quarantines of the respective data.

| Pre-Covid-19 | | | | | Post-Covid-19 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0% | 25% | 50% | 75% | 100% | 0% | 25% | 50% | 75% | 100% |
| 0.16 | 2.50 | 5.50 | 10.75 | 168.00 | 0.5 | 3.5 | 6.0 | 12.0 | 168.00 |

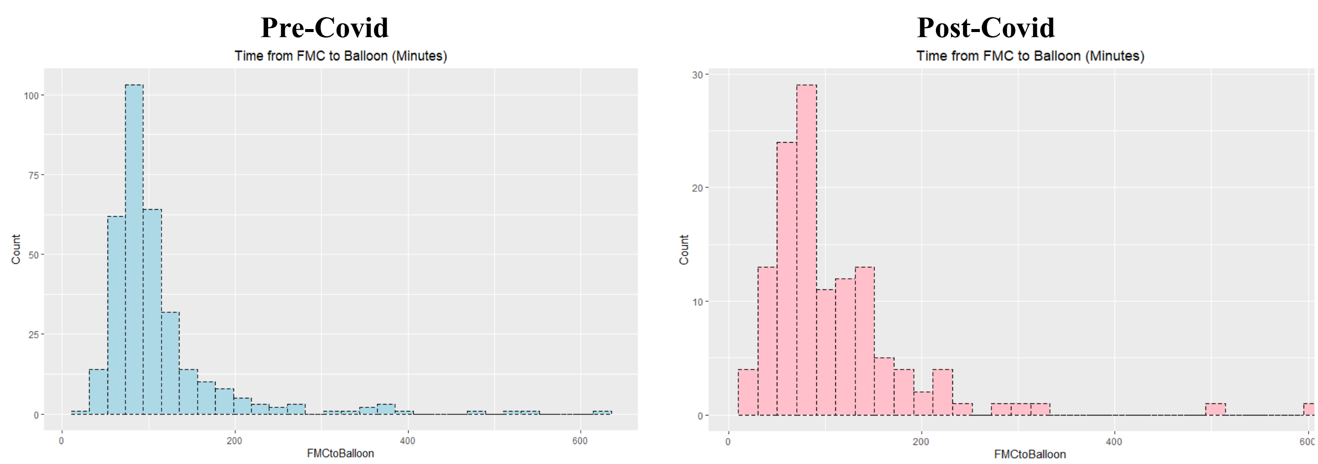



**Fig. 1.3:** These histograms show the time in minutes from first medical contact to when the patient got the balloon stent. The tables below the histograms show the quarantines of the respective data.

| Pre-Covid | | | | | Post-Covid | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0% | 25% | 50% | 75% | 100% | 0% | 25% | 50% | 75% | 100% |
| 29 | 74 | 90 | 117 | 633 | 15 | 62 | 82.5 | 134.5 | 600 |

As seen in Fig 1.3. Before the Covid-19 pandemic the time it took from first medical contact to getting the balloon stunting had a central tendency of 90 minutes, after the pandemic we saw this time reduce significantly to 82.5 minutes. This shows an increase in efficiency at the hospital, and better response time of the medical staff which may be attributed to the reduced number of walk-ins. This is further supported by the fact that in each quintile the door to balloon time is much lower in comparison to the time Pre Covid-19. Looking at this data we can extrapolate that the hospital may have been operating with a surplus of staff and thus with the reduced number of walk-ins we observed a much faster response time. This disproves the theory that the hospital was understaffed or overrun by Covid-19 patients, which leads us to question what the true cause of the large decrease in STEMI walk-ins was.

Data for Left ventricular ejection fraction was available for 497 patients and Killips classification for 488 patients. In Fig.1.4 we observe that there is a large increase in the percentage of patients with an ejection fraction less than or equal to 40 from 37.22% pre Covid-19 to 51.09% post Covid-19. There was also a significant drop in patients with an ejection fraction of 41-49 from 44.16% pre Covid-19 to 31.38% post Covid-19 and with an ejection fraction between 50-70 dropped from 18.61% to 17.51%. This illustrates that the severity of presentation and degree of heart failure at admission has increased post Covid-19.

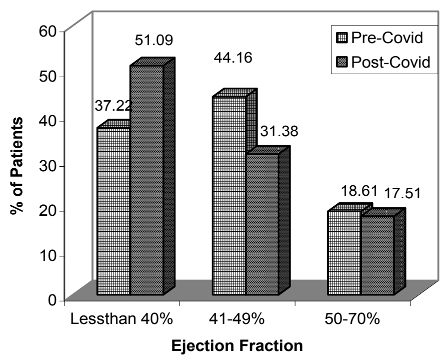



**Fig. 1.4.** Histogram showing ejection fraction of patients' pre-Covid and post-Covid.

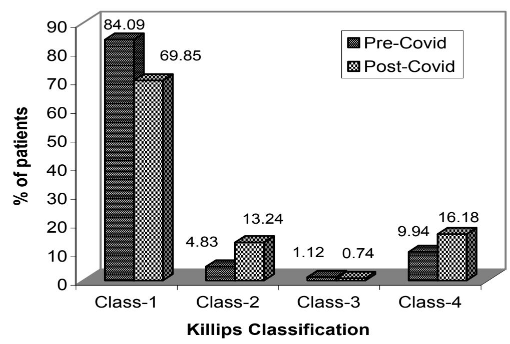



**Fig. 1.5:** Histogram showing Killips Classification of pre-Covid and post-Covid patients.

The risk of mortality in patients with acute STEMI is predicted using the Killip classification. The lesser the Killip's classification the greater is the mortality rate post myocardial infarction. In Fig.1.5 a drop in the percentage of patients was observed in Killips class-1 from 84.09% pre Covid-19 to 69.85% post Covid-19 and Killips class-3 from 1.13% pre Covid-19 to 0.73% post Covid-19. There was a rise in the percentage of patients classified in Killip's class-2 from 4.82% pre Covid-19 to 13.23% post Covid-19 and similarly in Killip's class-4 from 9.94% pre Covid-19 to 16.17% post Covid-19. This shows that post Covid-19 there was a shift of patients from Killips Class-1 to Class-2 and similar shift from Class-3 to Class-4. This can be explained by the delay in time of presentation to the emergency department post Covid-19 leading to an increased Killip class at admission which is a predictor of in-hospital and 6-month mortality.

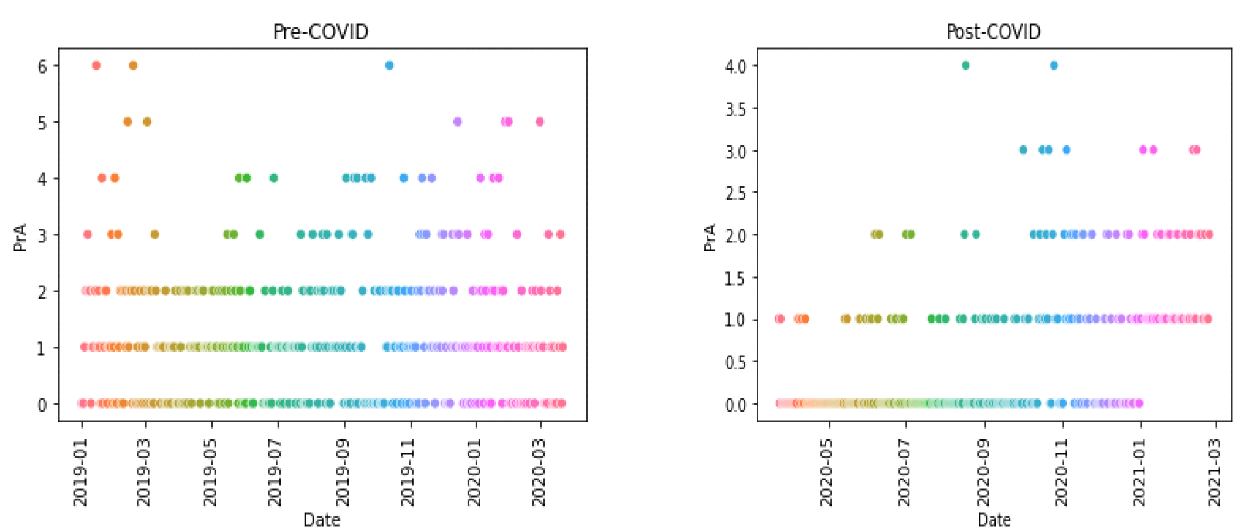



**Fig. 1.6:** Scatter plots to observe the general spread of the daily STEMI walk in data Pre and Post the Covid-19 pandemic.

Scatter plots seen in Fig 1.6 showed a large discrepancy between the data Pre Covid-19 and Post Covid-19. There is a very even spread of patients seen pre Covid-19 where we observe that most days 0 patients or maybe 1 or 2 patients are likely to walk in; More rarely we see 3 or 4 patients walk in, and 5 or 6 patients walk in very rarely. Post Covid-19 0 patients walked in from 25th March to 7th April 2020 and again from 13th April to 14th May 2020. We can see these gaps in the scatter plot, and that there were very few days when more than one patient walked in until October. Following October, we see an increased frequency of days where 1 or 2 patients walk in. 3 or 4 patients walk in very rarely and there are no instances of days where 5 or 6 patients walk in. Interestingly at the start of the new year, in 2021, we see a slight return to normalcy. With no days where 0 STEMI patients walked in, and a good spread of mostly 1 or 2 patients a day.

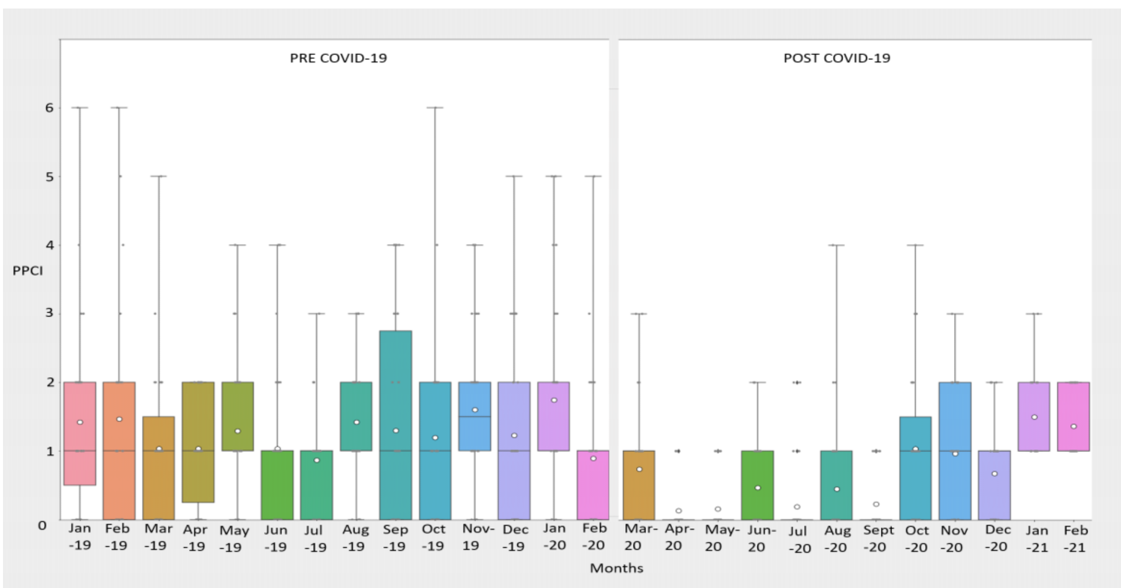



**Fig 1.7:** Box Plots to depict the monthly STEMI walk-ins. The white spots represent the mean.

When viewing the monthly box plots Pre and Post the Covid-19 Pandemic one discrepancy can be clearly seen, for the months of April, May, July, and September 2020 there are no box plots. This was because of limited data spread due to the values being clustered mainly at 0 walk-ins, with very few days where 1 walk-in took place, hence a box plot could not be formed for those months. If we look at the mean values for those months, they are all around 0 patients, the lowest being April with a mean of 0.13(0) patients per day, and similarly the median for those months is also 0. These measures of central tendency indicate that there were almost no patients walking in during the months of April, May, July, and September 2020. Following January 2020, we don't see the daily walk-ins increase to an average of 1 per day again until October 2020. When we compare this to the data pre Covid-19 the difference is striking.

By observing the scatter plots and box plots we could identify that although we had information about the existence of the corona virus since January, we only saw a large drop in walk-ins take place during and after March. We identified that the event which caused this disruption may hence be the Janta Curfew declared on March 22nd. This is strongly supported by the data in Fig 1.8, where we observe a sharp fall post March 22nd followed by long stretches of 0 walk-ins taking place.

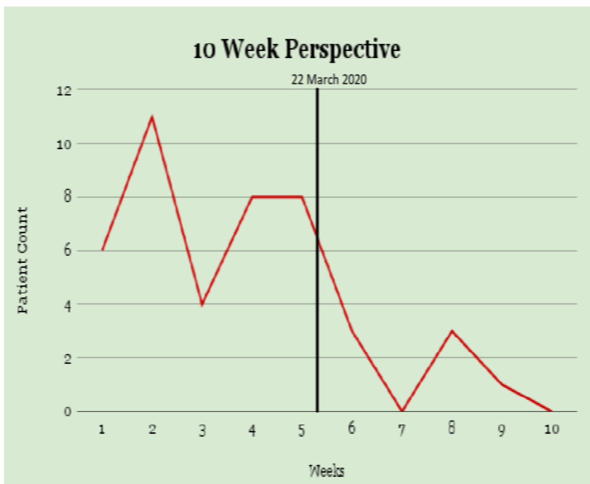



**Fig.1.8:** A 10-week perspective around the announcement of the March 22nd lockdown.

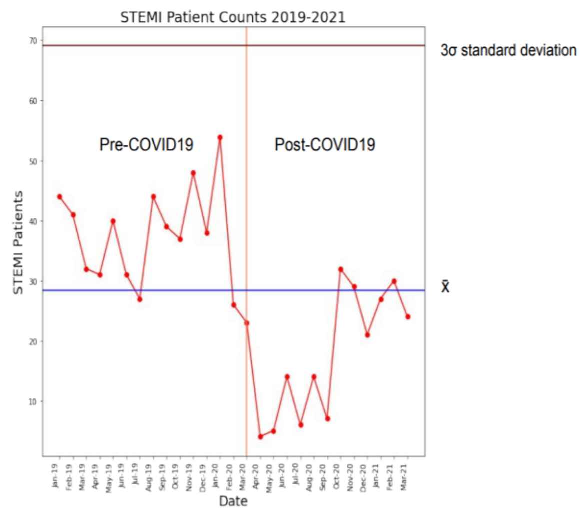



**Fig 1.9.** A cumulative plot showing monthly STEMI walk-ins from January 2019- March 2021.

Fig 1.9 can be used to visualize the disruption which took place as soon as people started to realize the implications of the corona virus as it was declared to be a pandemic, and restrictions began to be put into place to curb the catastrophic death tolls. During this time people were watching the number of patients, the severity of infection, and the number of deaths several times a day and fear was quickly rising amongst the public.

New guidelines were issued by the Ministry of Home Affairs as part of the September 1, 2020, Unlock 4, in order to open up more activities in regions away from the Containment zones. By October 5th the number of recovered patients had overtaken the active cases by 3.61 times and Unlock 5 began1[12]. We believe this explains the large increase, from 7 in September to 32 in October, of patient walk-ins. We can see, from October onwards, that the plot seems to be stabilizing and walk-ins are increasing. This may be an indication of a return to normalcy in the future.

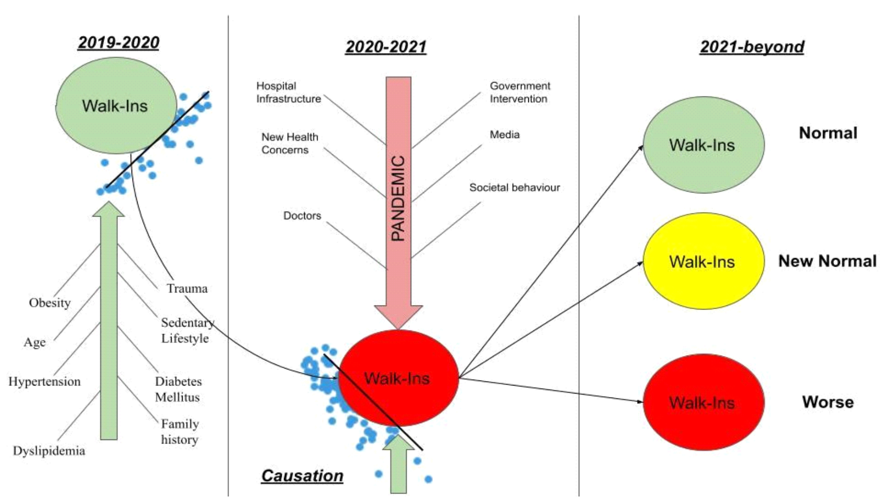



**Fig 1.10:** The first panel shows an Ishikawa diagram depicting the pre-pandemic walk-ins and the causation for them. With the second panel showing how the walk-ins were heavily impacted by the pandemic, and the causation behind their sudden decline. Finally, the third panel depicts the future trends we may observe in walk-in data.

Fig 1.10 depicts where our analysis led us. The Ishikawa or fishbone diagram is used for analyzing the reasons for failures, variations by visually creating a cause-and -effect diagram. We used this visual to see the causes which were previously driving up STEMI walk-ins, and then what factors are suppressing these causes to drive down the number of walk-ins in 2020-2021. We also use this visual to display the future we may face. There could be a return to the status quo, where the pandemic and its symptoms completely disappear. There could be a new normal where things remain the way they currently are in the future with no improvements. Or, lastly depending on the new factors that emerge we could see a worsening situation wherein the walk-ins go down even further. If we are looking at a new normal or worsening situation then it is imperative for us to adjust/adapt to the factors causing the downward trend.

### Ventricular Septal Rupture (VSR):

Before the Covid-19 pandemic the mean number of VSR walk-ins was around 1 patient per month. The upper control limit was around 3 patients per month, and the lower 0 patients per month. As can be seen in Fig 1.9, there was a slight change in walk-ins following the pandemic, the average stayed at around 1 patient per month. However, the upper limit became 4 patients per month. This may be indicative of a slightly higher number of VSR patients post pandemic.

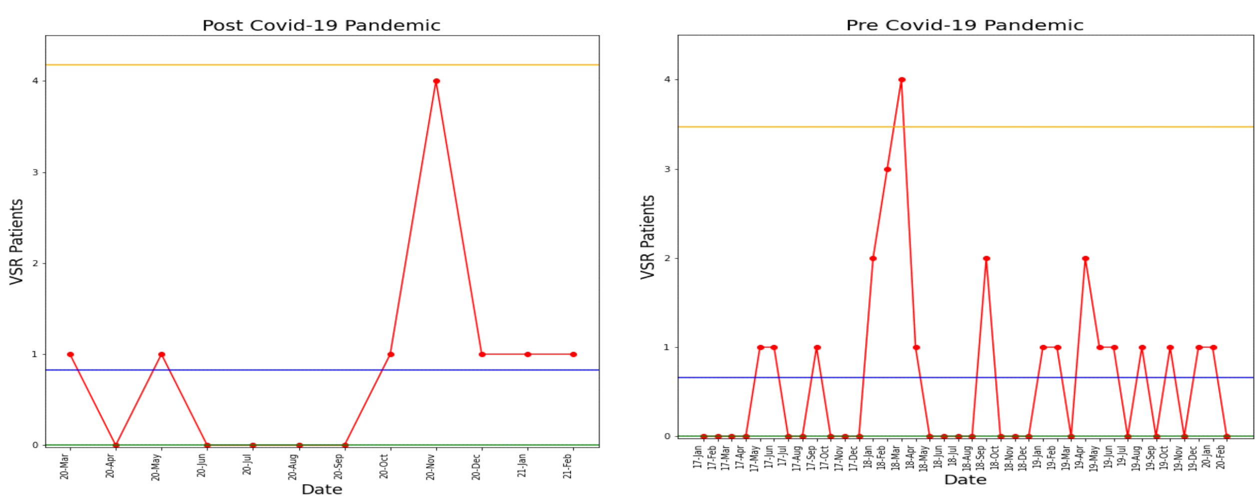



**Fig 2.1:** This graph is to illustrate the overall available data for VSR walk-ins (green) vs. the trend during the pandemic (red).

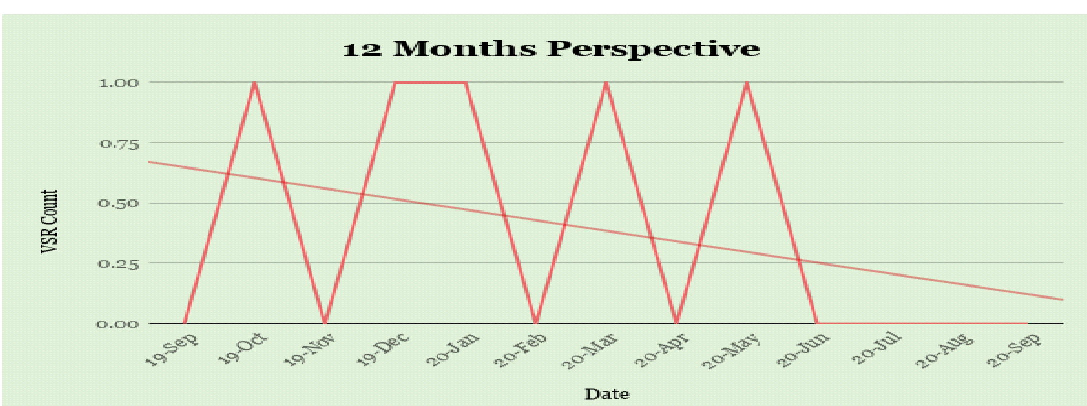



**Fig 2.2:** A 6-month perspective for VSR Count, 6 months before and after the Covid-19 pandemic.

In Fig 2.2, there was a surge of 4 patients in the month of November, and if we look at the overall data the trend is similar to what we saw in Fig 1.9 with a highly reduced number of patient walk-ins during the post Covid-19 era, then resurgence after September 2020, and a return to normalcy. Fig 2.2, Illustrates the sharp downward trend we saw in VSR count following the announcement of the Janta Curfew, like what we have already observed in the STEMI data.

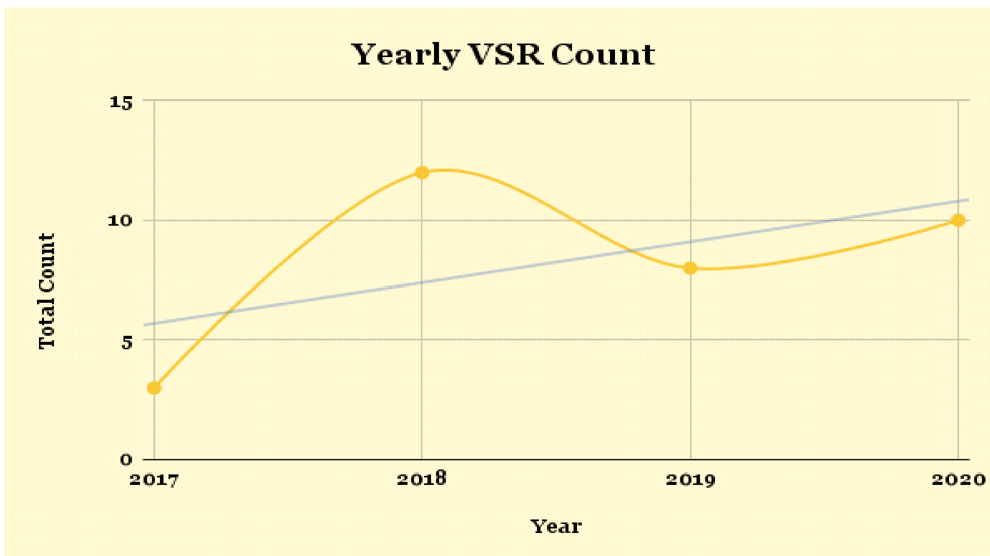



**Fig. 2.3:** A plot observing the number of VSR patient walk-ins over the course of 4 years.

For VSR patients we had data available from previous years 2017, 2018, 2019 and 2020. This meant that even though we had very few VSR cases yearly, we could understand the overall trend of VSR walk-ins better. From Fig 2.3 we can see that the actual number of overall walk-ins in 2020 was in fact higher than the walk-ins we saw in 2019 and 2017, although not as high as the walk-ins from 2018. This seems to indicate that overall, the VSR cases at the hospital were not significantly reduced due to the pandemic. Thus, leading us to believe that the overarching impact of the pandemic was not that severe in the case of Ventricular Septal Rupture patients, and we continued to see an overall upward trend of VSR cases.

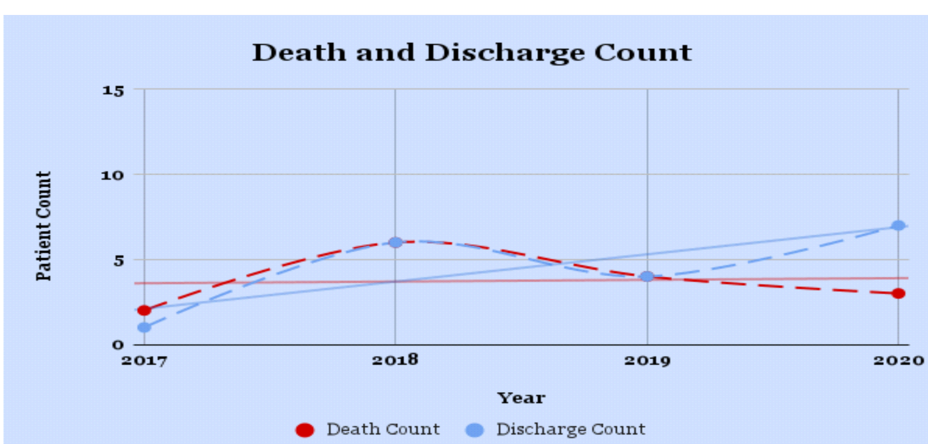



**Fig. 2.4:** A plot observing the death and discharge counts of VSR patients over the course of 4 years.

We also observed that the number of patients discharged after coming in with VSR were the highest in 2020 since the last 4 years. In addition to this we saw that the number of patients who passed away after coming with VSR were the second lowest, with only 3 patient deaths occurring.

## Acute Aortic Dissection (AAD):

Before the Covid-19 pandemic the mean number of Acute Aortic Dissection walk-ins was around 3 patients per month. The upper control limit was around 8 patients per month, and the lower 0 patients per month. In Fig 3.1 there is a large disparity pre and post Covid-19, the average dropped sharply to 1 patient per month, while the upper limit became 4 patients. We also see that this data is quite different when compared to the previous two heart emergencies since we do not see resurgence in cases up until January 2021, and even then, we do not see much stability or return to normalcy.

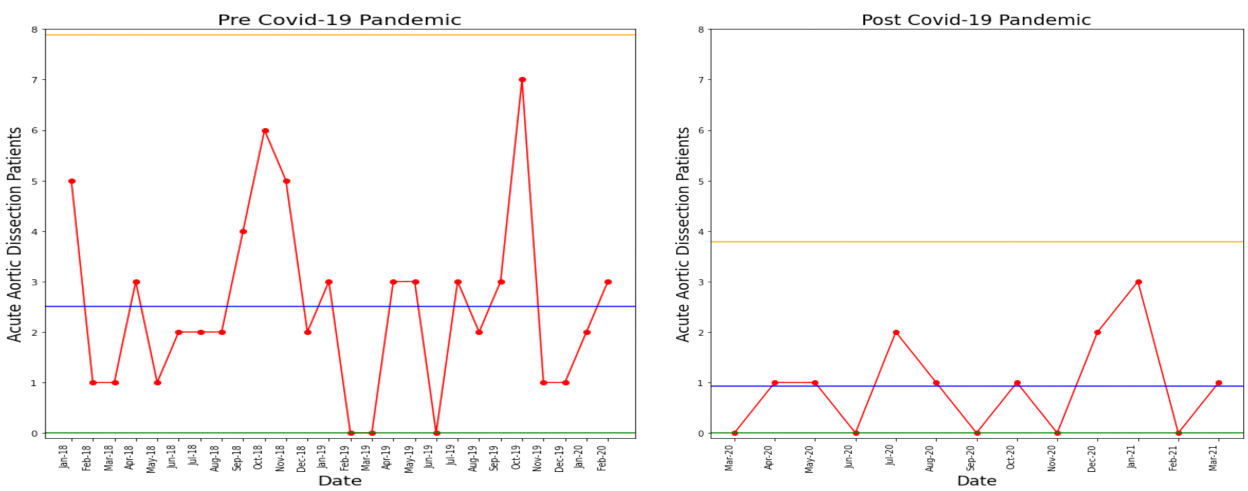



**Fig. 3.1:** Statistical process control charts Pre and Post Pandemic for AAD. Depicted in red is the monthly counts data for Aortic Dissection patient walk-ins, and the blue line represents the mean. The green and yellow lines represent the upper and lower 3σ standard deviations.

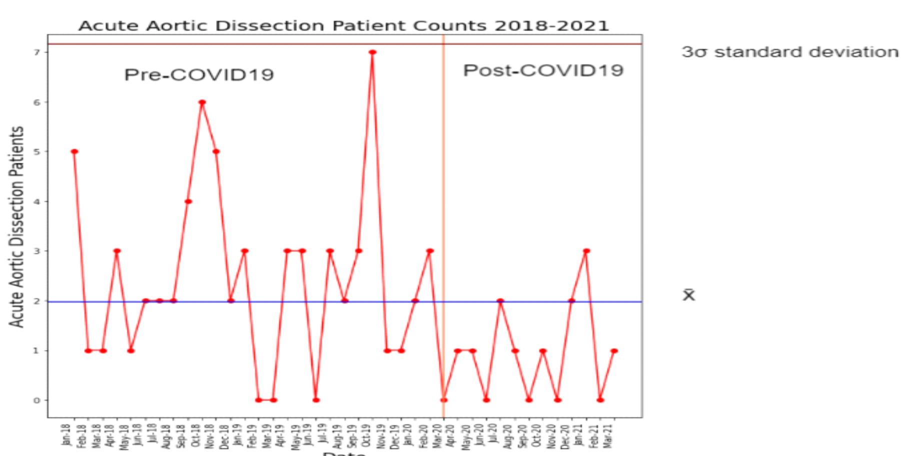



**Fig. 3.2:** The overall data available for Acute Aortic Dissection patient walk-ins can be seen in this plot.

Looking at the pre Covid-19 data in Fig 3.2 it can be discerned that there were only 3 instances of 0 AAD patients in a month, while in the post Covid-19 data we see 5 instances of 0 AAD patients in a month. We can also see that there is no resurgence of patients seen in the data even after 1st September 2020 (Unlock 4). Thus, indicating that daily Acute Aortic Dissection walk-ins were not returning to normal, and the downward trend was seen persisting until March 2021.


**Fig. 3.3:** A 6-month perspective, 6 months before and after the Covid-19 pandemic in March 2020. Illustrates the sharp downward trend we saw following the announcement of the Janta Curfew on March 22nd, 2020, similar to what we previously observed in the STEMI and VSR data.

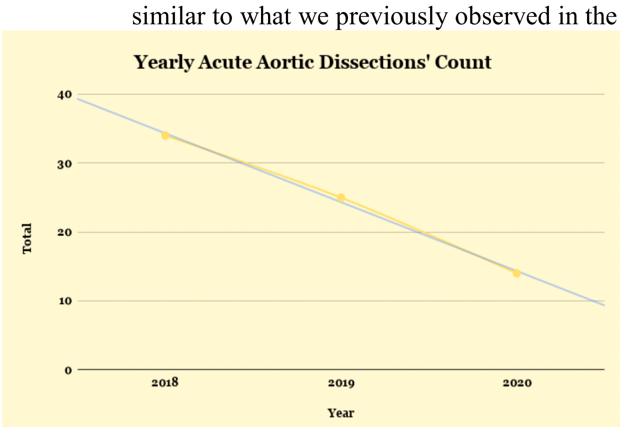



**Fig. 3.4:** Yearly walk-ins for Acute Aortic Dissection for the years 2018, 2019, and 2020.

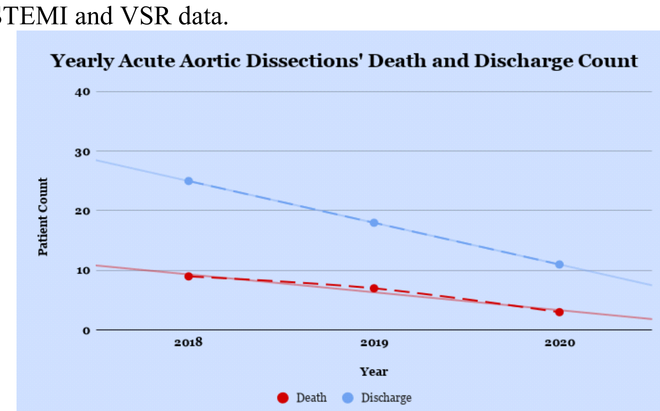



**Fig. 3.5:** A plot observing the death and discharge counts for acute aortic dissections over the course of 3 years.

It is surprising to see that there was already a sharp downward trend observed from 2018-2019 for Acute Aortic Dissection walk-ins, and the 2020 data almost perfectly fit this linear downward trend. This leads us to believe that the drop in walk-ins was not all that significant looking at the overall yearly data.

We also see that the discharge and death counts seem to be converging as years go on, with a much shorter gap between them in 2020 compared to previous years. This trend can be attributed to the decrease in overall patients each year which can be seen in Fig.3.1. But we can see that at large there were no large deviations in the data for the year 2020.

## Discussion

Our study exhibits a significant reduction in the number of patients presenting to the emergency department during the post Covid-19 era for acute cardiac emergencies at one of India's largest cardiac centres. This indicates that the COVID-19 pandemic has negatively influenced the presentation of acute cardiac emergencies namely STEMI, VSR and AAD. Our findings are in line with a study done at Cleveland Clinic showing a reduction in the number of emergency transfers for patients with Stroke, STEMI, and Acute aortic emergencies coinciding with the COVID-19 pandemic[13]. A study done in Italy showed a similar cutback in STEMI admissions during the COVID-19 period along with an increase in baseline and peak Troponin T, Creatinine Kinase, as well as increase time from symptom onset to first medical contact (FMC) and time from first medical contact (FMC) to PPCI[14]. We had similar findings in our analysis which showed an increase in time from the onset of symptoms to first medical contact.

Another similar study done at a tertiary care centre in Saudi Arabia showed a delay in the presentation to the hospital without much change in the standard of care during the COVID-19 pandemic[15]. These findings are also in line with our study where we found that the door to balloon time decreased from 90 mins pre Covid-19 to 82.5 mins post Covid-19, indicating a better response time of the medical staff.

Research done in Hong-Kong showed that delay in seeking treatment for Myocardial Infarction was associated with higher rates of mortality and post-MI complications[16]. Studies have also shown a strong inverse relationship between six-month mortality and EF with the highest risk group being in patients with EF < 30% with a 11% mortality rate[18]. Another study done in the UK showed a reduction in STEMI admissions, significant decrease in the ejection fraction and a 3-fold increase in the time to call for help during the COVID-19 era[17]. Our study supported these findings; we observed an increase in time from signs and symptoms to first medical contact post Covid-19 and ejection fraction of less than or equal to 40% increasing from 37.22% of patients pre Covid-19 to 50.7% of patients post Covid-19.

A large majority of people in India die at home rather than in an hospital, so the cause of death is commonly not assigned by a doctor, a problem which has only been exacerbated in the second wave. With India's death toll reaching around 4 lakhs[19], although most deaths may be attributed as being due to COVID-19, it is likely that the increase in deaths is also contributed to by under diagnosed and undertreated cardiac emergencies. This is a matter of public health concern globally, as we shed light on the need for hospitals to not only treat COVID-19 patients but also facilitate safe and effective emergency care facilities.

Patients may be disinclined to seek timely medical care due to fear of getting infected, violating social distancing practices, lack of awareness of the severity of symptoms, or belief of care being inaccessible. There is evidence of increased mortality and morbidity in such patients, which leads us to believe that this is an important public health concern which needs to be taken into consideration on a global scale. Telemedicine is a promising approach for such patients, by increasing access to immediate healthcare facilities via tele-consultation they would be better equipped to seek medical advice, especially during these trying times.

## Conclusion

Our study has shown substantial decline in STEMI, VSR, and AAD patient's presentation since the outbreak of COVID-19 and an increase in markers of adverse prognosis in STEMI patients. Our results indicate a high potential for increased cardiac related complications during the COVID-19 pandemic with a potential rise in cardiac related morbidity and mortality subsequently.

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## References

1. De Filippo O, D'Ascenzo F, Angelini F, Bocchino PP, Conrotto F, Saglietto A, et al. Reduced rate of hospital admissions for ACS during Covid-19 Outbreak in Northern Italy [published online ahead of print, 2020 Apr 28] N Engl J Med. 2020;383:88–9.
2. Garcia S, Albaghdadi MS, Meraj PM, Schmidt C, Garberich R, Jaffer FA, et al. Reduction in ST-segment elevation cardiac catheterization laboratory activations in the United States during COVID-19 pandemic. J Am Coll Cardiol. 2020;75:2871–2.

3. Solomon MD, McNulty EJ, Rana JS, Leong TK, Lee C, Sung SH, et al. The Covid-19 pandemic and the incidence of acute myocardial infarction. N Engl J Med. 2020; 383 (7):691–3. [Published online ahead of print, 2020 May 19]
4. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel corona virus in Wuhan, China. Lancet. 2020; 395: 497–506.
5. Mahmud E, Dauerman HL, Welt FG, Messenger JG, Rao SV, Grines C, et al. Henry, management of acute myocardial infarction during the COVID-19 pandemic. JACC. 2020 JACC202004039.
6. Wood S. The Mystery of the Missing STEMIs During the COVID-19 Pandemic. TCTMD.com. Available at https://www.tctmd.com/news/mystery-missing-stemis-during-covid-19-pandemic. Accessed April 17, 2020
7. Mubarik A, Iqbal AM. Ventricular Septal Rupture. [Updated 2021 Mar 22]. In: Stat Pearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021 https://www.ncbi .nlm. nih.gov/ books/ NBK534857/
8. Hajouli S, Ludhwani D. Heart Failure and Ejection Fraction.
9. Killip III T, Kimball JT. Treatment of myocardial infarction in a coronary care unit: a two year experience with 250 patients. The American Journal of Cardiology. 1967 Oct 1;20(4):457-64.
10. Crawford ES. The diagnosis and management of aortic dissection. Jama. 1990 Nov 21; 264 (19):2537-41.
11. Maji C. Impact of Media-Induced Fear on the Control of COVID-19 Outbreak: A Mathematical Study. International Journal of Differential Equations. 2021 Feb 10;2021.
12. Delhi, PIB. (2020, August 29). MHA issues new Guidelines. Press Information Bureau. https://pib.gov.in/Press Release Page.aspx? PRID=1649623.
13. Khot UN, Reimer AP, Brown A, Hustey FM, Hussain MS, Kapadia SR, Svensson LG. Impact of COVID-19 Pandemic on Critical Care Transfers for ST-Segment–Elevation Myocardial Infarction, Stroke, and Aortic Emergencies. Circulation: Cardiovascular Quality and Outcomes. 2020 Aug;13 (8):e006938.
14. Tomasoni D, Adamo M, Italia L, Branca L, Chizzola G, Fiorina C, Lupi L, Inciardi RM, Cani DS, Lombardi CM, Curello S. Impact of COVID-2019 outbreak on prevalence, clinical presentation and outcomes of ST-elevation myocardial infarction. Journal of Cardiovascular Medicine. 2020 Nov 1;21(11):874-81.
15. Balghith MA. The impact of COVID-19 pandemic on the presentation and hospital management of STEMI patients in a tertiary care center in Saudi Arabia. Heart Views. 2020 Jul 1;21(3):166.
16. Tam CC, Cheung KS, Lam S, Wong A, Yung A, Sze M, Lam YM, Chan C, Tsang TC, Tsui M, Tse HF. Impact of coronavirus disease 2019 (COVID-19) outbreak on ST-segment–elevation myocardial infarction care in Hong Kong, China. Circulation: Cardiovascular Quality and Outcomes. 2020 Apr; 13 (4): e006631.
17. Wilson SJ, Connolly MJ, Elghamry Z, Cosgrove C, Firoozi S, Lim P, Sharma R, Spratt JC. Effect of the COVID-19 pandemic on ST-segment–elevation myocardial infarction presentations and in-hospital outcomes. Circulation: Cardiovascular Interventions. 2020 Jul;13(7):e009438.
18. Burns RJ, Gibbons RJ, Yi Q, Roberts RS, Miller TD, Schaer GL, Anderson JL, Yusuf S, CORE Study Investigators. The relationships of left ventricular ejection fraction, end-systolic volume index and infarct size to six-month mortality after hospital discharge following myocardial infarction treated by thrombolysis. Journal of the American College of Cardiology. 2002 Jan 2;39(1):30-6.
19. India COVID: 30,132,958 Cases and 393,328 Deaths - Worldometer (worldometers.info) .

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