Reduction of Inhospital Mortality of Patient Admissions to Cardiac Intensive Care Units During the COVID-19 Pandemic in Hunan, China

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Summary

This study aims to evaluate the impact of the coronavirus disease 2019 (COVID-19) pandemic on patient admissions to Hunan’s cardiac intensive care units (CCUs).

We conducted a retrospective, single-center study. Data were collected from patients who were confirmed to have critical cardiovascular disease and admitted to the CCU of the Second Xiangya Hospital of Central South University, Hunan, from January 23 to April 23, 2020. Compared with the same period in 2019, the results show that the number of hospitalization decreased by 19.6%; the inhospital mortality rate of CCU was decreased (28.57% versus 16.67%; odds ratio (OR), 0.50; 95% confidence interval (CI), 0.251-0.996; \( P = 0.047 \)); hospital stay was decreased (7.97 versus 12.36, \( P < 0.001 \)); hospital emergency percutaneous coronary intervention (PCI) rate in patients with acute coronary syndromes (ACS) significantly decreased (76.00% versus 39.00%, \( P < 0.001 \)); among this, the PCI rate of patients with ST-segment elevation myocardial infarction (STEMI) decreased (76.32% versus 55.17%, \( P = 0.028 \)) as well. In addition, the number of patients transferred from other hospitals significantly decreased (76.79% versus 56.67%, \( P = 0.002 \)), and the number of patients transferred from other cities also decreased by 10.75%.

During the outbreak of the COVID-19 epidemic in Hunan Province, the number of patients admitted to CCU decreased, as well as the mortality rate; fewer patients with severe cardiovascular disease can be transported to better hospitals from remote rural areas. In addition to epidemic prevention and control, experts in China should focus on improved emergency transport medical services to reduce this impact.

Key words: Heart failure, SARS-CoV-2, CCU, Acute coronary syndrome, PCI

In early December 2019, an outbreak of a novel SARS-CoV-2 was reported in Wuhan City, Hubei Province, China, and now, it has become a global threat to human health.1 This infection has impacted health and the economy worldwide on an unprecedented scale. Especially, it created tremendous strain on healthcare systems in China.2 Over 40,000 medical staff rushed to frontline to help in Hubei’s hospital from other provinces and municipalities, and many hospitals are temporarily closed or reduced non-emergent procedures and hospitalizations to preserve hospital capacity and personal protective equipment.3 Hunan Province is close to Hubei Province, only 120 kilometers away from Wuhan. In January 23, Wuhan announced lockdown of the city.4 On the same day, Hunan Province also launched level 1 response to major public health emergencies (four levels in total; level 1 is the most serious). Hunan was one of the first provinces in China to be affected. Influences and changes in these medical measures also affect the admission rate of acute cardiovascular disease.

This study aims to evaluate the impact of the COVID-19 pandemic on patient admissions to Hunan’s cardiac intensive care unit (CCU) and compare the number of admission and inhospital mortality, as well as their clinical features, between the COVID-19 pandemic and previous year.

Methods

Patients: We conducted an observational, retrospective, single-center study. Data were collected from patients who were confirmed to have critical cardiovascular disease and admitted to the CCU of the Second Xiangya Hospital of Central South University, Changsha City, from January 23 to April 23, 2020. Changsha is the largest city and capital of Hunan Province, with a population of 6 million and 350 kilometers away from Wuhan. The Department of Cardiovascular Medicine of our hospital is the largest cardiovascular specialist center, which is also the diagnosis and treatment center of cardiovascular critical diseases in Hunan Province. It has the best critical cardiovascular care unit, especially the cardiac critical care and advanced...
medical equipment. In Hunan Province, especially in remote areas, many critically ill patients are transported to our center. Because January 24 this year is the Chinese Lunar New Year, and it is also the most important holiday in the country, we choose the same period last year as a comparison according to the Chinese lunar calendar (February 3 to May 3, 2019). The study protocol conformed to the ethical guidelines of the 1975 Declaration of Helsinki as reflected by prior approval from the human research committee of the Second Xiangya Hospital of Central South University. Data on the clinical, laboratory, and treatment outcomes were obtained with standardized data collection forms. Acute coronary syndromes (ACSs) diagnosis and classifications as having either ST-segment elevation myocardial infarction (STEMI) or non-ST-segment elevation myocardial infarction; HF, heart failure; UA, unstable angina; PCI, percutaneous coronary intervention; LVEF, left ventricular ejection fraction; and IABP, intra-aortic balloon pumping. P values comparing inhospital death and inhospital survival are from the rank-sum test, Student’s t-test, Chi-square test, Fisher’s exact test, and Mann-Whitney U test, as appropriate.

Table I. Clinical Features of 90 Patients Admitted to CCU During the COVID-19 Pandemic in Hunan, China

|                          | All patients (n = 90) | Dead (n = 15) | Survival (n = 75) | P value |
|--------------------------|----------------------|---------------|------------------|---------|
| Age (years)              | 59.99 (13.43)        | 58.60 (13.60) | 60.27 (13.47)    | 0.663   |
| Sex                      |                      |               |                  |         |
| Men                      | 64 (71.11%)          | 7 (46.67%)    | 57 (76%)         | 0.031   |
| Women                    | 26 (28.89%)          | 8 (53.33%)    | 18 (24%)         |         |
| Length of stay (days)    | 7.97 (5.88)          | 9.27 (8.50)   | 7.71 (5.24)      | 0.351   |
| Diagnosis                |                      |               |                  |         |
| STEMI                    | 29 (32.22%)          | 5 (33.33%)    | 24 (32%)         | 0.008   |
| NSTEMI                   | 14 (15.56%)          | 2 (13.33%)    | 12 (16%)         |         |
| HF                       | 9 (10%)              | 1 (6.67%)     | 8 (10.67%)       |         |
| Arrhythmia               | 5 (5.56%)            | 0 (0%)        | 5 (6.67%)        |         |
| Others                   | 17 (18.89%)          | 7 (46.67%)    | 10 (13.33%)      | 0.849   |
| Comorbidities            |                      |               |                  |         |
| Hypertension             | 47 (52.22%)          | 8 (53.33%)    | 39 (52%)         | 0.004   |
| Diabetes                 | 21 (23.33%)          | 2 (13.33%)    | 19 (25.33%)      | 0.003   |
| Systolic blood pressure (mmHg) | 124.00 (65–224) | 103 (65–164) | 125 (88–224)    | 0.019   |
| Diastolic blood pressure (mmHg) | 75 (38–125)   | 67 (38–84)   | 76 (53–125)      | 0.342   |
| Hemoglobin (g/L)         | 124 (7.02–178)       | 114 (55–145) | 126 (7.02–178)  | 0.003   |
| WBC (× 1000/µL)          | 7.69 (2.30–20.07)    | 8.19 (5.49–17.42) | 7.43 (2.30–20.07) | 0.001   |
| Creatinine (µmol/L)      | 82.90 (39.90–981.40) | 150.80 (47.50–981.40) | 81.60 (39.90–440) | < 0.001 |
| NT-proBNP (pg/mL)        | 1519 (14.80–35000)   | 9263 (131.57–35000) | 1010 (14.80–35000) | < 0.001 |
| cTnT (pg/ml)             | 78.76 (3–10000)      | 21.20 (3.10–399.50) | 16.60 (3.50–460.50) | 0.073   |
| CKMB (IU/L)              | 16.60 (3.10–460.50)  | 21.20 (3.10–399.50) | 16.60 (3.50–460.50) | 0.657   |
| LVEF                     | 56 (26–65)           | 56 (27–65)    | 56 (26–65)       | 0.257   |
| Hospital PCI             | 46 (51.11%)          | 4 (26.67%)    | 42 (56%)         | 0.049   |
| Cardiac function         | 2.83 (0.78)          | 3.87 (0.35)   | 2.63 (0.67)      | < 0.001 |
| IABP                     | 5 (5.56%)            | 2 (13.33%)    | 3 (4%)           | 0.192   |

Data are (n) (mean (SD), median (min-max), where n is the total number of patients with available data. STEMI indicates ST-segment elevation myocardial infarction; NSTEMI, non-ST-segment elevation myocardial infarction; HF, heart failure; UA, unstable angina; PCI, percutaneous coronary intervention; LVEF, left ventricular ejection fraction; and IABP, intra-aortic balloon pumping. P values comparing inhospital death and inhospital survival are from the rank-sum test, Student’s t-test, Fisher’s exact test, and Mann-Whitney U test, as appropriate.

Results

A total of 90 patients were admitted to CCU of our center during the COVID-19 pandemic, including 64 (71.11%) male patients; the average age is 59.99 (± 13.43) years old (Table I). The average hospital stay of these patients is 7.97 (± 5.88) day, and the most common disease is STEMI, followed by unstable angina (UA) and non-STEMI. A total of 46 (51.11%) patients underwent percutaneous coronary intervention (PCI) in the hospital, and 15 (16.67%) patients died during hospitalization; among them, the mortality rate of female patients is higher than male (30.77% versus 10.94%, P = 0.031). Compared with the patients who were discharged alive, the dead patients had lower blood pressure and higher creatinine (150.80 versus 81.60, P < 0.001) and NT-pro B-type natriuretic peptide values (9263.00 versus 1010.00, P < 0.001). At the same time, the dead patients had lower blood pressure and higher creatinine (150.80 versus 81.60, P < 0.001) and NT-pro B-type natriuretic peptide values (9263.00 versus 1010.00, P < 0.001). No one died among those with UA and arrhythmia. Age, length of hospital stay, comorbidities, creatine kinase MB, cardiac troponin T, white blood cell count,
Figure 1. A: The number of hospitalization decreased by 19.6%. B: Inhospital mortality rate of CCU was decreased (28.57% versus 16.67%, \( P = 0.047 \); OR = 0.50, 95% CI = 0.251, 0.996). C: Hospital stay was decreased (7.97 versus 12.36, \( P < 0.001 \)). D: Hospital emergency PCI rate in patients with ACS decreased significantly (76.00% versus 39.00%, \( P < 0.001 \)).

However, compared with 2019, inhospital mortality rate was decreased from 28.57% to 16.67%. This result is different from previous study in Italy published in the European Heart Journal. This may be mainly due to epidemic prevention policy and personal factors of patients or their families. Firstly, during the Chinese Lunar New Year holiday, the hospital has the most severe patients and also has higher mortality. Secondly, the decrease of hospital inpatients is mainly due to the impact of the epidemic situation of this year. There was a shortage of medical protection resources in the early stage, the medical service system was focused on COVID-19, and most healthcare resources were relocated to manage the pandemic. This has caused an attitude toward deferral of less urgent cases. Thirdly, the country also has promulgated a series of strict epidemic prevention measures, including home quarantine and lockdown of the city.

These methods not only effectively control the epidemic but also make it more difficult to transport patients with critical cardiovascular disease from remote rural areas to modern cardiovascular specialties, which will probably significantly increase mortality for patients with severe cardiovascular disease in Hunan Province. The fact is that most patient admission to our CCU are not as serious as last year, which can be reflected by their better heart function class and shorter hospital stay. Finally, during the outbreak, patients and their families are more likely to visit local hospitals and do not want to visit hospitals in big cities, even if the medical level there is higher. There-

and LVEF were similar between the two groups.

Overall, 112 patients were admitted to CCU at the corresponding period in 2019. Compared with this, there was a 19.64% reduction in this year (Figure 1A). Compared with 2019, patients in 2020 have a shorter hospital stay (7.97 versus 12.36, \( P < 0.001 \)) (Figure 1C), better cardiac function (2.83 versus 3.15, \( P = 0.002 \)), and lower inhospital mortality rate (28.57% versus 16.67%; \( P = 0.047 \); odds ratio (OR), 0.50; 95% confidence interval (CI), 0.251-0.996) (Figure 1B). In addition, hospital emergency PCI rate in patients with ACS significantly decreased (76.00% versus 39.00%, \( P < 0.001 \)) (Figure 1D). Compared with the same period in 2019, the number of patients transferred from other hospitals significantly decreased (76.00% versus 39.00%, \( P < 0.001 \)) (Figure 1D). Compared with the same period in 2019, the number of patients transferred from other cities also decreased by 10.75%, and the PCI rate of patients with STEMI decreased (76.32% versus 55.17%, \( P = 0.028 \)).

The thrombolytic number of patients with STEMI increased (10.53% versus 17.24%) and is shown in Figure 2. There was no significant difference in age, gender, and diagnosis. More detailed results are reported in Table II.

Discussion

The main finding of the present study is that the COVID-19 pandemic would cause a decrease in the number of patient admissions to CCU. This result is consistent with our expectation and previous research results. However, compared with 2019, inhospital mortality rate was decreased from 28.57% to 16.67%. This result is different from previous study in Italy published in the European Heart Journal. This may be mainly due to epidemic prevention policy and personal factors of patients or their families. Firstly, during the Chinese Lunar New Year holiday, the hospital has the most severe patients and also has higher mortality. Secondly, the decrease of hospital inpatients is mainly due to the impact of the epidemic situation of this year. There was a shortage of medical protection resources in the early stage, the medical service system was focused on COVID-19, and most healthcare resources were relocated to manage the pandemic. This has caused an attitude toward deferral of less urgent cases. Thirdly, the country also has promulgated a series of strict epidemic prevention measures, including home quarantine and lockdown of the city.

These methods not only effectively control the epidemic but also make it more difficult to transport patients with critical cardiovascular disease from remote rural areas to modern cardiovascular specialties, which will probably significantly increase mortality for patients with severe cardiovascular disease in Hunan Province. The fact is that most patient admission to our CCU are not as serious as last year, which can be reflected by their better heart function class and shorter hospital stay. Finally, during the outbreak, patients and their families are more likely to visit local hospitals and do not want to visit hospitals in big cities, even if the medical level there is higher. There-
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Figure 2. Compared with the same period in 2019, the number of patients transferred from other hospitals decreased significantly (76.79% versus 56.67%, \( P = 0.002 \)), the number of patients transferred from other cities also decreased by 10.75%. The PCI rate of STEMI patients decreased (76.32% versus 55.17%, \( P = 0.028 \)). The thrombolytic number of STEMI patients is shown in the figure (10.53% versus 17.24%)

|                      | 2019 | 2020 |
|----------------------|------|------|
| Patients transferred | 86   | 51   |
| Patients from other cities | 78   | 53   |
| PCI of STEMI         | 29   | 16   |
| Thrombolysis of STEMI| 4    | 5    |

Table II. Clinical Features Between 2020 and 2019

|                      | 2019     | 2020     | \( P \) value |
|----------------------|----------|----------|---------------|
| \( n \)              | 112      | 90       |               |
| Age (years)          | 63.33 (14.02) | 59.99 (13.43) | 0.088         |
| Length of stay (days)| 12.36 (9.42) | 7.97 (5.88) | < 0.001       |
| Sex                  |           |          | 0.740         |
| Men                  | 82 (73.21%) | 64 (71.11%) |              |
| Women                | 30 (26.79%) | 26 (28.89%) |              |
| Diagnosis            |           |          | 0.542         |
| STEMI                | 38 (33.93%) | 29 (32.22%) |              |
| UA                   | 13 (11.61%) | 16 (17.78%) |              |
| NSTEMI               | 24 (21.43%) | 14 (15.56%) |              |
| HF                   | 11 (9.82%)  | 9 (10.00%)  |              |
| Arrhythmia           | 5 (4.46%)  | 5 (5.56%)  |              |
| Others               | 21 (18.75%) | 17 (18.89%) |              |
| Hospital PCI of ACS  | 57 (76.00%) | 20 (33.90%) | < 0.001       |
| PCI of STEMI         | 29 (76.32%) | 16 (55.17%) | 0.028         |
| Thrombolysis of STEMI| 4 (10.53%) | 5 (17.24%)  | 0.485         |
| Transferred patients | 86 (76.79%) | 51 (56.67%) | 0.002         |
| Patients from other cities | 78 (69.64%) | 53 (58.89%) | 0.112         |
| Cardiac function     | 3.15 (0.67)  | 2.83 (0.78)  | 0.002         |
| Dead                 | 32 (28.57%) | 15 (16.67%) | 0.047         |

Data are \( (n) \) mean (SD), median (min-max), where \( n \) is the total number of patients with available data. STEMI indicates ST-segment elevation myocardial infarction; NSTEMI, non-ST-segment elevation myocardial infarction; HF, heart failure; UA, unstable angina; and PCI, percutaneous coronary intervention. \( P \) values comparing 2019 and 2020 are from the rank-sum test, Student’s \( t \)-test, Chi-square test, Fisher’s exact test, and Mann–Whitney \( U \) test, as appropriate.

Therefore, these multiple factors have led to a decreased in the number of hospitalizations and in-hospital mortality rate.

Meanwhile, compared with the same period last year, in 2020, fewer patients with ACS (76.00% versus 39.00%, \( P < 0.001 \)) underwent inhospital emergency PCI, and the PCI rate of patients with STEMI also decreased (76.32%
In conclusion, during the COVID-19 outbreak in Hunan Province, the number of patients admitted to CCU decreased, as well as the mortality rate; fewer patients with severe cardiovascular disease can be transported to better hospitals from remote rural areas. In addition to epidemic prevention and control, experts in China should focus on improving emergency transport services to reduce this impact.

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Disclosure

Conflicts of interest: The authors have no conflicts of interest to disclose.

Authors’ contributions: JJ Tang designed the study, ZJ Wu drafted the manuscript, ZJ Wu and QD Hu collected the data, and MX Chen and YQ Chen revised the paper. All authors approved the final version.

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versus 55.17%, \( P = 0.028 \)). This can also be attributed to multiple factors. During the outbreak, the green channel of direct PCI in chest pain center of hospital in Hunan Province is still in normal operation\(^{14} \); however, we have conducted a more strict assessment for patients with ACS. First, before hospitalization, all patients with fever will undergo COVID-19 nucleic acid tests two times, and positive patients will be sent to a special fever isolation ward. If the nucleic acid test is negative and the condition is relatively mild, chest CT is necessary. However, because of the insufficient medical protective materials and limited testing equipment during the peak of the epidemic, we cannot perform nucleic acid testing for every patient. If the patient develops a fever during the hospitalization, a special infectious disease expert will guide us to isolate the patient and immediately conduct a nucleic acid test. Fortunately, during the epidemic, although our hospital diagnosed more than 100 COVID-19 cases, there was no positive case in our CCU.

In addition, we followed the consensus\(^{15} \) of experts to adopt a more conservative treatment. The Chinese Society of Cardiology issued this consensus statement after the COVID-19 outbreak; for example, for STEMI, we should consider thrombolysis rather than PCI. Our central data also show that the proportion of patients with STEMI receiving PCI decreased (76.32% versus 55.17%, \( P = 0.028 \)) and thrombolytic therapy increased (10.53% versus 17.24%, \( P = 0.485 \)); however, this data of thrombolytic therapy is not statistically significant, probably because our sample size is too small. Unless necessary, we will perform PCI operation after the patient is excluded from the infection of the COVID-19. It should be noted that whether it is Chinese or Italian experts’ consensus,\(^{6,17} \) these consensus are not immutable and can be used for reference. Each region can also formulate better measures according to local conditions.

Our study has several limitations. First, our data was a retrospectively, observational, single-center collected study and cannot reflect the overall situation of Hunan Province. Second, our study may also suffer from selection bias. Third, we have only described this phenomenon in this study. Finally, we did not follow up the patient for a longer period of time.
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