



ORIGINAL ARTICLE

Single-center experience of organ transplant practice during the COVID-19 epidemic

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SUMMARY

In order to safely carry out organ donation transplants during the outbreak of coronavirus disease 2019 (COVID-19), we have formulated strict procedures in place for organ donation and transplantation. We retrospectively analyzed our transplantation work from January 20 to May 5, 2020, to discuss whether organ transplantation can be carried out safely during the epidemic period. From January 20 to May 5, 43 cases of donation were carried out in our hospital, and the utilization rate of liver, kidney, heart, lung, and pancreas donations was more than 90%. Forty-one cases of liver transplantation and 84 cases of kidney transplantation were performed. No graft loss or recipient death occurred within one month after kidney transplantation, and one patient (2.4%) died after liver transplantation. There was no significant difference in the length of hospital stay compared with that during the same period in the previous three years. More importantly, COVID-19 infection did not occur among healthcare providers, donors, patients, or their accompanying families in our center. Under the premise of correct protection, it is safe and feasible to carry out organ transplantation during the epidemic period. Our experience during the outbreak might provide a clinical reference for countries facing COVID-19 worldwide.

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Key words

coronavirus disease 2019, novel coronavirus, organ donation, organ transplantation

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Introduction

The outbreak of novel coronavirus pneumonia has caused a great threat to health systems and economic development worldwide. This epidemic was classified as an “international public health emergency” by the World Health Organization on January 31st and then

named “coronavirus disease 2019” (COVID-19) [1]. China and other countries around the world responded quickly and took active measures to address COVID-19. As of May 5th of this year, the pandemic has been effectively controlled in China. A total of 324 cities have no infected patients, and the total number of existing confirmed cases in China has dropped to

339 [2]. The work of epidemic prevention has won a staged victory. However, the understanding of COVID-19 is still in the preliminary stage, and there is not extensive experience regarding organ donation and transplantation during an epidemic. How to carry out organ donation and transplantation scientifically and in an orderly manner during a severe epidemic is a common challenge for transplant professionals worldwide. It is important and urgent to carry out organ donation and transplantation safely, to guide disease prevention for organ transplant recipients, and to optimize the relevant diagnosis and treatment process. Major transplant centers and societies put forward strategies and suggestions for organ donation and transplantation during the special period for clinical reference. According to the instructions of the National Health Committee, the Chinese Medical Association has issued a series of guidelines and expert opinions on organ donation and transplantation during the epidemic, with the aim of helping practitioners better carry out work in China [3].

In the face of the current epidemic, according to our hospital's epidemic prevention policy and expert guidelines, our center has formulated protocols for organ donation and transplantation to ensure regular clinical practice can continue. Without novel coronavirus infection occurring among medical staff, donors, or transplant patients and their accompanying family members, organ donation and transplantation practice has been carried out smoothly with donated organs of good quality and excellent transplant outcomes. Therefore, we would like to share our experience during the pandemic with healthcare providers and hope to provide a clinical reference and encouragement for peers.

Methods

We have formulated clear and detailed procedures for donor evaluation and procurement, candidates' admission, and transplantation surgery. It was the first principle that all procedures for epidemic prevention during organ donation and transplantation must comply with regional or national recommendations.

Before transplantation, the admission of donors and recipients and the fieldwork of OPO staff are the top priority of epidemic prevention. In principle, the admission of the donor and recipient shall comply with the outpatient admission procedure established by our hospital (Fig. 1). After receiving the admission notice, the recipients immediately went to the medical institution

for nucleic acid testing (NAT) and CT scans. NATs mainly collect respiratory tract samples, oropharyngeal or nasopharyngeal swabs, bronchial or alveolar lavage fluid, etc. Then SARS-CoV-2 nucleic acid was quantitatively detected by reverse transcription-polymerase chain reaction (RT-PCR). Patients with negative NAT and normal CT results can be admitted to hospital. OPO staff should work online as much as possible and do well in personal protection when necessary (Fig. 2). The arrangement of donor procurement surgery must follow the Recommendations on Procedures for Routine Surgical Management and Prevention and Control during COVID-19 Epidemic (Fig. 3). The operating room should strictly verify the CT and NAT results of each operative patient. Surgery was scheduled after COVID-19 infection was ruled out.

Scientific ward and family management is the key point of hospital epidemic prevention (Fig. 2). The ward is managed in a semi-closed way. All the family members and patients are not allowed to leave the ward without permission. All departments need to prepare 1–2 separate rooms as an isolation space. Follow-up of postoperative patients is recommended to be conducted online as far as possible or in the nearest low-risk hospital. The frequency of follow-up should be reduced as long as health permits (Fig. 2). More detailed information is provided in Appendix S1.

Data collection and statistical analysis

The donation data and the source of organs transplanted in our center during the COVID-19 pandemic between January 20 and May 5, 2020, and during the same period in the past three years were recorded. Donors' age, sex, BMI, donated organs, and causes of death were included in our study. The clinical data of the recipients were recorded in the electronic medical record system by the clinicians and then extracted by the researchers. The recipient characteristics, including age, sex, BMI, primary diagnosis, model for end-stage liver disease (MELD) score, test results for the graft function evaluation, and the one-month survival of the recipients and grafts, were selected for analysis.

Categorical variables are expressed as percentages and calculated by Fisher's exact test. Continuous variables are represented by the mean \pm standard deviation. One-way analysis of variance (ANOVA) was used for statistical analysis. All statistical analyses were performed using SPSS software (version 23.0; IBM, CA, USA).

This study was approved by the ethics committee of the First Affiliated Hospital of Sun Yat-sen University.

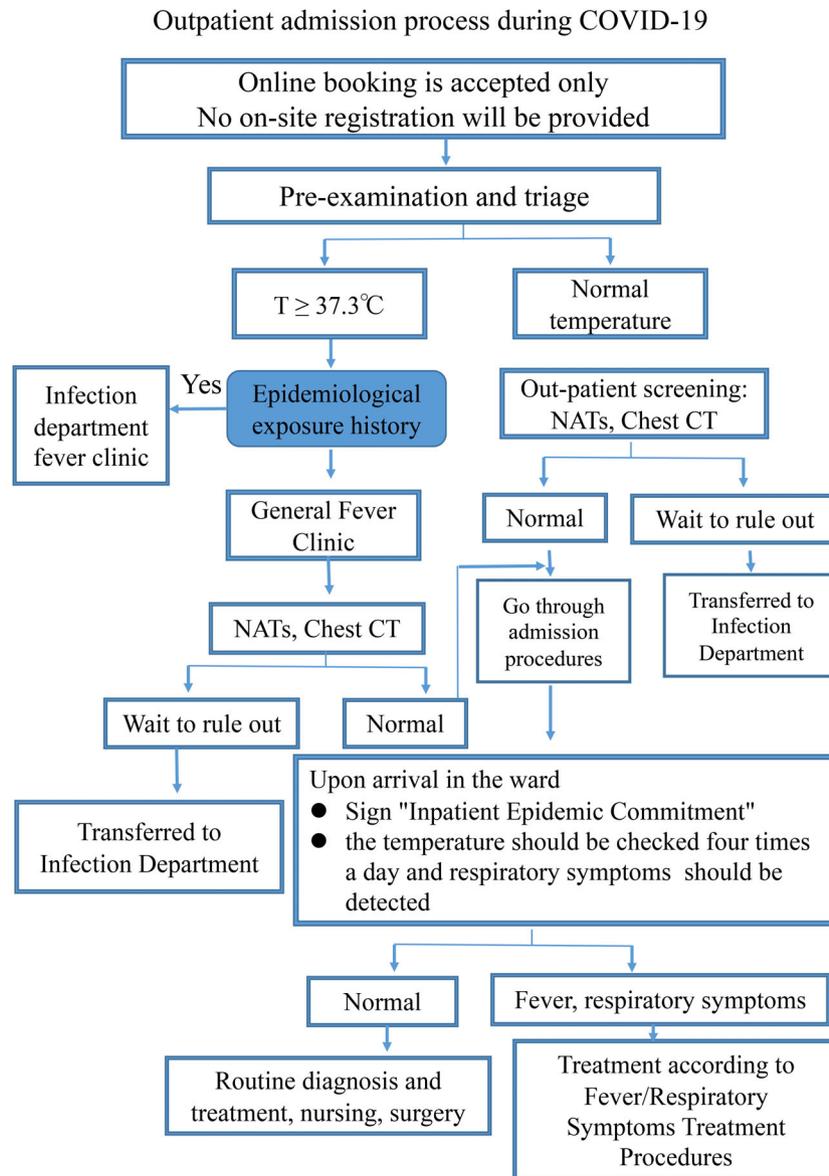


Figure 1 Outpatient admission process during COVID-19.

Results

Organ donation practice

From January 20 to May 5, 2020, and the same period in 2017–2019, the organ donation practices of our center are summarized in Table 1 and Fig. 4. From January 20 to May 5, 2020, a total of 43 donors donated organs in our center, including 32 males and 11 females. There was no significant difference in the causes of death compared with those during the same period of the past 3 years; 19 died of head trauma, 17 died of cerebrovascular disease, and six died of hypoxia. A total of 153 organs were donated with an average of 3.56 organs per

donor, including 39 livers, 80 kidneys, 12 hearts, 21 lungs, one pancreas, and 50 corneas. The number of lungs donated increased compared to that during the same period in 2017 and 2018. In addition, there was no significant difference in the number of other donated organs during the COVID-19 pandemic compared with the previous three years. The utilization rate of donated organs was more than 90% and not significantly different from that during the same period of the previous three years. Likely due to the COVID-19 pandemic, the number of organ donors was reduced slightly compared with the previous two years, but organ utilization and the average organ donation per donor remained at an ideal level, suggesting that organ

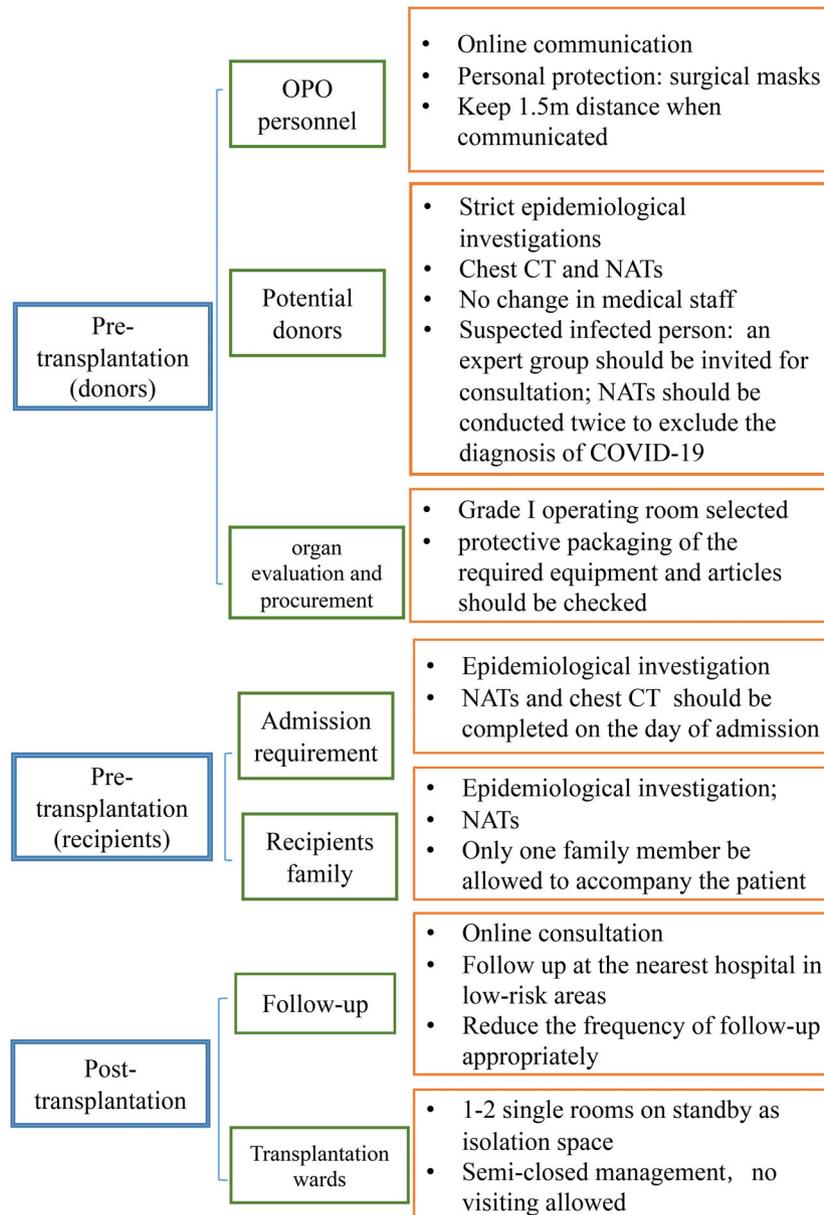


Figure 2 Suggestions on donor and recipient management and epidemic prevention measures pre- and post-transplantation.

donation can be carried out routinely on the premise of correct protection.

Kidney transplant outcomes

During the pandemic period, 84 patients underwent kidney transplantation (KT) in our center, 70 donor kidneys were procured in our hospital, and the remaining 14 were from other hospitals, similar to the previous three years. Seventy-four (88.1%) donor kidneys were from donation after brain death, and 8 (9.5%) donor kidneys were donated after cardiac

death. Only two kidneys were from live donors. There was no significant difference between the source of donor kidneys transplanted in our center during the epidemic period and that during the previous three years (Table 2).

Sixty-one percent of the recipients needed hemodialysis before the operation, and 29.8% needed peritoneal dialysis (Table 3). Postoperative infection occurred in three patients (one pneumonia, one urinary tract infection, and one infection in other sites). The number of KT operations during the outbreak decreased compared with the previous 2 years, but the main clinical

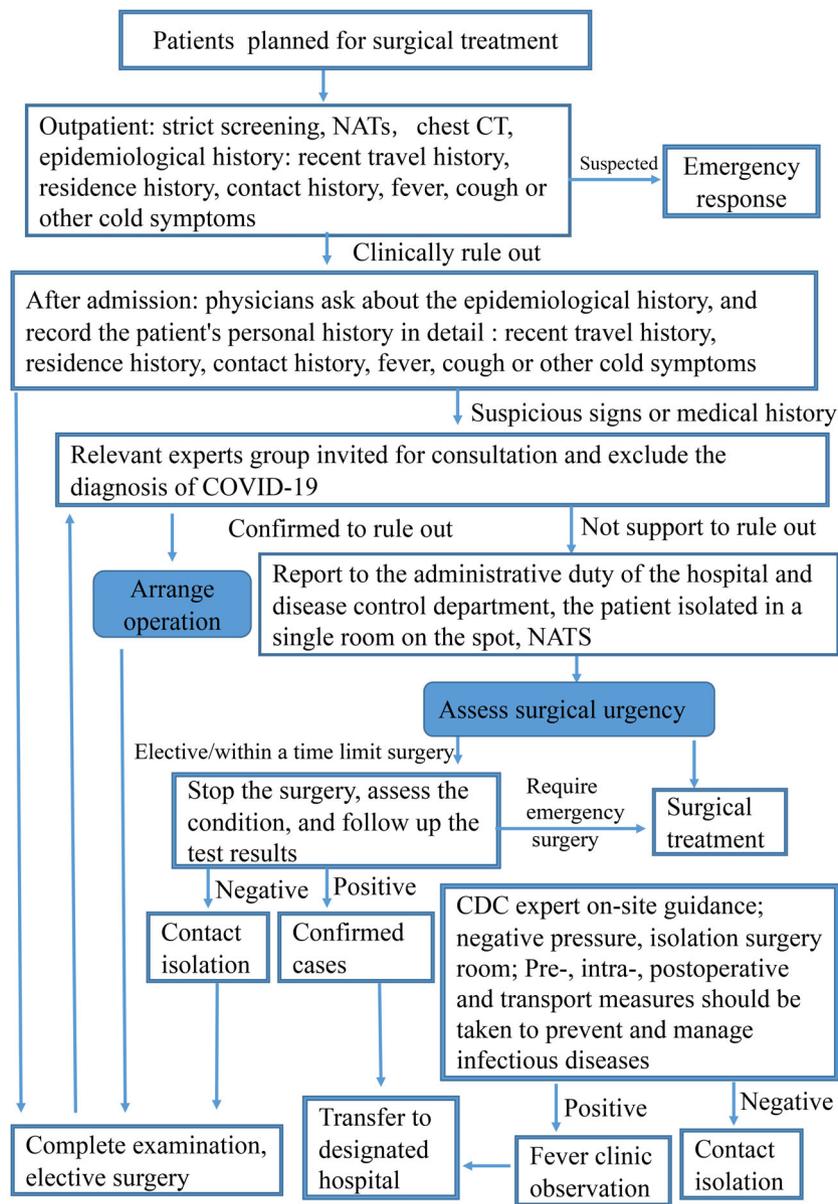


Figure 3 Suggestions on routine surgical management and prevention and control procedures during the epidemic.

outcomes of the patients remained at the previous level. Only one patient developed acute rejection, and no PNF occurred during the special period. The incidence of DGF was 10.7%, and there was no significant difference compared with the previous three years (10.4%, 12.3%, and 9.1%; $P = 0.875$). All recipients and grafts survived for one month. The average length of hospital stay was 13 days, similar to the length of hospital staying during the same period in 2017–2019.

Liver transplant outcomes

From January 20th to May 5th, a total of 41 patients with end-stage liver disease underwent LT in our

hospital. The average age of donors was 36.6 years, and the donors included 30 males and 11 females (Table 4). A total of 75.6% of donor livers were procured in our hospital, mainly from brain death donation. Head trauma (46.3%) and cerebrovascular disease (39.0) were the main causes of donor death. The characteristics of LT donors in our hospital during the epidemic period are similar to those during the past three years.

Recipient information and the main prognosis outcomes are shown in Table 5. More than half (63.4%) of the patients were diagnosed with hepatocellular carcinoma, 17.1% of the patients were diagnosed with cirrhosis, and 12.2% were diagnosed with liver failure. The mean laboratory MELD score of all patients was 16.5,

Table 1. Summary of organ donation from January 20 to May 5, 2017–2020.

Years	2017 (n = 40)	2018 (n = 62)	2019 (n = 52)	2020 (n = 43)	P*
Gender (M/F)	28/12	43/19	36/16	32/11	0.940
Age, n (%)					0.119
0–14	10 (25.0)	12 (19.4)	17 (32.7)	5 (11.6)	
15–50	26 (65.0)	42 (67.7)	27 (51.9)	27 (62.8)	
>50	4 (10)	8 (12.9)	8 (15.4)	11 (25.6)	
BMI (kg/m ²)					
Cause of death, n (%)					0.545
Head trauma	21 (52.5)	28 (45.2)	22 (42.3)	19 (44.2)	
Cerebrovascular diseases	13 (32.5)	24 (38.7)	14 (26.9)	17 (39.5)	
Hypoxic encephalopathy	4 (10.0)	9 (14.5)	14 (26.9)	6 (14.0)	
Others	2 (5.0)	1 (1.6)	2 (3.8)	1 (2.3)	
Average organ donation per donor	3.23	3.27	3.31	3.56	
Donated organs (%)					
Liver	37	57	47	39	0.981
Kidney	76	122	98	80	0.545
Heart	5	12	11	12	0.387
Lung	8 ^a	10 ^a	14 ^{a,b}	21 ^b	0.001
Pancreas	3	2	2	1	0.723
Corneal	59	78	58	50	0.260
Organ utilization rate (%)					
Liver	94.6	98.2	95.7	92.3	0.426
Kidney	81.6	86.9	93.9	90	0.337
Heart	100	100	90.9	100	0.400
Lung	100	100	80	90.5	0.349
Pancreas	66.7	0	50	100	0.657

BMI, body mass index; M/F, male/female.

*P values apply to comparisons of the four time periods and were calculated with Fisher's exact test for discrete variables.

^{a,b}There is statistical difference in target variable between groups with the different superscript letters.

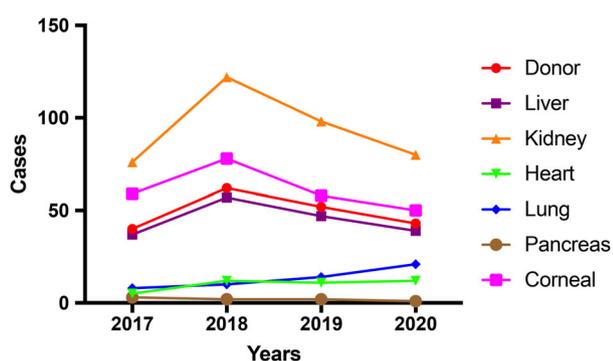


Figure 4 Comparison of organ donation in our center from January 20 to May 5, 2020, and the same period from 2017 to 2019.

which was significantly lower than last year but not significantly different from that in 2017 and 2018. One case of PNF and one case of acute rejection occurred, and the incidence rates were similar to those in our center in the past three years. Five patients had EAD, which was less than the number during the same period

in 2017 and 2018. No patients suffered anastomotic or nonanastomotic stricture. There was one case of biliary leakage and four cases of infection (one case of sepsis, two case of pneumonia, and two cases of abdominal infection). The average length of ICU and hospital stay was 64.4 h and 23.6 days, respectively. One patient died of PNF within one month. Compared to the same study period in the previous three years, the liver transplant activity in our hospital was fairly similar.

COVID-19 in Guangzhou and our hospital

From January 21 to May 4, the new cases, cumulative cases, and cured cases of COVID-19 in Guangzhou, the city where our hospital is located, are shown in Fig. 5 [4]. In the early, the number of new cases increased rapidly, and there were no cured cases in the first week, reflecting the high infectivity of COVID-19 and the need for a certain course of treatment. Then, with increased public awareness and official efforts, the number of new cases has dropped significantly. By

Table 2. Comparison of characteristics of donors in kidney transplantation.

	2017 (n = 77)	2018 (n = 122)	2019 (n = 132)	2020 (n = 84)	P*
Age (years)	33.2 ± 17.4	32.8 ± 18.4	32.4 ± 19.5	30.1 ± 18.2	0.707
Gender male, n (%)	49 (63.6%)	80 (65.6%)	90 (68.2%)	58 (69.0%)	0.159
BMI (kg/m ²)	21.1 ± 2.3	22.4 ± 3.4	22.8 ± 2.5	22.6 ± 2.8	0.823
Donor source, n (%)					
Our hospital	69 (89.6) ^{a,b}	113 (92.6) ^b	100 (75.8) ^a	70 (83.3) ^{a,b}	<0.001
Other hospital	8 (10.4) ^{a,b}	9 (7.4) ^b	32 (24.2) ^a	14 (16.7) ^{a,b}	
Donor type, n (%)					
Live donor	12 (15.6) ^a	11 (9.0) ^{a,b}	9 (6.8) ^{a,b}	2 (2.4) ^b	<0.001
DBD	49 (63.6) ^a	95 (77.9) ^{a,b}	93 (70.5) ^a	74 (88.1) ^b	
DBCD	4 (5.2)	1 (0.8)	1 (0.8)	0	
DCD	12 (15.6)	15 (12.3)	29 (22.0)	8 (9.5)	
Primary diseases, n (%)					
Head trauma	43 (66.2) ^a	59 (53.2) ^{a,b}	55 (44.7) ^b	44 (53.7) ^{a,b}	0.014
Cerebrovascular diseases	12 (18.5)	33 (29.7)	34 (27.6)	24 (29.3)	
Hypoxic encephalopathy	4 (6.2)	17 (15.3)	23 (18.7)	13 (15.9)	
Others	6 (9.2)	2 (1.8)	11 (8.9)	1 (1.2%)	
Warm ischemia time (min)	1.68 ± 3.45	1.51 ± 3.17	2.54 ± 5.81	1.58 ± 3.29	0.202
Cold ischemia time (h)	9.42 ± 4.91	9.32 ± 4.38	10.14 ± 5.09	8.54 ± 4.26	0.108

DBCD, donation after brain death followed by circulatory death; DBD, donation after brain death; DCD, donation after circulatory death.

*P values apply to comparisons of the four time periods and were calculated with Fisher's exact test for discrete variables and with one-way ANOVA test for continuous variables.

^{a,b}There is statistical difference in target variable between groups with the different superscript letters.

Table 3. Comparison of characteristics and clinical outcomes of recipients in kidney transplantation.

	2017 (n = 77)	2018 (n = 122)	2019 (n = 132)	2020 (n = 84)	P*
Age (years)	40.0 ± 15.1	40.8 ± 14.7	41.6 ± 16.5	40.4 ± 17.0	0.903
Gender (M/F)	55/22	81/41	82/50	58/26	0.528
BMI (kg/m ²)	21.8 ± 3.3	22.3 ± 3.8	22.1 ± 3.63	22.3 ± 3.8	0.423
Dialysis, n (%)					
Hemodialysis	37 (48.1)	75 (61.5)	84 (63.6)	51 (60.7)	0.425
Peritoneal dialysis	30 (39.0)	38 (31.1)	38 (28.8)	25 (29.8)	
None	10 (13.0)	9 (7.4)	10 (7.6)	8 (9.5)	
HLA mismatch(loci)	3.1 ± 1.8	2.9 ± 2.1	3.3 ± 1.9	3.2 ± 1.7	0.503
PRA positive, n (%)	4 (5.2)	6 (4.9)	8 (6.1)	5 (6.0)	0.977
Infection, n (%)	7 (9.1)	14 (11.5)	13 (9.8)	3 (3.6)	0.253
Pneumonia	3 (3.9)	7 (5.7)	9 (6.8)	1 (1.2)	
Urinary tract	3 (3.9)	3 (2.5)	2 (1.5)	1 (1.2)	
Others	1 (1.3)	4 (3.3)	2 (1.5)	1 (1.2)	
Acute rejection, n (%)	3 (3.9)	9 (7.4)	5 (3.8)	1 (1.2)	0.183
PNF, n (%)	0	1 (0.8)	0	0	0.484
DGF, n (%)	8 (10.4)	15 (12.3)	12 (9.1)	9 (10.7)	0.875
One-month patient survival, n (%)	77 (100)	120 (98.4)	132 (100)	84 (100)	0.575
One-month graft survival, n (%)	77 (100)	120 (98.4)	131 (99.2)	84 (100)	0.332
Length of hospital stay (days)	13.6 ± 6.3	13.2 ± 8.5	14.1 ± 7.2	13.8 ± 6.9	0.512

HLA, human lymphocyte antigen; M/F, male/female; PRA, panel reactive antibody.

*P values apply to comparisons of the four time periods and were calculated with Fisher's exact test for discrete variables and with one-way ANOVA test for continuous variables.

Table 4. Comparison of characteristics of donors in liver transplantation.

	2017 (n = 51)	2018 (n = 62)	2019 (n = 52)	2020 (n = 84)	P*
Age (years)	30.4 ± 16.0	32.5 ± 16.2	34.5 ± 16.3	36.6 ± 18.5	0.317
Gender (M/F)	38/13	39/23	35/17	30/11	0.538
BMI	21.7 ± 6.3	21.9 ± 3.0	21.7 ± 3.6	22.5 ± 3.5	0.853
Blood type, n (%)					
A	16 (31.4)	20 (32.3)	9 (17.3)	8 (19.5)	0.389
B	13 (25.5)	19 (30.6)	12 (23.1)	12 (29.3)	
AB	4 (7.8)	2 (3.2)	3 (5.8)	2 (4.9)	
O	18 (35.3)	21 (33.9)	28 (53.8)	19 (46.3)	
Donor source, n (%)					
Our hospital	22 (43.1) ^a	37 (59.7) ^{a,b}	33 (63.5) ^{a,b}	31 (75.6) ^b	0.015
Other hospital	29 (56.9) ^a	25 (40.3) ^{a,b}	19 (36.5) ^{a,b}	10 (24.4) ^b	
Donor type, n (%)					
DBD	37 (72.5) ^a	53 (85.5) ^{a,b}	45 (86.5) ^{a,b}	39 (95.1) ^b	0.043
DBCD	2 (3.9)	0	0 ^b	0	
DCD	12 (23.5)	9 (14.5)	7 (13.5)	2 (4.9)	
Primary diseases, n (%)					
Head trauma	18 (54.9)	25 (40.3)	18 (35.3)	19 (46.3)	0.501
Cerebrovascular diseases	15 (29.4)	22 (35.5)	22 (43.1)	16 (39.0)	
Hypoxic encephalopathy	6 (11.8)	11 (17.7)	5 (9.8)	3 (7.3)	
Others	2 (3.9)	4 (6.5)	6 (11.8)	3 (7.3)	
Cold ischemia time (min)	464.7 ± 157.3 ^a	353.1 ± 139.8 ^b	253.1 ± 163.3 ^b	378.7 ± 117.7 ^b	<0.001

BMI, body mass index; DBCD, donation after brain death followed by circulatory death; DBD, donation after brain death; DCD, donation after circulatory death; M/F, male/female.

*P values apply to comparisons of the four time periods and were calculated with Fisher's exact test for discrete variables and with one-way ANOVA test for continuous variables.

^{a,b}There is statistical difference in target variable between groups with the different superscript letters.

February 25, it had achieved zero new cases effectively controlling the spread of the disease. However, since March 16, the epidemic has turned a turning point. After 14 days of no new cases in the mainland, the number of confirmed imported cases has increased, which has brought great challenges to the customs and hospitals. By April 21, the outbreak had been brought under control again, and the cumulative number of confirmed cases in Guangzhou was finally 503 (as of May 5).

From January 20 to May 5, 30001 patients were treated in our emergency department, up to 400 patients a day can be treated. The number of emergency patients in each department is shown in Fig. 6, and the top three are internal medicine, surgery, and fever. In fever clinic, the patients' body temperature was mainly low fever, and the main causes were common diseases such as upper respiratory tract infection (44.62%), community acquired pneumonia (23.18%), and pharyngeal tonsillitis (20.29%). A total of seven outpatients with COVID-19 infection were confirmed in the isolation treatment. None of the inpatients were confirmed as having COVID-19. On January 25th, at the very

beginning of the pandemic, an emergency patient was admitted to the ICU, and one of his family members' NAT results was strongly positive. Although two NAT results for the patient were negative, we still regarded him as a suspected case and reported it to the medical department. At the same time, the medical staff who had close contact with the patient and his family were required to be isolated at home for 14 days and received two NATs.

Discussion

The world is being swept by a COVID-19 outbreak, which has had a great impact on all clinical work, including organ donation and transplantation. The decrease in donation and transplantation activity in some countries has been dramatic [5]. According to an anonymous web-based survey of 19 OPOs in the United States, compared with the same period last year, organ authorization decreased by 11%, the organ recovery rate decreased by 17%, and the number of transplanted organs decreased by 18% during March–May 2020 [6]. The reduction in transplantation activity is mainly due

Table 5. Comparison of characteristics and clinical outcomes of recipients in liver transplantation.

	2017 (n = 51)	2018 (n = 62)	2019 (n = 52)	2020 (n = 41)	P*
Age (years)	47.5 ± 10.8	52.7 ± 11.1	51.7 ± 12.8	50.1 ± 10.9	
Gender (M/F)	46/5	52/10	45/7	37/4	0.723
BMI	22.5 ± 2.6	23.7 ± 2.0	21.9 ± 2.9	22.5 ± 2.6	
Blood type					
A	13 (25.5)	20 (32.3)	12 (23.1)	9 (22.0)	0.593
B	15 (29.4)	21 (33.9)	12 (23.1)	11 (26.8)	
AB	7 (13.7)	4 (6.5)	5 (9.6)	3 (7.3)	
O	16 (31.4)	17 (27.4)	17 (27.4)	18 (43.9)	
Primary diseases					
Hepatocellular carcinoma	31 (60.8)	37 (59.7)	31 (59.6)	26 (63.4)	0.603
Cirrhosis	13 (25.5)	13 (21.0)	11 (21.2)	7 (17.1)	
Liver failure	7 (13.7)	6 (9.7)	8 (15.4)	5 (12.2)	
Others [‡]	0 (0)	6 (9.7)	2 (3.8)	3 (7.3)	
MELD score	19.9 ± 5.0	20.4 ± 6.7	23.0 ± 6.2	21.2 ± 6.8	0.064
Surgery time (min)	501.4 ± 111.5 ^a	453.2 ± 110 ^b	432.4 ± 81.5 ^b	420.5 ± 69.6 ^b	0.001
Complications					
EAD	23 (45.1) ^a	23 (37.1) ^a	13 (25.0) ^{a,b}	5 (12.2) ^b	0.004
PNF	2 (3.9)	2 (3.2)	0	1 (2.4)	0.648
Acute rejection	4 (7.8)	2 (4.8)	3 (5.8)	1 (2.4)	0.726
Anastomotic stricture	4 (7.8)	4 (6.5)	2 (3.8)	0	0.345
Nonanastomotic stricture	A1 (2.0)	2 (3.2)	1 (1.9)	0	0.907
Biliary leakage	2 (3.9)	0	1 (1.9)	1 (2.4)	0.486
Sepsis	7 (13.7)	5 (8.1)	1 (1.9)	1 (2.4)	0.059
Abdominal infection	8 (15.7)	3 (4.8)	2 (3.8)	2 (4.9)	0.067
Pneumonia	10 (19.6)	7 (11.3)	5 (9.6)	1 (2.4)	0.071
ICU stay (h)	103.1 ± 189.0	96.8 ± 113.6	71.4 ± 80.3	64.4 ± 61.3	0.366
Hospital stay (days)	26.7 ± 13.5	24.6 ± 10.6	20.7 ± 10.1	23.6 ± 16.5	0.114
One-month graft survival	46 (90.2)	54 (87.1)	49 (94.2)	40 (97.6)	0.255
One-month patient survival	48 (94.1)	54 (87.1)	49 (94.2)	40 (97.6)	0.250

BMI, body mass index; EAD, early allograft dysfunction; ICU, intensive care unit; M/F, male/female; MELD, model for end-stage liver disease; PNF, primary nonfunction.

*P values apply to comparisons of the four time periods and were calculated with Fisher's exact test for discrete variables and with one-way ANOVA test for continuous variables.

[‡]Other primary diseases: primary sclerosing cholangitis, primary biliary cirrhosis, cholangiocarcinoma, or hepatitis of an unknown origin.

^{a,b}There is statistical difference in target variable between groups with the different superscript letters.

to saturation of the healthcare system and ICU capacity and to clinical physicians' concerns about the greater risk of COVID-19 infection because of the postoperative immunosuppressive status of the recipients [7, 8]. In April, the Canadian Organ Donation and Transplantation Expert Advisory Committee (ODTEAC) issued a consensus that recommendations must balance the incidence trends in provinces and territories, the risk posed to transplant candidates who will become immunocompromised, and the risks of suspending or delaying transplantation [9]. The American Association for the Study of Liver Disease (AASLD) believes that transplants should not be postponed when institutional resources

are sufficient [10], which is consistent with the guidelines given by the American Society of Transplantation (AST) and the American Society of Transplant Surgeons (ASTS) [11, 12]. Considering that organ donation and transplantation is an essential life-saving and life-preserving medical intervention, it is not recommended that transplantation be canceled or postponed in our center. At a time when the number of cases diagnosed was rising, we successfully performed 41 liver transplants and 84 kidney transplants. And no medical personnel or patients or their families were infected with COVID-19 during the entire perioperative period. However, in fact, at that time, the probability of COVID-19

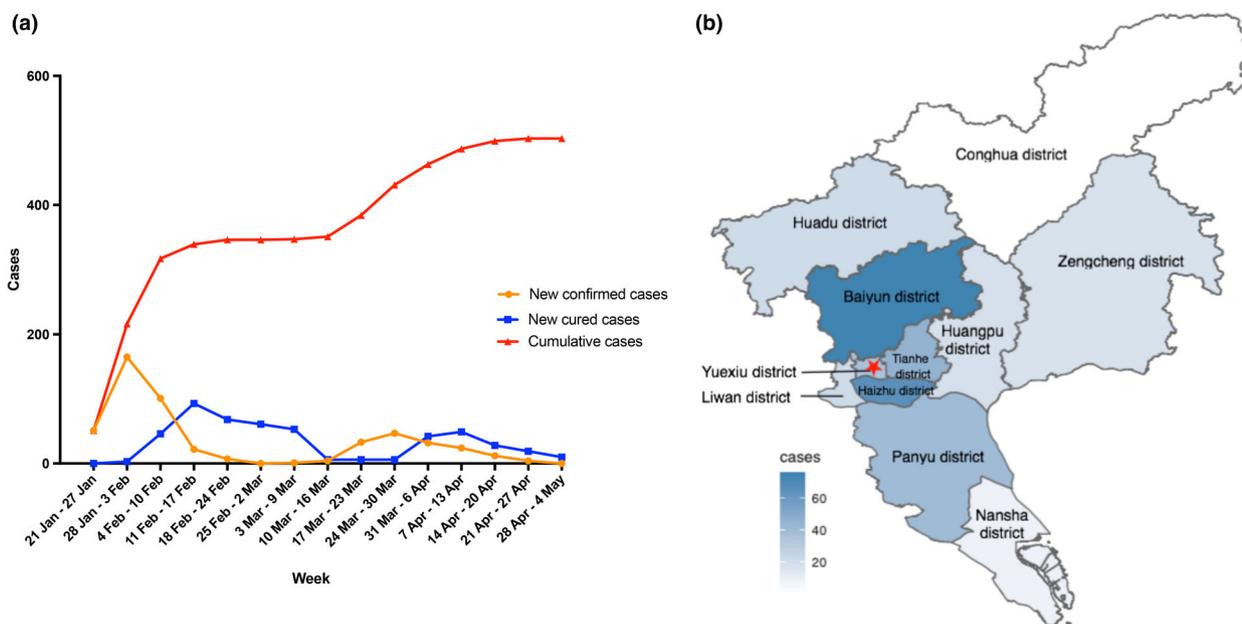


Figure 5 The epidemic in Guangzhou. (a) The trend of new confirmed cases, cumulative confirmed cases, and cured cases of COVID-19 per week in Guangzhou from January 20 to May 5. (b) Distribution of reported COVID-19 cases in Guangzhou, February 25, 2020.

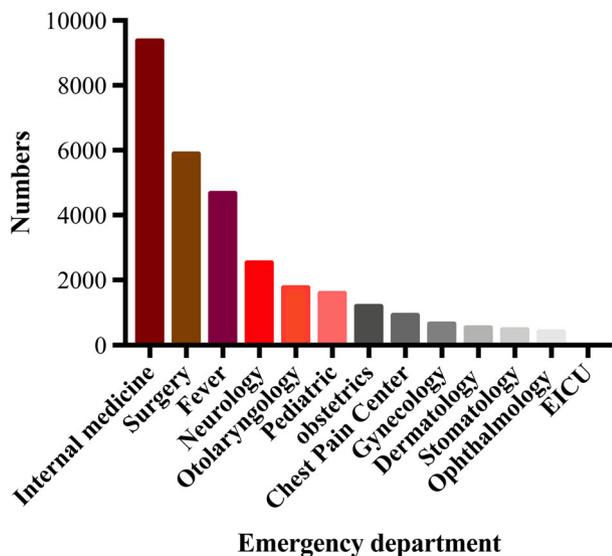


Figure 6 The distribution of emergency patients in each department of our hospital from January 20, 2020, to May 5.

infection was relatively high in Guangzhou. Our fever clinic alone confirmed seven cases of COVID-19. This showed that the method we carried out can effectively build an effective barrier between the hospital and the outside environment to prevent the spread of the virus into the hospital. Our study did not set up a comparison to directly demonstrate the effectiveness of our approach. It can only indicate that organ transplantation under strict protection is safe and reliable during epidemics of infectious diseases.

There is no complete consensus on how to carry out donation and transplantation activities safely [12]. The screening and management methods for donors, transplant candidates, and recipients have varied in different societies and centers during the outbreak, since the development of suggestions or guidelines for each center requires comprehensive consideration of the local epidemic situation, the capacity of the hospital, and the reserve of medical supplies. In the early days, The Transplantation Society (TTS) suggested that routine NAT screening should only be performed in areas with significant ongoing community transmission to minimize the risk of false-positive testing and organ wastage, while TTS suggested in their latest guidance that both donors and recipients should undergo an NAT unless the need for transplantation is urgent [7]. In other countries, such as Canada, Switzerland, Italy, and Spain, NATs are only used for donor screening, and screening of pretransplant recipients is based on clinical manifestations [13], which will leave many asymptomatic infected candidates undiagnosed. So we insist on NATs for every donor and transplant candidate. At the same time, chest CT is very important for the screening and diagnosis of COVID-19. NAT has a certain possibility of false negatives, and there are many patients who do not have obvious clinical symptoms, but have poor radiographic findings. CT can not only help us to exclude the diagnosis of COVID-19, but also judge the severity of the disease very well [14]. Therefore, even though there is the possibility of wasting

medical resources, NATs combined with chest CT scans were the standard procedures for screening for COVID-19 in both potential donors and recipients in our hospital. This is where the policy of our center differs most from the recommendations of foreign institutes. The center required medical personnel not to have left the city during the 14 days prior to participating in the transplantation work, which is not required by the first domestic transplant work guideline.

The outbreak of COVID-19 has brought many inconveniences and risks to transplantation activities, but as the only treatment for end-stage organ failure, transplantation work should be carried out in an orderly manner under scientific and effective protection. The experience of our center also proves that transplantation activities can be carried out with sufficient preparations. We also hope that our experience can give encouragement to other transplant centers that it is feasible to carry out transplant activities during the outbreak.

Authorship

JHX, MH, YL and CJH: contributed equally to the article and should be considered the co-first authors. ZYG, GDC and XSH: initiated and designed the project and directed the research. JHX, MH, YL and CJH: participated in data collection and the writing of the paper. DPW, XFZ, CXW and JH: participated in data analysis and explanation.

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Conflict of interest

The authors of this manuscript have no conflicts of interest to disclose as described by the *Transplantation International*.

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Ethical approval

The local ethical committee approved the study protocol. The whole study respected local laws and epidemic prevention policies. Also, the study adheres both the Declarations of Helsinki and Istanbul and that no executed prisoners were used in the study. Each patient (or their family) signed informed consent.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Appendix S1. The more detailed epidemic prevention measures of our hospital during the COVID-19 outbreak.

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