Original Article

In-hospital mortality of liver transplantation and risk factors: a single-center experience

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Background: Liver transplantation (LT) is a life-saving treatment for patients with end-stage liver disease and acute liver failure. However, in-hospital death cannot be avoided. We designed this study to analyze patients' in-hospital mortality rate after LT and the factors correlated with in-hospital death.

Methods: The data of patients who received LT in our hospital between January 11, 2015, and November 19, 2019, were obtained from the China Liver Transplant Registry and medical records. The in-hospital mortality rate was calculated, and factors related to mortality, cause of death, and factors related to cause of death were analyzed by reviewing patients' data.

Results: A total of 529 patients who underwent cadaveric LT were enrolled in this study. Modified piggyback orthotopic LT was performed for all patients. Seventy patients died in the hospital after LT, and the in-hospital mortality rate was 13.2%. Factors including model for end-stage liver disease (MELD) score, Child-Pugh grading, intraoperative blood loss, and anhepatic phase were correlated with in-hospital death. MELD score and intraoperative blood loss were determined as the two independent risk factors of in-hospital death. The first two causes of death were infection (34.3%) and primary non-function (15.7%). Pulmonary fungal infection was the main cause of infectious death. MELD score was the independent risk factor for infectious death, and both body mass index of donors and cold ischemic time were independent risk factors of primary non-function.

Conclusions: In-hospital death poses a threat to certain patients undergoing LT. Our study suggests that the main cause of in-hospital death is an infection, followed by primary non-function.

Keywords: Liver transplantation (LT); in-hospital mortality; risk factor

Submitted Jul 31, 2020. Accepted for publication Nov 09, 2020.

doi: 10.21037/atm-20-5618

View this article at: http://dx.doi.org/10.21037/atm-20-5618

Introduction

Liver transplantation (LT) is the most effective treatment for patients with chronic end-stage liver disease and acute liver failure. It can also benefit some patients with malignant tumors of the liver. With the development of medicines and the accumulation of experience, recipients' survival rate has improved significantly since the first report of LT by Starzl *et al.* (1) in 1968. The 1-year survival rate was 82% in the European Liver Transplant Registry and 87% in the Japanese registry, and the 10-year survival rate ranges from 53% to 76% in the American, European, and Japanese registries (2-4).

Despite the rapid developments in LT, in-hospital death threatens a certain percentage of recipients. Bennett-Guerrero *et al.* (5) reported that the in-hospital mortality after LT was 8.4%. Gil *et al.* (6) reported that the overall in-hospital mortality was 6.3%, and the mortality of deceased donor LT was 13.5%. In this study, we reviewed the data of patients who received LT at our center to calculate the

in-hospital mortality and analyze the main death-related factors. We present the following article following the STROBE reporting checklist (available at http://dx.doi.org/10.21037/atm-20-5618).

Methods

Data collection

The data of patients who received LT in our hospital between January 11, 2015, and November 19, 2019, were collected and analyzed retrospectively. Clinical data were obtained from the China Liver Transplant Registry and medical records. Cadaveric LT was performed for all these adult patients. Cases of pediatric LT, living donor LT, and multi-organ transplantation were excluded from this study. Recipient information included age, gender, body mass index (BMI), comorbidities, a model for end-stage liver disease (MELD) score, Child-Pugh score, causes for transplantation, laboratory variables before and after the operation, operation time, anhepatic phase, and intraoperative blood loss. Donor information included age, gender, BMI, cold ischemic time (CIT), warm ischemic time (WIT), and the last laboratory variables. The study was conducted following the Declaration of Helsinki (as revised in 2013). The protocol was reviewed and approved by the institutional review committee of Beijing Chaoyang Hospital (approval number: 2020-科-303), and individual consent for this retrospective analysis was waived.

Organ procurement and allocation

The allocation of organs abided by the Basic Principles and Core Policies of the Allocation and Sharing of Human Organs in China. The China Organ Transplant Response System (COTRS) was used for the allocation of organs.

Operative procedures

Modified piggyback orthotopic LT was conducted. A curved incision below the right costal margin was made, and in some cases, a Mercedes Benz incision was needed. Firstly, the perihepatic ligaments were separated, then the second porta hepatis was divided to expose the left, middle, and right hepatic vein. The next step was to skeletonize the proper hepatic artery, expose the hepatic artery's bifurcation upwards, and ligate and cut off the right and left hepatic arteries, respectively. The portal vein was then skeletonized, the left and right branches of the portal vein were cut off, then finally, the common hepatic duct was cut off. The next procedure following the separation of the first porta hepatis was to divide the short hepatic veins. The left and middle hepatic veins were cut off and sutured, the right hepatic vein was clipped and sheared off, and the liver was removed.

The stump of the right hepatic vein was trimmed, then the vein anastomosis between the stumps of the suprahepatic inferior vena cava of the donor liver and the right hepatic vein of the recipient was completed. Anastomosis the stump of the portal vein and then restore the hepatic blood flow. Anastomosis hepatic artery and extrahepatic biliary passages. The operation was completed after the placement of the drainage tube and closing incision.

Immunosuppression

Basiliximab (20 mg) was administered within 2 hours before the operation and the fourth day after the operation. Methylprednisolone (500 mg) was used intraoperatively. The dose of methylprednisolone decreased progressively after LT. From the second day after the operation, immunosuppressive agents were given to recipients. The initial dose of tacrolimus, which was used most frequently, was 2 mg twice per day. The dose was adjusted, or patients were given a combination of tacrolimus and mycophenolate mofetil according to the blood concentration and biochemical parameters. Hormones were prohibited in patients who were diagnosed with liver malignancy, and sirolimus was usually provided for these patients 1 month later.

Definitions and diagnostic criteria

In-hospital death

Recipients usually experienced a relatively longer hospital stay after LT, and we defined in-hospital death as follows: (I) patients died of complications after transplantation during their hospitalization without discharge from hospital; (II) patients who were rehospitalized or died without operation were excluded.

Primary non-function (PNF)

PNF was defined as post-transplant liver dysfunction requiring re-transplantation or leading to death within 7 days.

Hemophagocytic syndrome (HPS)

Diagnostic criteria fulfilled (5 out of the 8 criteria below):

(I) Fever which was more than 38.5 ℃ and lasted for at least 7 days;
(II) Splenomegaly;
(III) Cytopenias (affecting ≥2 of 3 lineages in the peripheral blood): hemoglobin <90 g/L, platelets $<100\times10^9$/L, neutrophils $<1.0\times10^9$/L;
(IV) Hypertriglyceridemia and/or hypofibrinogenemia: fasting triglycerides ≥3.0 mmol/L, fibrinogen ≤1.5 g/L;
(V) Hemophagocytosis in bone marrow, spleen or lymph nodes, and no evidence of malignancy;
(VI) Low or absent natural killer (NK) cell activity;
(VII) Ferritin ≥500 mg/L;
(VIII) Soluble CD25 (i.e., soluble IL-2 receptor) ≥2,400 U/mL.

Graft-versus-host disease (GVHD)

There were no standard diagnostic criteria for GVHD after LT, though GVHD was highly suspected if the following criteria were fulfilled:

(I) Clinical manifestations including rash, fever, diarrhea, pancytopenia, and a normal liver function, which presented 2 to 8 weeks after LT;
(II) Epidermal necrolysis was found by skin biopsy;
(III) Chimerism was observed by pathological examination.

Statistical analysis

SPSS 16.0 (IBM, Chicago, Illinois, USA) was used for data analysis. Quantitative variables were analyzed with the Student's *t*-test according to data distribution. Categorical variables were analyzed using the Chi-square test or Fisher's exact test as appropriate. P values less than 0.05 were considered significant. The Kaplan-Meier method was used to calculate the rate of perioperative death. Univariate analyses were performed to identify risk factors for perioperative death, infection-related death, and PNF. After univariate analyses, variables with P values less than 0.05 were included in the multivariate logistic regression analysis to identify the independent factors associated with perioperative death, infection-related death, and PNF.

Results

Recipient characteristics

The data of 529 recipients who underwent LT in our hospital were collected and analyzed retrospectively. Modified piggyback orthotopic LT was performed for all cases, and all of the allografts were from donation after cardiac death (DCD). There were 416 male and 113 female recipients, with a mean age of 51.6±10.4 years, ranging from 19 to 82 years. The mean BMI was 24.4±3.8 kg/m^2 (range, 15.4–38.5 kg/m^2), and a BMI of more than 30 kg/m^2 was found in 45 patients. Diabetes mellitus was confirmed in 197 patients, hypertension was found in 152 patients, and cardiopathy was found in 41 patients. The reasons for LT were as follows: hepatitis B virus (HBV)-associated liver failure in 283 cases, hepatitis C virus (HCV)-associated liver failure in 26 cases, hepatitis E virus (HEV)-associated liver failure in three cases, fulminant hepatic failure in 16 cases, alcoholic-associated liver failure in 42 cases, autoimmune hepatitis-induced liver failure in 38 cases, liver malignancy with/without liver failure in 46 cases, hepatolenticular degeneration in 17 cases, schistosomal cirrhosis in two cases, nonalcoholic steatohepatitis (NASH) in 19 cases, a congenital polycystic liver in ten cases, and liver failure after transplantation in 27 cases. The mean MELD score was 24.1±12.3 (range, 6.0–40.0), and the mean Child-Pugh score was 9.9±2.7 (range, 5.0–15.0). The mean operative time and anhepatic phase times were 514.3±132.2 min (range, 240.0–1,320.0 min) and 91.8±32.4 min (range, 30.0–230.0 min), respectively. The mean intraoperative blood loss was 1,151.5±1,014.5 mL (range, 100.0–8,000.0 mL). The mean age gap between donor and recipient was 14.8±11.5 years (range, 0–54.0 years). ABO-incompatible LT was conducted in 54 (10.2%) recipients.

Donor characteristics

Of the 529 donors, 434 were male, and 95 were female, and the mean age was 46.3±14.7 years (range, 4–79 years). The mean BMI was 24.6±3.6 kg/m^2 (range, 17.4–35.6 kg/m^2). The mean CIT was 6.2±2.7 hours (range, 2.0–15.0 hours), and the mean WIT was 43.0±1.2 min (range, 40–59 min). The last serum sodium and creatinine levels were 149.7±14.3 mmol/L (range, 125.0–187.7 mmol/L)

Table 1 Univariate analysis of factors related to perioperative death after liver transplantation

Parameters	Perioperative death (n=70)	No-death (n=459)	P values
Age, years			0.258
<60	49 (12.3)	350 (87.7)	
≥60	21 (16.2)	109 (83.8)	
Gender			0.058
Male	49 (11.8)	367 (88.2)	
Female	21 (18.6)	92 (81.4)	
BMI, kg/m^2			0.820
≤25	44 (13.5)	282 (86.5)	
>25	26 (12.8)	177 (87.2)	
MELD score			<0.001
6–10	3 (2.9)	102 (97.1)	
11–20	9 (7.4)	113 (92.6)	
21–30	12 (12.4)	85 (87.6)	
31–40	46 (22.4)	159 (77.6)	
Child-Pugh grading			<0.001
A	3 (3.3)	89 (96.7)	
B	6 (5.6)	102 (94.4)	
C	61 (18.5)	268 (81.5)	
Operative time, min			0.928
<360	5 (12.8)	34 (87.2)	
360–600	51 (13.0)	342 (87.0)	
>600	14 (14.4)	83 (85.6)	
Intraoperative blood, mL			<0.001
<2,000	47 (10.6)	395 (89.4)	
≥2,000	23 (26.4)	64 (73.6)	
Anhepatic phase, min			0.045
≤60	8 (7.4)	100 (92.6)	
>60	62 (14.7)	359 (85.3)	
Age gap between donor and recipient, years			0.062
≤10	19 (8.4)	208 (91.6)	
10–20	26 (16.6)	131 (83.4)	
21–30	15 (15.8)	80 (84.2)	
31–40	5 (17.9)	23 (82.1)	
>40	5 (22.7)	17 (77.3)	
Incompatibility of ABO blood type			0.102
Yes	11 (20.4)	43 (79.6)	
No	59 (12.4)	416 (87.6)	

The values were presented as number (%). BMI, body mass index; MELD, model for end-stage liver disease.

and 106.4±85.4 μmol/L (range, 21.1–924.0 μmol/L), respectively. Gender mismatch between donor and recipient occurred in 176 cases. The main cause of cardiac arrest in the DCD donors was cerebral hemorrhage, including spontaneous cerebral hemorrhage and traumatic intracranial hemorrhage.

General characteristics of in-hospital deaths

Of the 529 cases, in-hospital death was confirmed in 70 recipients, and the in-hospital mortality rate was 13.2%. The causes for LT in the 70 recipients were as follows: HBV-associated liver failure in 18 (25.7%) cases, liver malignancy with/without liver failure in 24 (34.3%) cases, alcoholic-associated liver failure in 10 (14.3%) cases, HEV-associated liver failure in 1 (1.4%) case, autoimmune hepatitis-induced liver failure in 7 (10.0%) cases, schistosomal cirrhosis in 1 (1.4%) case, congenital polycystic liver in 1 (1.4%) case, and liver failure after transplantation in 5 (7.1%) cases. A total of 65 patients underwent LT for the first time, and the remaining five patients received their first LT several years ago. A total of 7 recipients received reoperation for complications after LT, including debridement and hemostasis for three recipients and removal of intra-abdominal abscesses for four recipients. After LT, the survival time ranged from 6 hours to 84 days, with a median of 37 days.

Risk factors of in-hospital death

As shown in *Table 1*, the univariate analysis demonstrated that the MELD score before surgery was positively correlated with in-hospital death after LT. The mortality rates were 2.9%, 7.4%, 12.4%, and 22.4% in patients with MELD scores of 6–10, 11–20, 21–30, and 31–40, respectively (P<0.001). Child-Pugh grading was also positively correlated with mortality, and the incidence

Table 2 Multivariate analysis of risk factors related to perioperative death

Risk factors	Multivariate analysis of perioperative death		
	RR	95% CI	P value
MELD score	1.775	1.231–2.560	0.002
Child-Pugh grading	1.374	0.704–2.682	0.352
Intraoperative blood	2.719	1.500–4.929	0.001
Anhepatic phase	1.843	0.834–4.073	0.131

MELD, model for end-stage liver disease.

rates were 3.3%, 5.6%, and 18.5% for grades A, B, and C, respectively (P<0.001). Patients with intraoperative blood loss ≥2,000 mL had a significantly increased in-hospital mortality (26.4% *vs.* 10.6%, P<0.001). Although total operative time was not associated with mortality in this study, anhepatic phase >60 min led to a higher mortality rate (14.7% *vs.* 7.4%, P=0.045). The mortality rate increased as the age gap between donor and recipient increased; however, the age gap was not demonstrated to influence in-hospital death. In *Table 2*, the multivariate analysis showed that the MELD score (P=0.002) and intraoperative blood loss (P=0.001) were the two independent risk factors of in-hospital death.

Causes of in-hospital death

All patients died postoperatively for all 70 cases of in-hospital death, and no intraoperative deaths were found. Several causes of in-hospital death after LT were detected in this study. The most common cause was an infection, including bacterial and fungal infections. Infectious death was confirmed in 24 (34.3%) recipients. Of the 24 recipients, pulmonary fungal infection, as the fatal cause, was confirmed in 15 cases, while one of these cases was diagnosed with fungal pneumonia with HPS. As HPS was cured, fungal pneumonia was the cause of death. Concurrently, pulmonary and intra-abdominal infection, intra-abdominal infection, and intracranial infection were diagnosed in 5, 2, and 2 recipients, respectively. The second most common cause of in-hospital death was PNF, which was confirmed in 11 (15.7%) recipients. The third cause of in-hospital death, multi-organ failure, was confirmed in 9 (12.9%) recipients. As the fourth cause of death, cerebral hemorrhage was found in 8 (11.4%) recipients. Myocardial infarction, intra-abdominal hemorrhage, GVHD, pulmonary embolism, and heart failure due to severe pulmonary hypertension were confirmed in 7 (10.0%), 3 (4.3%), 3 (4.3%), 2 (2.9%), and 2 (2.9%) recipients, respectively. HPS, as a cause of in-hospital death, was found in 1 (1.4%) recipient (2 recipients encountered HPS, 1 died of it, the other died of fungal pneumonia).

Analysis of pathogenic microorganisms

Of the recipients who died of infection, *Aspergillus fumigatus*, *Aspergillus flavus*, and *Cryptococcus neoformans* were detected in 12, 2, and 1 case, respectively. *Klebsiella pneumoniae* was found in seven recipients, including carbapenem-resistant *Klebsiella pneumoniae* in five recipients. *Acinetobacter baumannii* was confirmed in seven recipients, methicillin-resistant *Staphylococcus aureus* in two recipients, *Pseudomonas aeruginosa* in five recipients, *Stenotrophomonas maltophilia* in three recipients, *Escherichia coli* in four recipients, *Enterococcus faecium* in four recipients, and *Enterobacter cloacae* in two recipients.

Factor analysis of infectious death

The results in *Table 3* demonstrated that the MELD score was correlated with infectious death. The mean score was 33.7±8.7 in the infectious death group, which was significantly higher than 23.6±12.3 in the control group (P<0.001). The infectious death group had a higher Child-Pugh score of 11.5±2.0, and the score was 9.8±2.7 in the control group (P=0.003). The intraoperative blood loss was 1,595.8±1,144.9 mL in the infectious death group and 1,130.3±1,004.3 mL in the control group (P=0.028). The multivariate analysis demonstrated that the MELD score was an independent risk factor of infectious death.

Factor analysis of PNF

The univariate analysis demonstrated that the following

Table 3 Analysis of risk factors related to infectious death

Parameters	Univariate analysis			Multivariate analysis		
	Infectious death group (n=24)	Control group (n=505)	P value	RR	95% CI	P value
Age, years	49.7±12.1	51.7±10.3	0.358	–	–	–
Gender, male/female	17/7	399/106	0.340	–	–	–
BMI, kg/m^2	24.4±4.0	24.4±3.8	0.972	–	–	–
MELD score	33.7±8.7	23.6±12.3	<0.001	1.079	1.016–1.146	0.014
Child-Pugh score	11.5±2.0	9.8±2.7	0.003	1.018	0.759–1.365	0.906
Operative time, min	543.29±168.0	512.9±130.3	0.262	–	–	–
Anhepatic phase, min	95.0±33.3	91.7±32.4	0.618	–	–	–
Blood loss, mL	1,595.8±1,144.9	1,130.3±1,004.3	0.028	1.000	1.000–1.000	0.183
Age gap between donor and recipient, years	17.5±13.2	14.6±11.4	0.228	–	–	–
Incompatibility of ABO blood type, yes/no	3/21	51/454	0.704	–	–	–
Mis-match of gender, yes/no	8/16	168/337	0.995	–	–	–

The values were presented as mean ± standard deviation or number. BMI, body mass index; MELD, model for end-stage liver disease; RR, relative risk; CI, confidence interval.

variables of donors were associated with the development of PNF: BMI (P=0.017), CIT (P<0.001), and WIT (P<0.001). A high level of creatinine (P=0.098) and ABO incompatibility (P=0.059) showed a tendency towards association with PNF. The multivariate analysis illustrated that the BMI of donors, CIT, and WIT were independent PNF risk factors (*Table 4*).

Discussion

LT has been considered the standard treatment for benign end-stage liver diseases and even for some liver tumors. The survival of recipients has improved markedly on account of the refinements in surgical techniques and postoperative care. However, immediate postoperative death still occurs for various reasons (7,8). Recent studies have reported that in-hospital mortality ranged from 5% to 10% after LT (9). A study designed by Gil *et al.* (6) showed that the in-hospital mortality of deceased donor LT was 13.5%, which was significantly higher than living donor LT. A new report by Molinari *et al.* (7) demonstrated that postoperative mortality was 9.1% within 90 days after cadaveric LT. The in-hospital mortality of recipients after cadaveric LT was 13.2% in our study, which was similar to the results of Gil *et al.*

Several factors of recipients have an impact on in-hospital mortality. Nafea *et al.* (10) reported that MELD score, preoperative graft-recipient weight ratio, number of intraoperative blood transfusion units, postoperative alanine aminotransferase (ALT) levels, and postoperative total leukocyte counts were significant predictors for early mortality. Other studies have shown that factors of recipients, including high MELD scores (11), several comorbidities (12), advanced age (13), abnormal BMI (14), and low-performance status (15), were correlated with higher perioperative death after LT. In our study, we found that the MELD score influenced postoperative mortality. Child-Pugh grading, intraoperative blood loss, and anhepatic phase were also confirmed to be correlated with in-hospital death. Female recipients, or recipients who accepted a graft with a large age gap, seemed to have higher mortality, although no significant differences were confirmed. MELD score and intraoperative blood loss were confirmed as the independent risk factors of in-hospital death in this study.

Ten causes of death were summarized in our study, and the main cause was an infection, followed by PNF and multi-organ failure. Kusakabe *et al.* (16) found that the three leading causes of death after LT were sepsis, graft failure, and pulmonary complications. Kwak *et al.* (17) reported that the first three causes of death for recipients after LT were infection, recurrence of hepatocellular carcinoma, and graft failure, accounting for 34.8%, 18.3%, and 15.0% of cases,

Table 4 Analysis of risk factors related to PNF

Factors	Univariate analysis			Multivariate analysis		
	PNF group (n=11)	No-PNF group (n=518)	P value	RR	95% CI	P value
Age, years	51.9±13.6	46.2±14.8	0.201	–	–	–
Gender, male/female	3/8	92/426	0.416	–	–	–
BMI, kg/m^2	27.2±4.8	24.6±3.5	0.017	1.213	1.025–1.435	0.025
Cold ischaemic time, hours	9.0±4.3	6.2±2.6	<0.001	1.339	1.107–1.620	0.003
Warm ischaemic time, min	44.3±1.5	43.0±1.2	<0.001	1.274	1.008–1.610	0.043
Age gap between donor and recipient, years	13.7±8.2	14.8±11.6	0.761	–	–	–
Incompatibility of ABO blood type, yes/no	3/8	51/467	0.059	–	–	–
Mis-match of gender, yes/no	6/5	170/348	0.130	–	–	–
Last serum sodium, mmol/L	154.8±13.1	149.6±14.3	0.233	–	–	–
Last creatinine, μmol/L	148.6±78.5	105.5±85.4	0.098	–	–	–

The values were presented as mean ± standard deviation or number. BMI, body mass index; PNF, primary non-function; RR, relative risk; CI, confidence interval.

respectively. Different incidences of infection after LT have been reported. For example, Ayvazoglu Soy *et al.* (18) reported that the early postoperative infection rate in patients with LT was 23.3%, while a study designed by Kawecki *et al.* (19) showed an infection rate of 27.2% within the first 4 weeks after LT. In some studies, infection was confirmed as the main cause for both short- and long-term death (20). Park *et al.* (21) reported that 57 (9.7%) recipients who underwent living donor LT experienced infection within 1 month after surgery and 34 recipients lost their lives due to infection, and the incidence of infectious death was 5.7% (34/596). A study designed by Kwak *et al.* (17) demonstrated that pneumonia, which occurred in 46.3% of patients, was the most common cause of all infectious deaths. Infection was also confirmed as the main cause of in-hospital death in our study, as infectious death was found in 34.3% of patients, which was similar to the results of Kwak *et al.* Pneumonia was responsible for most of the infectious deaths, and fungal pneumonia, which was confirmed in 15 cases, was the first lethal cause among the pneumonias. Fungal infection is not uncommon after LT. Some studies have demonstrated that the incidence of fungal infection in LT recipients ranged from 16% to 42% (22,23). Castaldo *et al.* (24) reported that the incidence of fungal infection after LT was 25.3% in 178 adult recipients, and 7.3% of adult recipients died of fungal infection. Additionally, they found that the most common site of fungal infection was the lung. The incidence of death induced by fungal infection was 2.8% in our study.

Previous studies have confirmed that factors including female gender, vancomycin-resistant *Enterococcus* colonization, a longer stay in the hospital, abdominal reoperation, mechanical ventilation ≥48 hours, continuous renal replacement therapy, acute liver failure, re-transplantation, allograft rejection, induction of immunosuppression for the treatment of acute cellular rejection, long-term use of vascular and urinary catheters, a longer stay in the intensive care unit, higher MELD score, and elevated bilirubin levels were correlated with postoperative infection (25). However, factors that are correlated with infectious death have not been summarized in detail until now. Our study showed that higher MELD score, higher Child-Pugh score, and more intraoperative blood loss were correlated with a higher incidence of infectious death, and MELD score was confirmed as the independent risk factor of infectious death.

Primary graft dysfunction (PGD), which can be divided into PNF and early allograft dysfunction (EAD), also called initial poor function (IPF), is a severe event after LT. PNF is most often defined as either the need for re-transplantation or the recipient's death within the first 7 days after LT. EAD is diagnosed based on elevated

serum bilirubin, ALT, and aspartate transaminase levels and international normalized ratio level measured on the 2nd to the 10th day after LT. The incidence of EAD ranges from 5.2% to 36.3%, whereas the incidence of PNF ranges from 0.9% to 7.2% (26,27). Donor-related factors including age, nutritional status, fatty infiltration of the liver, and ischemia time and recipient-related factors including recipient status and transplantation type have been previously reported as risk factors for PGD (28-30). In our study, 2.1% (11/529) of recipients died of PNF. The BMI of donors, CIT, and WIT were confirmed as the independent risk factors of PNF.

The shortcomings of our study were that the infection rates and the incidence rates of PGD for all recipients could not be calculated due to shortages in some records. Factors related to death causes apart from infection and PNF could not be analyzed exactly due to the small sample size. The collection and analysis of several other factors, including results of further laboratory examinations and characteristics of the recipient and donor-related causes of death, are needed in future studies.

In conclusion, the in-hospital mortality rate of recipients after LT was 13.2%, and MELD score and intraoperative blood loss were determined as the two independent risk factors of in-hospital death. Infection was the main cause of death, followed by PNF. Furthermore, the risk factor for infection was the MELD score, and the BMI of donors, CIT, and WIT were independent risk factors of PNF.

Acknowledgments

Funding: None.

Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at http://dx.doi.org/10.21037/atm-20-5618

Data Sharing Statement: Available at http://dx.doi.org/10.21037/atm-20-5618

Peer Review File: Available at http://dx.doi.org/10.21037/atm-20-5618

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/atm-20-5618). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The protocol was reviewed and approved by the institutional review committee of Beijing Chaoyang Hospital (approval number: 2020-科-303) and individual consent for this retrospective analysis was waived.

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Cite this article as: Zhang XM, Fan H, Wu Q, Zhang XX, Lang R, He Q. In-hospital mortality of liver transplantation and risk factors: a single-center experience. Ann Transl Med 2021;9(5):369. doi: 10.21037/atm-20-5618

