IMPACT FACTORS LEADING TO RENAL IMPAIRMENT AFTER LIVER TRANSPLANTATION:
A SINGLE CENTER CONSECUTIVE 12 YEARS' EXPERIENCE

Batsaikhan Batsuuri[1,2,3], Shiirevnyamba Avirmed[1,2], Chuluunbileg Batbold[4], Bat-Ireedui Badarch[3], Ariunaa Togtokh[6], Sergelen Orgoi[2,3]

[1] Graduate School, Mongolian National University of Medical Sciences, Ulaanbaatar, Mongolia
[2] Department of Surgery, Mongolian National University of Medical Sciences, Ulaanbaatar, Mongolia
[3] The Transplantation Center, The First Central Hospital of Mongolia, Ulaanbaatar, Mongolia
[4] Internal Medicine Residency, Health Development Center, Ulaanbaatar, Mongolia
[5] Department of Nephrology, Mongolian National University of Medical Science

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Introduction

✓ Renal impairment (RI) is not uncommon and influenced by multiple factors, leading to poor outcomes.

✓ This study aimed to investigate the factors leading to early renal impairment after liver transplantation (LT) in our cases.

✓ Despite the challenges of differing definitions and calculation methods for RI, high post-LT rates are consistent in the literature.

✓ A recent review of 67 observational studies published over three decades suggests an early post-LT RI rate exceeding 50%.

✓ Thorsten et al. placed RI post-LT incidence at 65.8%.

Methods

Patients

- This was a retrospective, single-center study approved by the ethical committee of the Mongolian National University of Medical Sciences (No. 2021/3-01).

- Data from all the patients who underwent liver transplantation in FCHM between September 2011 and December 2022 were collected retrospectively. Patients were divided into two groups according to the postoperative renal function, which was determined by measuring glomerular filtration rate (GFR) post-LT: Renal impairment (RI) and Non-Renal impairment (NRI).

- Patients < 18 years old and with incomplete data to calculate the estimated glomerular filtration rate (EGFR) were excluded.

Clinical and laboratory data

- Pre-LT data included routine recipient's demographic variables (age, gender), blood ABO-type, body surface area (BSA), body mass index (BMI), comorbidities, Child-Turcotte-Pugh (CTP) and MELD-Na (Model for End-Stage Liver Disease with Sodium) scores, diagnosis and waiting list days, previous LT, ABO compatibility, bridge therapies and preoperative RI.

- Perioperative data included graft type and weight, GRWR, graft fatty change percentage, IVC cross-clamping, operation time, cold and warm ischemic times, ascites volume, portosystemic shunts, perioperative preoperative continuous renal replacement therapy (CRRT), blood products' transfusion (LR-RBC, PLT, FFP, cryoprecipitate), and hemodynamic variables (heart rate, mean arterial pressure (MAP), baseline and lowest MAP difference, lowest central venous pressure (CVP) and urine output.

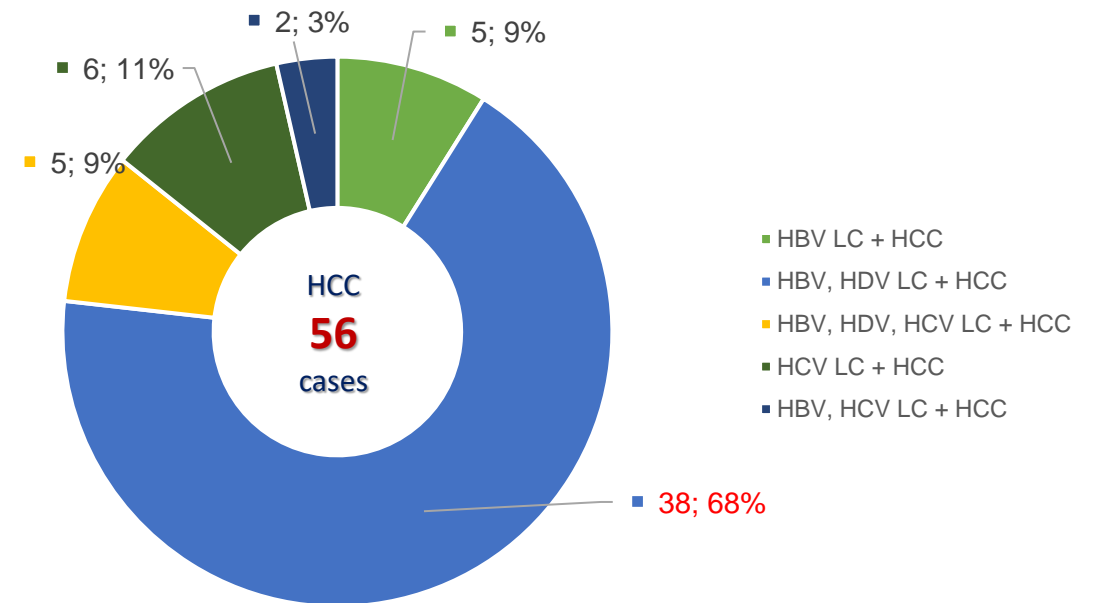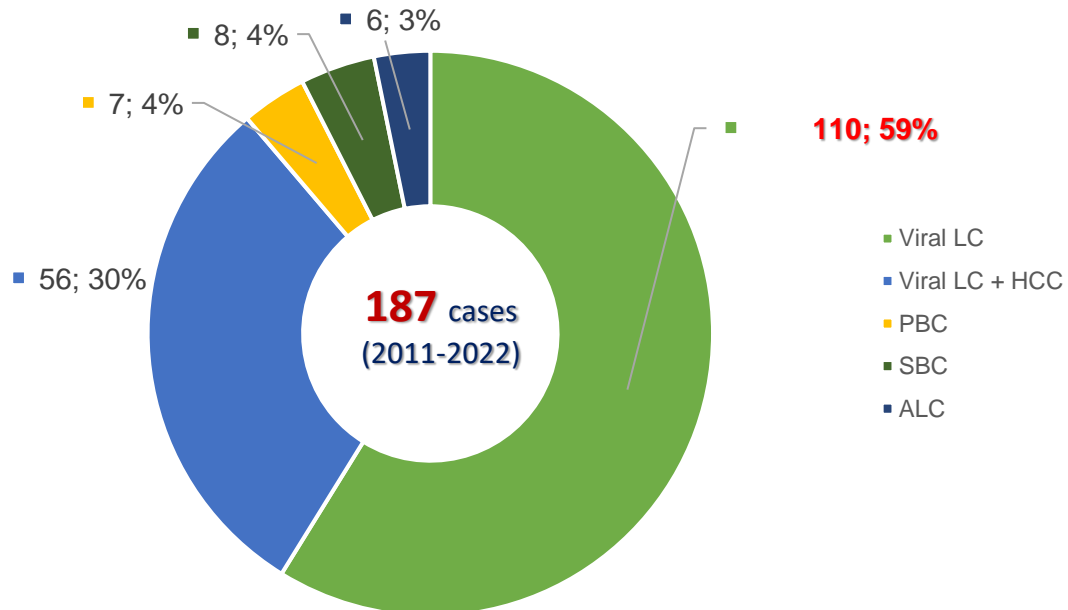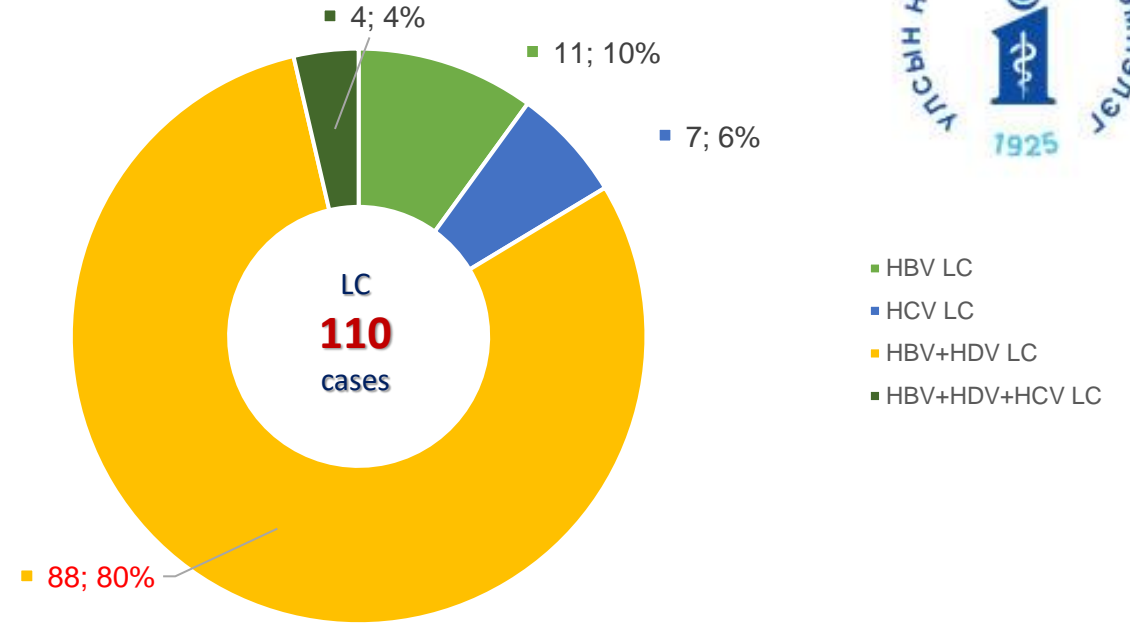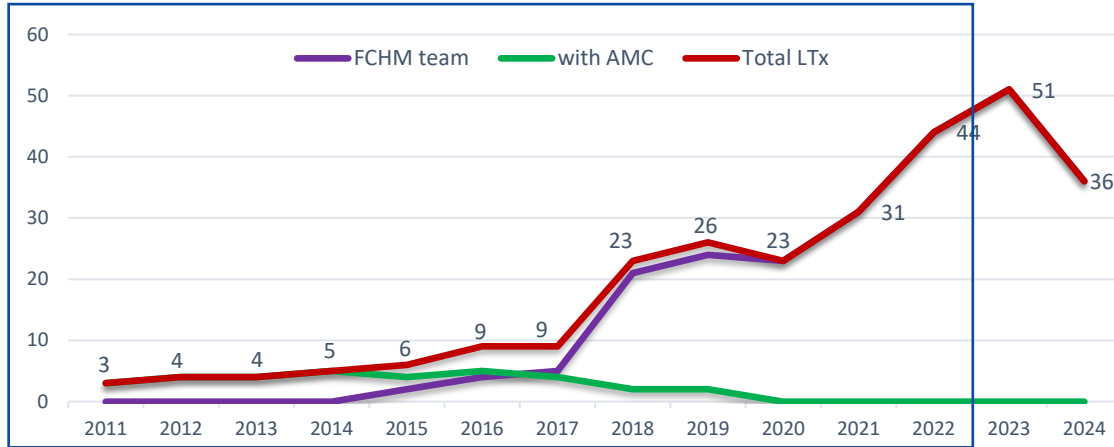- Postoperative data included post-LT early complication within the first month, immunosuppression maintenance regime, blood products' transfusion (LR-RBC, PLT, FFP, cryoprecipitate), intubated hours, total hospital stay days.

- Renal function was determined by measuring GFR by Cockcroft-Gault creatinine clearance formulation at pre-transplantation, 24h, 72h, 7d, 14d, and 28d post-LT. We defined renal impairment as an EGFR <60 mL/min at any point during the first 28 days after LT.

Statistical analysis

- We performed statistical analysis using STATA version 15.0.

- We conducted both Shapiro-Wilk's test and a histogram to determine the normality of the data.

- We presented continuous parametric variables as a mean with standard deviations and compared them using the student's T-test.

- Continuous non-parametric variables were presented as medians with interquartile ranges and compared using the Mann-Whitney U test.

- Categorical variables were expressed as frequencies and percentages. Chi-square and Fisher exact tests were performed to determine the difference in categorical variables.

- Logistic regression was conducted to identify the association of independent variables with dependent variables in patients with and without renal impairment.

- Survival rates using the Kaplan-Meier method at three years were computed and compared with the log-rank tests for renal dysfunction groups.

- All statistical tests were 2-sided, and a P-value <0.05 was considered significant.

LT at FCHM

LC
110 cases
- HBV LC — 11; 10%
- HCV LC — 7; 6%
- HBV+HDV LC — 88; 80%
- HBV+HDV+HCV LC — 4; 4%

187 cases (2011-2022)
- Viral LC — 110; 59%
- Viral LC + HCC — 56; 30%
- PBC — 7; 4%
- SBC — 8; 4%
- ALC — 6; 3%

HCC
56 cases
- HBV LC + HCC — 5; 9%
- HBV, HDV LC + HCC — 38; 68%
- HBV, HDV, HCV LC + HCC — 5; 9%
- HCV LC + HCC — 6; 11%
- HBV, HCV LC + HCC — 2; 3%

Total LTx: 3, 4, 4, 5, 6, 9, 9, 23, 26, 23, 31, 44, 51, 36 (2011–2024)

Results

- The study included 187 patients who had undergone LT at the FCHM.

- 181 (male=94, female=87) patients met the study's inclusion criteria, and **57 (31.5%)** patients developed RI after LT.

- The mean age of the study participants at the time of LT was 44±11 years.

- Recipients with RI after LT were 31.5% out of all.

Kaplan-Meier survival curve

Log-rank P=0.224
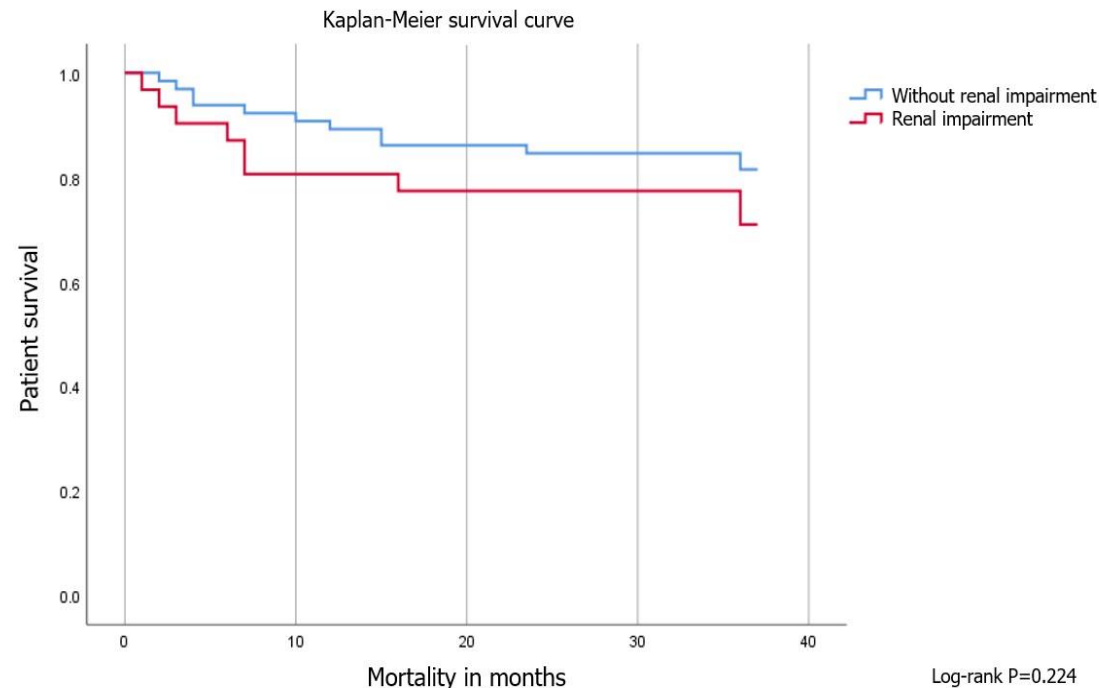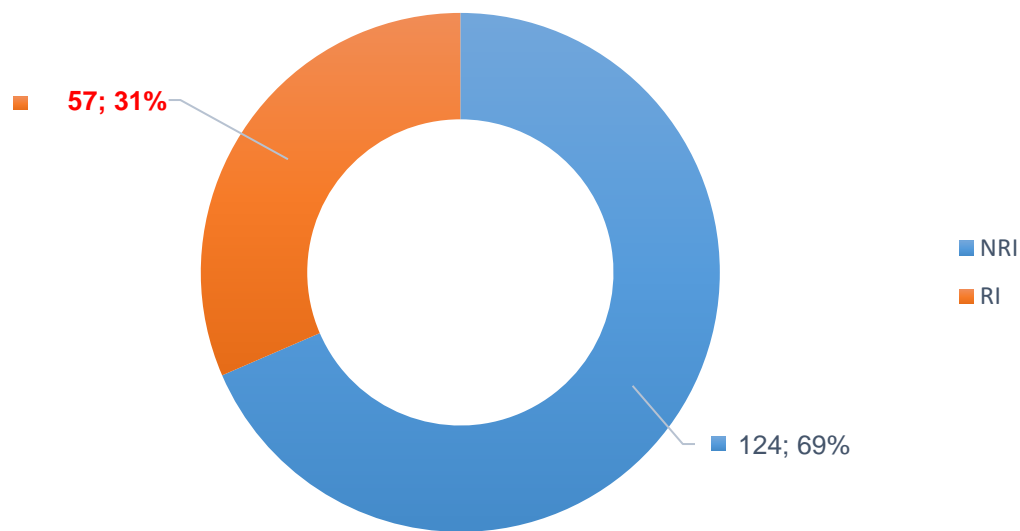
- Kaplan-Meier survival analysis showed that the 1-year and 3-year survival rates in the RI group were 93.4% and 78.1%, respectively.

- Difference in survival rates between recipients with and without RI was not statistically significant (P=0.224)

Recipient baseline characteristics

Variables		Total (n = 181)	NRI (n = 124)	RI (n = 57)	P value*
Recipients age		44±11	42±10	49±10	0.000^α
Recipient's gender					
	Male	94 (51.9%)	75 (60.5%)	19 (33.3%)	0.001
	Female	87 (48.1)	49 (39.5%)	38 (66.7%)	
Recipients BMI (kg/m²)		25.2 (24.4-25.8)	25.1 (21.8-30.1)	25.2 (21.6-28.6)	0.711^β
Recipients BSA (m²)		1.8 (1.7-1.8)	1.8 (1.6-2.0)	1.7 (1.6-1.9)	0.009^β
Recipient blood type					
	O+	63 (34.8%)	46 (37.1%)	17 (29.8%)	0.43[¶]
	A+	48 (26.5%)	35 (28.2%)	13 (22.8%)	
	B+	61 (33.7%)	37 (29.8%)	24 (42.1%)	
	AB+	9 (5.0%)	6 (4.8%)	3 (5.3%)	
Child Pugh score					
	A	23 (12.7%)	21 (16.9%)	2 (3.5%)	0.008
	B	87 (48.1%)	62 (50.0%)	25 (43.9%)	
	C	71 (39.2%)	41 (33.1%)	30 (52.6%)	
MELD score		15 (14-16)	14 (10-20)	17 (12-23)	0.000^β
Diagnosis					
	Liver cirrhosis	114 (63.0%)	77 (62.1%)	37 (64.9%)	0.137[¶]
	Hepatocellular carcinoma	58 (32.0%)	41 (33.1%)	17 (29.8%)	
	Primary biliary cirrhosis	7 (3.9%)	6 (4.8%)	1 (1.8%)	
	Secondary biliary cirrhosis	2 (1.1%)	0 (0.0%)	2 (3.5%)	
Waiting days		140 (122-186)	184 (70-319)	116 (42-346)	0.024^β

*Chi-square test, ¶Fisher Exact test, ^αStudents' T-test, ^βMann-Whitney U test
BMI-Body Mass Index, BSA-Body Surface Area, MELD-Model for End-Stage Liver Disease, CRRT-Continuous Renal Replacement Therapy

Comparison of perioperative parameters

Variables		Total (n = 181)	NRI (n = 124)	RI (n = 57)	P value*
Graft type					
	Right	167 (92.3%)	116 (93.5%)	51 (89.5%)	0.67[¶]
	Left	2 (1.1%)	1 (0.9%)	1 (1.8%)	
	Whole	12 (6.6%)	7 (5.6%)	5 (8.8%)	
Graft weight (gr)		728 (686-756)	694 (583-859)	760 (640-898)	0.026^β
GRWR		1.03 (0.99-1.07)	0.9 (0.8-1.24)	1.1 (0.9-1.4)	0.000^β
Graft liver fatty change		5 (5-10)	5 (5-15)	5 (5-20)	0.521^β
Porto-systemic shunt		85 (47%)	63 (50.8%)	22 (38.6%)	0.15
Operation time /recipients/		859 (834-886)	852 (758-986)	872 (735-1065)	0.846^β
Cold ischemic time (min)		126±62	123±55	132±77	0.370^α
Warm ischemic time (min)		80±23	82±23	79±22	0.370^α
Total ischemia time (min)		193 (182-207)	190 (162-249)	195 (157-248)	0.983^β
Ascites /ml/		200 (150-400)	150 (160-1500)	800 (950-4500)	0.003^β
Intraoperative LR-RBC (units)		6 (6-8)	5 (2-10)	8 (4-18)	0.000^β
Intraoperative PLT (units)		5 (5-10)	5 (4-15)	5 (5-14)	0.018^β
Intraoperative FFP (units)		10 (10-12)	10 (6-18)	14 (10-26)	0.000^β
Intraoperative cryoprecipitate (units)		6 (3-10)	4 (5-15)	6 (4-20)	0.168^β
MAP difference (mm.Hg)		25 (24-29)	25 (12-47)	28 (16-51)	0.225^β
Lowest CVP (mm.Hg)		2 (2-3)	2 (1-4)	1 (1-5)	0.848^β
Perioperative CRRT			0 (0.0%)	1 (1.9%)	0.31[¶]
Intraoperative urine output (cc)		2438 (1390-1605)	1523 (1081-2225)	1385 (924-2050)	0.051^β

*Chi-square test, ¶Fisher Exact test, ^αStudents' T-test, ^βMann-Whitney U test
GRWR-Graft-to-recipient weight ratio, IVC- Inferior vena cava, LR-RBC-Leucoreduced red blood cells, PLT-Platelet, FFP-Fresh frozen plasma, MAP-Mean Arterial Pressure, CVP-Central Venous Pressure, CRRT-Continuous Renal Replacement Therapy

Comparison of postoperative outcomes

Variables		Total (n = 181)	NRI (n = 124)	RI (n = 57)	P value*
Vascular complication		20 (11.0%)	14 (11.3%)	6 (10.5%)	0.879
Rejection		5 (2.8%)	3 (2.4%)	2 (3.5%)	0.678¶
Biliary complication		33 (18.2%)	25 (20.2%)	8 (14.0%)	0.321
Early return to operation room		18 (9.9%)	11 (8.9%)	7 (12.3%)	0.476
Postoperative mortality		22 (12.2%)	12 (9.7%)	10 (17.5%)	0.13
Starting maintenance					
	Cyclosporin	8 (4.4%)	4 (3.2%)	4 (7.0%)	0.25
	Tacrolimus	173 (95.6%)	120 (96.8%)	53 (93.0%)	
Postoperative LR-RBC (units)		3 (2-4)	2 (2-6)	4 (2-11)	0.006β
Postoperative PLT (units)		15 (15-20)	15 (5-35)	15 (10-30)	0.160β
Postoperative FFP (units)		6 (6-8)	6 (2-12)	6 (4-20)	0.179β
Postoperative cryoprecipitate (units)		1 (0-12)	1 (0-15)	2 (0-30)	0.020β
Intubated hours		31 (30-32)	31 (27-35)	33 (29-53)	0.002β
Hospital stay (days)		30 (29-32)	30 (24-39)	30 (21-44)	0.408β

*Chi-square test, ¶Fisher Exact test, βMann-Whitney U test

Risk factors associated with renal impairment

Variables	cOR*	95% CI	aOR¶	95% CI
Recipient age	1.07	1.03-1.11	1.07	1.03-1.11
Recipient gender				
Male	1		1	
Female	3.06	1.58-5.91	2.87	1.45-5.71
MELD score	1.09	1.03-1.16	1.15	1.08-1.22
Child Pugh score				
A	1		1	
B	4.23	0.92-19.41	3.98	0.82-19.39
C	7.68	1.67-35.30	9.48	1.93-46.40
GRWR	3.45	1.23-9.63	5.7	1.85-17.52
Intraoperative LR-RBC (units)	1.09	1.04-1.14	1.09	1.04-1.14
Intraoperative PLT (units)	1.06	1.00-1.12	1.07	1.01-1.14
Intraoperative FFP (units)	1.07	1.02-1.11	1.09	1.04-1.14
Postoperative LR-RBC (units)	1.09	1.04-1.14	1.1	1.03-1.17
Postoperative cryoprecipitate (units)	1.1	1.01-1.19	1.11	1.01-1.22
Intubated hours	1.04	1.01-1.07	1.04	1.01-1.07

*Logistic regression, ¶adjusted by recipients' age and gender

Discussion

- This is the first study to investigate the risk factors for RI after LT in patients at a single center in Mongolia. Utilizing the Cockroft-Gault formula, our study determined a lower incidence at 31.5%.

- Our study found that female sex, high CTP scores, preoperative CRRT, and high GRWR were risk factors for developing RI after LT in Mongolia.

- However, significant differences were observed in age, sex, BSA, CTP score, MELD score, preoperative CRRT, GRWR, transfusion requirements, and duration of intubation between the RI and NRI groups.

Conclussion

- Renal impairment (RI) is a frequent complication of recipients after liver transplantation (LT) and was 31.5% in Mongolia.

- Risk factors for RI after LT in Mongolian cases were female gender, high Child-Turcotte-Pugh (CTP) score, preoperative continuous renal replacement therapy (CRRT), and high graft-to-recipient weight ratio (GRWR).

- The recipient's first and third-year survival rates with RI post-liver transplantation were 93.4% and 78.1%, respectively.