

Table S1 Diagnosis of liver dysfunction due to potential other causes excluded from MIMIC-IV database

ICD_code	ICD_version	Long_title
Viral hepatitis		
07020	9	Viral hepatitis B with hepatic coma, acute or unspecified, without mention of hepatitis delta
07022	9	Chronic viral hepatitis B with hepatic coma without hepatitis delta
07030	9	Viral hepatitis B without mention of hepatic coma, acute or unspecified, without mention of hepatitis delta
07031	9	Viral hepatitis B without mention of hepatic coma, acute or unspecified, with hepatitis delta
07032	9	Chronic viral hepatitis B without mention of hepatic coma without mention of hepatitis delta
07033	9	Chronic viral hepatitis B without mention of hepatic coma with hepatitis delta
07041	9	Acute hepatitis C with hepatic coma
07044	9	Chronic hepatitis C with hepatic coma
07053	9	Hepatitis E without mention of hepatic coma
07054	9	Chronic hepatitis C without mention of hepatic coma
07070	9	Unspecified viral hepatitis C without hepatic coma
07071	9	Unspecified viral hepatitis C with hepatic coma
5731	9	Hepatitis in viral diseases classified elsewhere
B159	10	Hepatitis A without hepatic coma
B169	10	Acute hepatitis B without delta-agent and without hepatic coma
B1711	10	Acute hepatitis C with hepatic coma
B178	10	Other specified acute viral hepatitis
B179	10	Acute viral hepatitis, unspecified
B181	10	Chronic viral hepatitis B without delta-agent
B182	10	Chronic viral hepatitis C
B1910	10	Unspecified viral hepatitis B without hepatic coma
B1920	10	Unspecified viral hepatitis C without hepatic coma
B1921	10	Unspecified viral hepatitis C with hepatic coma
B251	10	Cytomegaloviral hepatitis
Liver cirrhosis and chronic liver diseases		
5712	9	Alcoholic cirrhosis of liver
5715	9	Cirrhosis of liver without mention of alcohol
5716	9	Biliary cirrhosis
K7030	10	Alcoholic cirrhosis of liver without ascites
K7031	10	Alcoholic cirrhosis of liver with ascites
K741	10	Hepatic sclerosis
K743	10	Primary biliary cirrhosis
K745	10	Biliary cirrhosis, unspecified
K7460	10	Unspecified cirrhosis of liver
K7469	10	Other cirrhosis of liver
Acute or chronic liver failure		
570	9	Acute and subacute necrosis of liver
K7040	10	Alcoholic hepatic failure without coma
K7041	10	Alcoholic hepatic failure with coma
K7200	10	Acute and subacute hepatic failure without coma
K7201	10	Acute and subacute hepatic failure with coma
K7210	10	Chronic hepatic failure without coma
K7290	10	Hepatic failure, unspecified without coma
K7291	10	Hepatic failure, unspecified with coma
K9182	10	Postprocedural hepatic failure
toxic hepatitis		
K710	10	Toxic liver disease with cholestasis
K7110	10	Toxic liver disease with hepatic necrosis, without coma
K7111	10	Toxic liver disease with hepatic necrosis, with coma
K713	10	Toxic liver disease with chronic persistent hepatitis
K7151	10	Toxic liver disease with chronic active hepatitis with ascites
K716	10	Toxic liver disease with hepatitis, not elsewhere classified
K717	10	Toxic liver disease with fibrosis and cirrhosis of liver
Liver and hepatic vascular injury		
86400	9	Injury to liver without mention of open wound into cavity, unspecified injury
86402	9	Injury to liver without mention of open wound into cavity, laceration, minor
86403	9	Injury to liver without mention of open wound into cavity, laceration, moderate
86404	9	Injury to liver without mention of open wound into cavity, laceration, major
86405	9	Injury to liver without mention of open wound into cavity laceration, unspecified
86411	9	Injury to liver with open wound into cavity, hematoma and contusion
86414	9	Injury to liver with open wound into cavity, laceration, major
90211	9	Injury to hepatic veins
90222	9	Injury to hepatic artery
S36113A	10	Laceration of liver, unspecified degree, initial encounter
S36116A	10	Major laceration of liver, initial encounter
S36118A	10	Other injury of liver, initial encounter
S36119A	10	Unspecified injury of liver, initial encounter
Hepatic infarction		
5734	9	Hepatic infarction
K763	10	Infarction of liver
K765	10	Hepatic veno-occlusive disease
Autoimmune hepatitis		
57142	9	Autoimmune hepatitis
K754	10	Autoimmune hepatitis
Obstruction of bile duct		
5762	9	Obstruction of bile duct
K831	10	Obstruction of bile duct
Q442	10	Atresia of bile ducts
Cholangitis		
5761	9	Cholangitis
K8030	10	Calculus of bile duct with cholangitis, unspecified, without obstruction
K8031	10	Calculus of bile duct with cholangitis, unspecified, with obstruction
K8032	10	Calculus of bile duct with acute cholangitis without obstruction
K8033	10	Calculus of bile duct with acute cholangitis with obstruction
K830	10	Cholangitis
K8301	10	Primary sclerosing cholangitis
K8309	10	Other cholangitis
Intrahepatic and biliary malignant tumors		
1551	9	Malignant neoplasm of intrahepatic bile ducts
1561	9	Malignant neoplasm of extrahepatic bile ducts
C221	10	Intrahepatic bile duct carcinoma
C240	10	Malignant neoplasm of extrahepatic bile duct
C787	10	Secondary malignant neoplasm of liver and intrahepatic bile duct
D135	10	Benign neoplasm of extrahepatic bile ducts
2115	9	Benign neoplasm of liver and biliary passages
2353	9	Neoplasm of uncertain behavior of liver and biliary passages

MIMIC, Medical Information Mart for Intensive Care; ICD, International Classification of Diseases.

Table S2 Missing rates for continuous variables and whether imputation was performed

Variable	Number and distribution of pre-filling variables							Number and distribution of variables after filling							Miss rate (%)	Processing method
	Total	Mean value	Median	25% quantiles	75% quantile	Minimum value	Maximum value	Total	Mean value	Median	25% quantiles	75% quantile	Minimum value	Maximum value		
HH (bpm)	766	96.244	96.055	83.571	108.078	48.864	153.4	770	96.265	96.055	83.684	108.078	48.864	153.4	0.519	Filling data
SBP (mmHg)	763	108.08	105.824	99.325	114.016	74.31	215.868	770	108.103	105.923	99.329	114.14	74.31	215.868	0.909	Filling data
DBP (mmHg)	763	59.299	58.407	52.681	64.691	30.696	104.75	770	59.339	58.456	52.821	64.755	30.696	104.75	0.909	Filling data
MBP (mmHg)	766	73.106	72.043	66.979	78.059	49.174	124.324	770	73.114	72.043	66.979	78.066	49.174	124.324	0.519	Filling data
RR (bpm)	766	22.005	21.883	18.443	25.059	11.461	37.1	770	22.021	21.898	18.456	25.069	11.461	37.1	0.519	Filling data
Temperature (°C)	742	36.96	36.891	36.579	37.405	33.008	39.725	770	36.962	36.903	36.58	37.404	33.008	39.725	3.636	Filling data
SPO ₂ (%)	766	96.806	97.125	95.753	98.535	72.188	100	770	96.803	97.125	95.753	98.533	72.188	100	0.519	Filling data
UO (mL/24 h)	731	1503.3	1216	615	2100	0	7885	770	1496.849	1217	629.25	2083.75	0	7,885	5.065	Filling data
SOFA	766	9.007	9	6	11	0	21	770	9.008	9	6	11	0	21	0.519	Filling data
Hemoglobin (g/dL)	770	30.681	30.3	25.7	35.1	6.4	56	770							0	Not processed
Hematocrit (%)	770	10.007	9.8	8.3	11.4	1.7	18.3	770							0	Not processed
MCHC (g/dL)	770	32.578	32.6	31.5	33.7	26.4	37.8	770							0	Not processed
MCH (pg)	770	29.824	30.05	28.5	31.4	19.6	41.1	770							0	Not processed
MCV, fL	770	91.69	91	87	96	62	122	770							0	Not processed
Platelet (K/UL)	770	193.288	170	98.5	246.75	8	944								0	Not processed
Red blood cell (m/UL)	770	3.38	3.33	2.83	3.88	0.59	6.23	770							0	Not processed
RDW (%)	770	16.452	15.7	14.3	17.8	11.6	28.5	770							0	Not processed
White blood cell (K/UL)	770	14.864	12.7	7.325	19.5	0.1	328.4	770							0	Not processed
Albumin (g/dL)	676	2.588	2.6	2.2	3	1	5	770	2.581	2.6	2.2	3	1	5	12.208	Filling data
Anion gap (mEq/L)	770	16.573	16	13	19	-4	38	770							0	Not processed
Bicarbonate (mEq/L)	770	20.629	21	18	24	5	39	770							0	Not processed
BUN (mg/dL)	770	39.369	31	19	52	3	170	770							0	Not processed
Calcium (mg/dL)	770	7.91	7.9	7.325	8.5	3.4	14.2	770							0	Not processed
Chloride (mEq/L)	770	103.426	103	99	108	77	153	770							0	Not processed
Creatinine (mg/dL)	770	2.027	1.4	0.9	2.5	0.1	15.9	770							0	Not processed
Glucose (mg/dL)	770	151.692	131	104	169.75	37	1260	770							0	Not processed
Sodium (mEq/L)	770	137.26	137	134	141	118	175	770							0	Not processed
Potassium (mEq/L)	770	4.206	4.1	3.7	4.6	1.8	9.6	770							0	Not processed
PO ₂ (mmHg)	729	118.957	84	48	154	18	548	770	118.458	85	49	154	18	548	5.325	Filling data
PCO ₂ (mmHg)	728	41.397	39	33	47	12	127	770	41.458	39	33	47	12	127	5.455	Filling data
FiO ₂ _chartevents (%)	489	70.262	60	50	100	28	100	770	70.443	68.75	50	100	28	100	36.494	Elimination
FiO ₂ (%)	491	63.181	50	40	100	21	100	770	63.024	55	45	80	21	100	36.234	Elimination
PaO ₂ /FiO ₂ ratio	501	214.446	177	102.875	294	23	1237.5	770	211.942	178	107	282.5	23	1,237.5	34.935	Elimination
PH	728	7.335	7.35	7.278	7.42	6.82	7.6	770	7.335	7.35	7.28	7.41	6.82	7.6	5.455	Filling data
Base excess (mEq/L)	728	-3.548	-3	-7	0	-29	12	770	-3.517	-3	-7	0	-29	12	5.455	Filling data
Total CO ₂ (mEq/L)	728	22.765	23	19	26	7	41	770	22.803	23	19	26	7	41	5.455	Filling data
Lactate (mmol/L)	717	2.851	2.3	1.5	3.5	0.6	16.8	770	2.846	2.3	1.5	3.5	0.6	16.8	6.883	Filling data
ALT (IU/L)	768	140.772	36	20	78	2	7750	770	140.515	36	20	78	2	7,750	0.26	Filling data
AST (IU/L)	769	251.35	58	33	131	5	17600	770	251.207	58	33	131.75	5	17,600	0.13	Filling data
ALP (IU/L)	769	154.114	100	64	174	22	1584	770	154.016	100	64	174	22	1,584	0.13	Filling data
Total bilirubin (mg/dL)	770	2.647	2.1	1	3	0.1	33.3								0	Not processed
LDH (IU/L)	680	655.525	355.5	246	570	100	20270	770	655.384	358.5	249.25	571.75	100	20,270	11.688	Filling data
Basophils (%)	646	0.147	0	0	0.2	0	2	770	0.148	0	0	0.2	0	2	16.104	Filling data
Eosinophils (%)	646	0.807	0	0	1	0	34	770	0.8	0.1	0	1	0	34	16.104	Filling data
Lymphocytes (%)	646	10.299	7	3.5	11	0	100	770	10.135	7	3.9	11	0	100	16.104	Filling data
Monocytes (%)	646	5.118	4	2.1	7	0	40	770	5.113	4	2.425	6.8	0	40	16.104	Filling data
Neutrophils (%)	646	76.392	82	71.625	88	0	99	770	76.473	81.625	71.25	87.7	0	99	16.104	Filling data
PT (s)	765	19.405	16.2	13.9	19.6	10.1	150	770	19.423	16.2	14	19.6	10.1	150	0.649	Filling data
PTT (s)	764	42.743	34.3	30	44.6	19.2	150	770	42.715	34.3	30.025	44.6	19.2	150	0.779	Filling data
INR	765	1.796	1.5	1.3	1.8	0.9	14.1	770	1.798	1.5	1.3	1.8	0.9	14.1	0.649	Filling data

HH, hypoxic hepatitis; HR, heart rate; SBP, systolic pressure; DBP, diastolic pressure; MBP, mean arterial pressure; RR, respiratory rate; SPO₂, saturation of pulse oxygen; UO, urine output; SOFA, sequential organ failure assessment score; MCHC, mean corpuscular hemoglobin concentration; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin; RDW, red blood cell distribution width; BUN, blood urea nitrogen; PO₂, oxygen partial pressure; PCO₂, carbon dioxide partial pressure; FiO₂, fraction of inspiration O₂; PH, potential of hydrogen; ALT, alanine aminotransferase; AST, aspartate aminotransferase; ALP, alkaline phosphatase; LDH, lactate dehydrogenase; PT, prothrombin time; PTT, partial thromboplastin time; INR, international normalized ratio.

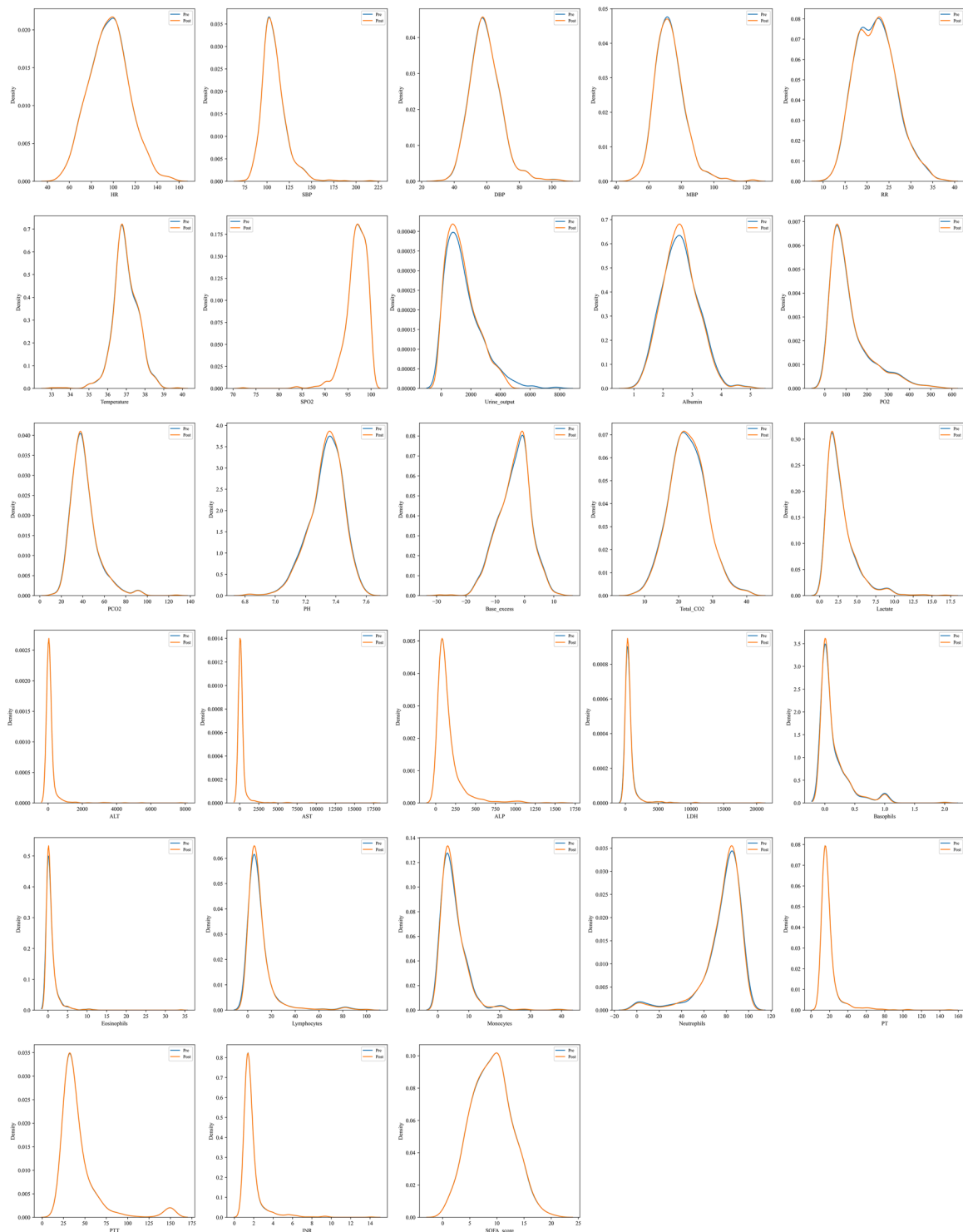


Figure S1 Distribution before and after imputation of continuous variables. HR, heart rate; SBP, systolic pressure; DBP, diastolic pressure; MBP, mean arterial pressure; RR, respiratory rate; SPO₂, saturation of pulse oxygen; PO₂, oxygen partial pressure; PCO₂, carbon dioxide partial pressure; PH, potential of hydrogen; ALT, alanine aminotransferase; AST, aspartate aminotransferase; ALP, alkaline phosphatase; LDH, lactate dehydrogenase; PT, prothrombin time; PTT, partial thromboplastin time; INR, international normalized ratio; SOFA, sequential organ failure assessment score.

Table S3 Regression coefficients for variables in the LASSO regression

	Value
λ	0.03768844
(Intercept)	7.16063048
variable	
Type, n (%)	0.17739291
Occurrence time (hour)	0.0037172
Gender, n (%)	.
Age	0.000162608
hypertension	.
hyperlipidemia	.
Diabetes without complication	.
Diabetes with complication	.
Atrial fibrillation	0.127856388
Old myocardial infarction	.
Chronic heart failure	.
Chronic pulmonary disease	.
Chronic renal disease	.
Peripheral vascular disease	.
Cerebrovascular disease	.
Malignant cancer	.
Hypothyroidism	.
Acute heart failure	.
Septic shock	.
Acute myocardial infarction	0.482578179
Acute respiratory failure	0.233744349
Acute renal failure	.
Coagulation disorder	.
Acute post-hemorrhagic anemia	.
Toxic encephalopathy	.
Heart rate (bpm)	.
Systolic pressure (mmHg)	.
Diastolic pressure (mmHg)	.
Mean arterial pressure (mmHg)	.
Respiratory rate (bpm)	.
Temperature (°C)	-0.248906736
SPO ₂ (%)	.
Urine output (mL/24 h)	-0.000156223
Hematocrit (%)	.
Hemoglobin (g/dL)	.
MCHC (g/dL)	.
MCH (pg)	.
MCV (fL)	.
Platelets (K/uL)	.
Red blood cell (m/uL)	.
RDW (%)	0.080555597
White blood cell (K/uL)	.
Albumin (g/dL)	.
Anion gap (mEq/L)	.
Bicarbonate (mEq/L)	.
BUN (mg/dL)	.
Chloride (mEq/L)	.
Glucose (mg/dL)	.
Sodium (mEq/L)	.
Potassium (mEq/L)	.
Calcium (mg/dL)	.
Creatinine (mg/dL)	.
PO ₂ (mmHg)	.
PCO ₂ (mmHg)	.
PH	.
Base excess (mEq/L)	.
Total CO ₂ (mEq/L)	.
Lactate (mmol/L)	.
Alanine transaminase (IU/L)	.
Aspartate transaminase (IU/L)	.
Alkaline phosphatase (IU/L)	.
Total bilirubin (mg/dL)	.
Lactate dehydrogenase (IU/L)	.
Basophils (%)	.
Eosinophils (%)	.
Lymphocytes (%)	.
Monocytes (%)	.
Neutrophils (%)	.
PT (s)	.
PTT (s)	0.002621153
INR	.
Renal replacement therapy	0.185405847
Frozen plasma	.
Extraintestinal nutrition	.
Invasive ventilation	.
Cardiotonic drugs	.
Vasoactive drugs	.
Blood transfusion	.
Anticoagulant	.

LASSO, least absolute shrinkage and selection operator; SPO₂, saturation of pulse oxygen; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin; MCHC, mean corpuscular hemoglobin concentration; RDW, red blood cell distribution width; BUN, blood urea nitrogen; PO₂, oxygen partial pressure; PCO₂, carbon dioxide partial pressure; PH, potential of hydrogen; PT, prothrombin time; PTT, partial thromboplastin time; INR, international normalized ratio.