

Table S1 The different conditions were evaluated as defined by Charlson in his original paper

Comorbidities definition

Cardiovascular disease

- ❖ Angina includes patients with chronic exertional angina, those with a coronary artery bypass graft, and those initially admitted with unstable angina
- ❖ Myocardial infarction includes patients with one or more definite or probable myocardial infarctions; these patients were hospitalized and had electrocardiographic and/or enzyme changes. Patients with electrocardiographic changes alone were not designated as having had an infarction
- ❖ Congestive heart failure includes patients who had exertional or paroxysmal nocturnal dyspnea and who responded symptomatically (or on physical examination) to digitalis, diuretics, or afterload-reducing agents. It does not include patients who are on medication, but have had no symptomatic response and no evidence of improvement of physical signs
- ❖ Arrhythmia includes patients with chronic atrial fibrillation or flutter {36% [33]}, sick sinus syndrome, or ventricular arrhythmias requiring chronic treatment
- ❖ Valvular disease includes patients with hemodynamically significant aortic stenosis and/or insufficiency, those with significant mitral stenosis and/or insufficiency, and those with prosthetic aortic or mitral valves and those with symptomatic mitral valve prolapse, asymmetric septal hypertrophy requiring treatment, or tricuspid insufficiency
- ❖ Peripheral vascular disease includes patients with intermittent claudication or those who had a bypass for arterial insufficiency, those with gangrene or acute arterial insufficiency, and those with an untreated thoracic or abdominal aneurysm (6 cm or more)
- ❖ Hypertension includes patients with diastolic pressures over 120 mmHg; those with diastolic pressures between 100 and 120; and those with diastolic pressures below 100 as well as with controlled hypertension

Neurological disease

- ❖ Cerebrovascular disease includes patients with a history of a cerebrovascular accident with minor or no residual or transient ischemic attacks
- ❖ Paralysis includes patients with dense hemiplegia or paraplegia, whether as a result of a cerebrovascular accident or other condition
- ❖ Dementia includes patients with chronic cognitive deficit
- ❖ Other neurologic conditions include patients with Parkinson's disease, uncontrolled seizures, or syncope without an identified cause or treatment

Pulmonary disease

- ❖ Mild pulmonary disease includes patients who are dyspneic with moderate activity without treatment or those who are dyspneic only with attacks (e.g., asthma)
- ❖ Moderate pulmonary disease includes patients who are dyspneic with slight activity, with or without treatment and those who are dyspneic with moderate activity despite treatment
- ❖ Severe pulmonary disease includes patients who are dyspneic at rest despite treatment, those who require constant oxygen, those with CO₂ retention and those with a baseline PO₂ below 50 torr

Endocrine disorders:

- ❖ Severe diabetes includes patients with retinopathy, neuropathy, or nephropathy
- ❖ Moderate diabetes includes patients who were previously hospitalized for ketoacidosis, hyperosmolar coma, or check-up and those with juvenile onset or brittle diabetes
- ❖ Mild diabetes includes all other diabetes treated with insulin or oral hypoglycemia, but not diet alone
- ❖ Other endocrine includes patients with hypopituitarism, adrenal insufficiency, and recurrent acidosis

Renal disease

- ❖ Severe renal disease includes patients on dialysis, those who had a transplant, and those with uremia
- ❖ Moderate renal insufficiency includes patients with serum creatinine of >3 mg%
- ❖ Mild renal includes those with serum creatinine of 2–3 mg%

Liver disease

- ❖ Severe liver disease consists of patients with cirrhosis, portal hypertension and a history of variceal bleeding
- ❖ Moderate liver disease consists of cirrhosis with portal hypertension, but without bleeding
- ❖ Mild liver disease consists of cirrhosis without portal hypertension or chronic hepatitis

Gastrointestinal disease

- ❖ Inflammatory bowel disease includes patients with ulcerative colitis or regional enteritis
- ❖ Peptic ulcer disease includes patients who required treatment for an ulcer, including a bleeding ulcer
- ❖ Gastrointestinal bleeding includes those who have had bleeding requiring transfusion for causes other than ulcer

Immunological, hematological and rheumatological diseases

- ❖ Acquired immune deficiency syndrome includes patients with definite or probable AIDS, i.e., AIDS-related complex
- ❖ Lymphoma includes patients with Hodgkin's, lymphosarcoma, Waldenstrom's macroglobulinemia, myeloma, and other lymphomas
- ❖ Leukemia includes patients with acute or chronic myelogenous leukemia, acute or chronic lymphocytic leukemia, and polycythemia vera
- ❖ Rheumatologic disease includes patients with systemic lupus erythematosus, polymyositis, mixed connective tissue disease, polymyalgia rheumatica, and moderate to severe rheumatoid arthritis
- ❖ Coagulopathy includes patients with a circulating anticoagulant or other coagulopathy

Tumors

- ❖ Tumor designates patients with solid tumors without documented metastases, but initially treated in the last five years, including liver, breast, colon, lung, and a variety of other tumors
- ❖ Metastatic cancer includes patients with metastatic solid tumors, including colon, breast, lung, and other tumors

Charlson's original paper: Charlson ME, Pompei P, Ales KL, *et al.* A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis* 1987;40:373-83.

Table S2 Univariate analysis for postoperative mortality

Characteristic	Regression coefficient	OR	95% CI	P
Age	0.091	1.095	1.06–1.131	<0.001
Sex, male	0.226	1.254	0.706–2.227	0.441
BMI	–0.33	0.967	0.906–1.033	0.320
BSA	–1.294	0.274	0.081–0.934	0.038
SLV	–0.001	0.999	0.998–1.000	0.038
Liver tumor				
CRLM and OM		1		
Biliary	1.398	4.046	2.258–7.248	<0.001
HCC and OP	0.927	2.526	1.099–5.806	0.029
Primary tumor	1.204	3.333	1.943–5.718	<0.001
Surgery				
Classic ALPPS vs. modified	0.645	1.906	1.065–3.413	0.030
Open approach	19.457	2.835E8	0.000	0.998
Surgical approach of the hepatic hilus vs. PVE (hybrid + RALPPS + tourniquet)	1.757	5.796	0.778–43.157	0.086
Parenchyma surgical vs. other	0.944	2.570	0.994–6.641	0.051
Classic ALPPS (vs. partial)	1.521	4.575	2.1963–9.531	<0.001
Hybrid ALPPS	–1.166	0.312	0.041–2.369	0.260
Tourniquet ALPPS	–0.457	0.633	0.261–1.540	0.314
RALPPS	–0.771	0.463	0.059–3.601	0.462
Resection of more than 4 segments	0.619	1.857	0.950–3.630	0.070
Comorbidities				
Presence of comorbidities	0.839	2.315	1.285–4.170	0.005
Number of comorbidities	0.345	1.412	1.189–1.677	<0.001
CCI	–0.183	0.832	0.731–0.947	0.005
aCCI	–0.002	0.998	0.888–1.121	0.969
Cardiovascular disease	0.917	2.502	1.448–4.325	0.001
Angina				
Myocardial infarction	0.992	2.696	–	–
Congestive heart failure	1.525	4.597	1.005–21.035	0.049
Arrhythmia	0.867	2.379	0.895–6.329	0.082
Valvular disease	–0.309	0.734	0.090–5.971	0.773
Peripheral vascular disease	1.736	5.672	1.982–16.232	0.001
Hypertension	0.621	1.860	1.096–3.158	0.021
Severe cardiovascular disease ¹	1.429	4.175	2.109–8.265	<0.001
Neurological disease	0.323	1.381	0.382–4.986	0.622
Cerebrovascular disease	0.172	1.187	0.254–5.546	0.827
Paralysis	–	–	–	–
Dementia	–	–	–	–
Other neurological disease	0.395	1.484	0.163–13.494	0.726
Pulmonary disease	0.183	1.203	0.510–2.838	0.672
Severe pulmonary disease	22.995	9.693E9	0.000	1.000
Moderate pulmonary disease	0.169	1.184	0.136–10.304	0.878
Mild pulmonary disease	–0.320	0.726	0.212–2.483	0.610
COPD	0.174	1.190	0.335–4.232	0.788
Endocrine disorders	0.833	2.300	1.283–4.122	0.005
Moderate and severe diabetes	1.444	4.237	1.455–12.339	0.008
Severe diabetes	2.224	9.242	1.514–56.428	0.016
Moderate diabetes	1.262	3.532	1.004–12.424	0.049
Mild diabetes	0.852	2.345	1.169–4.702	0.016
Other endocrine disease	0.097	1.102	0.408–2.973	0.097
Renal disease	2.359	10.583	2.465–45.435	0.002
Severe renal disease	–19.441	0.000	0.000	1.000
Moderate renal disease	23.010	9.847E9	0.000	0.999
Mild renal disease	2.224	9.242	1.514–56.428	0.016
Liver disease	–0.073	0.909	0.267–3.235	0.909
Severe liver disease	–	–	–	–
Moderate liver disease	–0.173	0.842	0.102–6.955	0.873
Mild liver disease	–0.016	0.984	0.215–4.502	0.984
Gastrointestinal disease	0.495	1.641	0.445–6.048	0.457
Inflammatory bowel disease	2.498	12.159	1.086–136.081	0.043
Peptic ulcer	0.172	1.187	0.254–5.546	0.827
Gastrointestinal bleeding	22.995	9.693E9	0.000	1.000
Immunological or hematological disease	0.709	2.033	0.635–6.507	0.232
AIDS	–	–	–	–
Lymphoma	–	–	–	–
Leukemia	–19.429	0.000	0.000	1.000
Rheumatologic disease	1.262	3.532	1.004–12.424	0.049
Coagulopathy	–19.429	0.000	0.000	1.000
Any tumor	–0.537	0.584	0.074–4.643	0.611
Any non-metastatic tumor	–0.537	0.584	0.074–4.643	0.611
Metastatic solid tumor	–	–	–	–

The table displays the respective logistic regression coefficients and OR with 95% CI for pre-Stage 1 variables. ¹, severe cardiovascular disease: any of congestive heart disease, myocardial infarction or peripheral vascular disease. OR, odds ratios; CI, confidence intervals; BMI, body mass index; BSA, body surface index according to the Mosteller formula; SLV, standard liver volume according to the Vauthey formula; CRLM, colorectal liver metastasis; OM, other metastatic liver tumor; HCC, hepatocellular carcinoma; OP, other primary liver tumor; ALPPS, Associating Liver Partition and Portal vein ligation for Staged hepatectomy; PVE, portal vein embolization; RALPPS, radiofrequency-assisted ALPPS; aCCI, age-adjusted Charlson Comorbidity Index; CCI, Charlson Comorbidity Index.