

# **Supplemental Material**

**Table S1. The International Classification of Diseases (ICD)-Clinical Modification (CM) codes for acute heart failure.**

ICD-9 CM codes	428.21, 428.23, 428.31, 428.33, 428.41, 428.43
ICD-10-CM codes	I50.21, I50.23, I50.31, I50.33, I50.41 and I50.43.

**Table S2. The International Classification of Diseases (ICD)-Clinical Modification (CM) codes for Elixhauser Comorbidities.**

Comorbidities	Elixhauser's original ICD-9-CM	Elixhauser AHRQ-Web ICD-9-CM	ICD-10	Enhanced ICD-9-CM
Congestive heart failure	398.91, 402.11, 402.91, 404.11, 404.13, 404.91, 404.93, 428.x	398.91, 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 428.x	I09.9, I11.0, I13.0, I13.2, I25.5, I42.0, I42.5-I42.9, I43.x, I50.x, P29.0	398.91, 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 425.4-425.9, 428.x
Cardiac arrhythmias	426.10, 426.11, 426.13, 426.2-426.53, 426.6-426.8, 427.0, 427.2, 427.31, 427.60, 427.9, 785.0, V45.0, V53.3		I44.1-I44.3, I45.6, I45.9, I47.x-I49.x, ROO.O, ROO.1, ROO.8, T82.1, Z45.0, Z95.0	426.0, 426.13, 426.7, 426.9, 426.10, 426.12, 427.0-427.4, 427.6-427.9, 785.0, 996.01, 996.04, V45.0, V53.3
Valvular disease	093.2, 394.0-397.1, 424.0-424.91, 746.3-746.6, V42.2, V43.3	093.2, 394.x-397.1, 397.9, 424.x, 746.3-746.6, V42.2, V43.3	A52.0, I05.x-I08.x, I09.1, I09.8, I34.x-I39.x, Q23.O-Q23.3, Z95.2, Z95.4	093.2, 394.x-397.x, 424.x, 746.3-746.6, V42.2, V43.3
Pulmonary circulation Disorders	416.x, 417.9	416.x, 417.9	I26.x, I27.x, I28.0, I28.8, I28.9	415.0, 415.1, 416.x, 417.0, 417.8, 417.9
Peripheral vascular disorders	440.x, 441.2, 441.4, 441.7, 441.9, 443.1-443.9, 447.1, 557.1, 557.9, V43.4	440.x, 441.x, 442.x, 443.1-443.9, 447.1, 557.1, 557.9, V43.4	I70.x, I71.x, I73.1, I73.8, I73.9, I77.1, I79.0, I79.2, K55.1, K55.8, K55.9, Z95.8, Z95.9	093.0, 437.3, 440.x, 441.x, 443.1-443.9, 447.1, 557.1, 557.9, V43.4
Hypertension, uncomplicated	401.1, 401.9	401.1, 401.9, 642.0	I10.x	401.x
Hypertension, complicated	402.10, 402.90, 404.10, 404.90, 405.1, 405.9	401.0, 402.x-405.x, 642.1, 642.2, 642.7, 642.9	I11.x-I13.x, I15.x	402.x-405.x
Paralysis	342.0, 342.1, 342.9-344.x	342.x-344.x, 438.2-438.5	G04.1, G11.4, G80.1, G80.2, G81.x, G82.x, G83.0-G83.4, G83.9	334.1, 342.x, 343.x, 344.0-344.6, 344.9
Other neurological disorders	331.9, 332.0, 333.4, 333.5, 334.x, 335.x, 340.x, 341.1-341.9, 345.0, 345.1, 345.4, 345.5, 345.8, 345.9, 348.1, 348.3, 780.3, 784.3	330.x-331.x, 332.0, 333.4, 333.5, 334.x, 335.x, 340, 341.1-341.9, 345.x, 347.x, 780.3, 784.3	G10.x-G13.x, G20.x-G22.x, G25.4, G25.5, G31.2, G31.8, G31.9, G32.x, G35.x-G37.x, G40.x, G41.x, G93.1, G93.4, R47.0, R56.x	331.9, 332.0, 332.1, 333.4, 333.5, 333.92, 334.x-335.x, 336.2, 340.x, 341.x, 345.x, 348.1, 348.3, 780.3, 784.3
Chronic pulmonary disease	490-492.8, 493.00-493.91, 494.x-505.x, 506.4	490x-492.x, 493.x, 494x-505.x, 506.4	I27.8, I27.9, J40.x-J47.x, J60.x-J67.x, J68.4, J70.1, J70.3	416.8, 416.9, 490.x-505.x, 506.4, 508.1, 508.8
Diabetes, uncomplicated	250.0-250.3	250.0-250.3, 648.0	E10.0, E10.1, E10.9, E11.0, E11.1, E11.9, E12.0, E12.1, E12.9, E13.0, E13.1, E13.9, E14.0, E14.1, E14.9	250.0-250.3
Diabetes, complicated	250.4-250.7, 250.9	250.4-250.9, 775.1	E10.2-E10.8, E11.2-E11.8, E12.2-E12.8, E13.2-E13.8, E14.2-E14.8	250.4-250.9
Renal failure	403.11, 403.91, 404.12, 404.92, 585.x, 586.x, V42.0, V45.1, V56.0, V56.8	403.01, 403.11, 403.91, 404.02, 404.03, 404.12, 404.13, 404.92, 404.93, 585.x, 586.x, V42.0, V45.1, V56.x	I12.0, I13.1, N18.x, N19.x, N25.0, Z49.0-Z49.2, Z94.0, Z'99.2	403.01, 403.11, 403.91, 404.02, 404.03, 404.12, 404.13, 404.92, 404.93, 585.x, 586.x, 588.0, V42.0, V45.1, V56.x
Liver disease	070.32, 070.33, 070.54, 456.0, 456.1, 456.2, 571.0, 571.2-571.9, 572.3, 572.8, V42.7	070.22, 070.23, 070.32, 070.33, 070.44, 070.54, 456.0, 456.1, 456.20, 571.0, 571.2-571.9, 572.3, 572.8, V42.7	B18.x, I85.x, I86.4, I98.2, K70.x, K71.1, K71.3-K71.5, K71.7, K72.x-K74.x, K76.0, K76.2-K76.9, Z94.4	070.22, 070.23, 070.32, 070.33, 070.44, 070.54, 070.6, 070.9, 456.0-456.2, 570.x, 571.x, 572.2-572.8, 573.3, 573.4, 573.8, 573.9, V42.7

**Table S3. List of Variables Used for Adjustments.**

<p>Elixhauser Comorbidities</p>	<ol style="list-style-type: none"> <li>1. Valvular disease</li> <li>2. Pulmonary Circulation disorders</li> <li>3. Peripheral vascular disease</li> <li>4. Hypertension (combine uncomplicated and complicated)</li> <li>5. Paralysis</li> <li>6. Neurological disorders</li> <li>7. Chronic pulmonary disease</li> <li>8. Diabetes without chronic complications</li> <li>9. Diabetes with chronic complications</li> <li>10. Hypothyroidism</li> <li>11. Renal failure</li> <li>12. Liver disease</li> <li>13. Chronic Peptic ulcer disease</li> <li>14. HIV and AIDS</li> <li>15. Lymphoma</li> <li>16. Metastatic cancer</li> <li>17. Solid tumor without metastasis</li> <li>18. Rheumatoid arthritis/collagen vascular diseases</li> <li>19. Coagulation deficiency</li> <li>20. Obesity</li> <li>21. Weight loss</li> <li>22. Fluid and electrolyte disorders</li> <li>23. Blood loss anemia</li> <li>24. Deficiency anemia</li> <li>25. Alcohol Abuse</li> <li>26. Drug Abuse</li> <li>27. Psychosis</li> <li>28. Depression</li> </ol>
<p>Demographic variables</p>	<p>A. Age, gender, race, income (quartile classification of the estimated median household income of residents in the patient's ZIP Code) and urban or rural hospitalization</p>

**Table S4. Complications and Utilization of Procedures in Patients with Heart Failure.**

<b>Variable, No. (%)</b>	<b>2002-2006 (n=297112)</b>	<b>2007-2011 (n=4039603)</b>	<b>2012-2016 (n=7469964)</b>	<b>P-value</b>
<b>Cardiac Procedures/Complications</b>				
Echocardiogram	22372 (7.5)	297286 (7.4)	581835 (7.8)	<0.001
Left Heart Catheterization	32449 (10.9)	408866 (10.1)	790280 (10.6)	<0.001
Right Heart Catheterization	1949 (0.7)	44132 (1.1)	124125 (1.7)	<0.001
Percutaneous Coronary Intervention	7503 (2.5)	113464 (2.8)	235220 (3.1)	<0.001
Coronary Artery Bypass Graft	3842 (1.3)	61599 (1.5)	112385 (1.5)	<0.001
Left Ventricular Assist Device	294 (0.1)	6347 (0.2)	17275 (0.2)	<0.001
Automatic Implantable Cardioverter Defibrillator	4779 (1.6)	56604 (1.4)	107175 (1.4)	<0.001
Acute Myocardial Infarction	8051 (2.7)	101578 (2.5)	152505 (2.0)	<0.001
Cardiogenic Shock	3749 (1.3)	81828 (2.0)	230825 (3.1)	<0.001
Percutaneous Ventricular Assist Device	-	2416 (0.1)	15240 (0.2)	<0.001
Intra-Aortic Balloon Pump	2346 (0.8)	38674 (1.0)	71710 (1.0)	<0.001
Cardiopulmonary Resuscitation	2195 (0.7)	33822 (0.8)	78645 (1.1)	<0.001
Ventilator	21408 (7.2)	271831 (6.7)	564200 (7.6)	<0.001
Tracheostomy	2116 (0.7)	24263 (0.6)	46485 (0.6)	<0.001
<b>Non-Cardiac Procedures/Complications</b>				
Dialysis	4475 (1.5)	211227 (5.2)	436575 (5.8)	<0.001
Percutaneous Endoscopic Gastrostomy	2557 (0.9)	47189 (1.2)	87275 (1.2)	<0.001
Vasopressors	1266 (0.4)	29996 (0.7)	79660 (1.1)	<0.001
Extra Corporeal Membrane Oxygenation	2981(1.0)	46080 (1.1)	45590 (0.6)	<0.001
Blood transfusion	28508 (9.6)	458190 (11.3)	673250 (9.0)	<0.001