

Appendix A. Candidate Variables Included in the Model Building.

Appendix A	Risk Factors	N (%) or Mean (SD)	Readmitted within 30 Days	Not Readmitted within 30 Days	p-value
			330 (25%)	965 (75%)	
		N (%) or Mean (SD)	N (%) or Mean (SD)	N (%) or Mean (SD)	
Age		62.83 (16.53)	65.62 (15.60)	61.88 (16.73)	0.0004
Length of Hospitalization		5.9 (5.97)	7.23 (8.02)	5.50 (2.02)	<0.0001
Discharge Status					<0.0001
Home		837 (65%)	171 (52%)	666 (69%)	
Home with Care		202 (16%)	65 (20%)	137 (14%)	
LTACH/Rehab		35 (3%)	16 (5%)	19 (2%)	
SNF		191 (15%)	70 (21%)	121 (13%)	
Other		29 (2%)	8 (2%)	21 (2%)	
Missing		1 (0%)			
Gender					0.6704
Male		676 (52%)	176 (54%)	500 (52%)	
Female		612 (48%)	153 (46%)	459 (48%)	
Missing		7 (0%)			
Race					0.7692
Caucasian		782 (60%)	195 (61%)	587 (62%)	
African American		451 (35%)	118 (37%)	333 (35%)	
Other		33 (3%)	7 (2%)	26 (3%)	
Missing		29 (2%)			
Smoking Status					0.1195
Current		132 (10%)	28 (11%)	104 (17%)	
Former		437 (34%)	132 (52%)	305 (48%)	
Never		310 (24%)	92 (37%)	218 (35%)	
Missing		416 (32%)			
Income		46,360 (19,105.59)	47,146.59 (19,797.18)	46,090.93 (18,864.05)	0.4511
Missing		33 (3%)			
Alcohol Abuse					0.7365
Yes		51 (4%)	12 (4%)	39 (4%)	
No		1237 (96%)	317 (96%)	920 (96%)	
Missing		7 (0%)			
Anxiety					0.8501
Yes		246 (19%)	64 (20%)	182 (19%)	
No		1042 (81%)	265 (80%)	777 (81%)	
Missing		7 (0%)			
Asthma					0.2587
Yes		275 (21%)	63 (19%)	212 (22%)	

Bronchiectasis	No	1013 (79%)	266 (81%)	747 (78%)	0.0342
	Missing	7 (0%)			
	Yes	59 (5%)	22 (7%)	37 (4%)	
Cancer	No	1229 (95%)	307 (93%)	922 (96%)	0.0011
	Missing	7 (0%)			
	Yes	644 (50%)	190 (58%)	454 (47%)	
Coronary Heart Disease	No	644 (50%)	139 (42%)	505 (53%)	0.0002
	Missing	7 (0%)			
	Yes	412 (32%)	132 (40%)	280 (29%)	
Heart Failure	No	876 (68%)	197 (60%)	679 (71%)	0.0011
	Missing	7 (0%)			
	Yes	357 (28%)	114 (35%)	243 (25%)	
Cirrhosis	No	931 (72%)	215 (65%)	716 (75%)	0.6828
	Missing	7 (0%)			
	Yes	56 (4%)	13 (4%)	43 (5%)	
Chronic Kidney Disease	No	1232 (96%)	316 (96%)	916 (95%)	0.001
	Missing	7 (0%)			
	Yes	302 (23%)	99 (30%)	203 (21%)	
Connective Tissue Disease	No	986 (77%)	230 (70%)	756 (79%)	0.8275
	Missing	7 (0%)			
	Yes	56 (4%)	15 (5%)	41 (4%)	
COPD	No	1232 (96%)	314 (95%)	918 (96%)	0.2799
	Missing	7 (0%)			
	Yes	400 (31%)	110 (33%)	290 (30%)	
Dementia	No	888 (69%)	219 (67%)	669 (70%)	0.8159
	Missing	7 (0%)			
	Yes	52 (4%)	14 (4%)	38 (4%)	
Depression	No	1236 (96%)	315 (96%)	921 (96%)	0.3783
	Missing	7 (0%)			
	Yes	171 (13%)	39 (12%)	132 (14%)	
Diabetes	No	1117 (87%)	290 (88%)	827 (86%)	
	Missing	7 (0%)			
	Yes				

	Yes	454 (35%)	134 (41%)	320 (33%)	0.0159
	No	834 (65%)	195 (59%)	639 (67%)	
	Missing	7 (0%)			
Diaphragm Paralysis					
	Yes	17 (1%)	3 (1%)	14 (2%)	0.4523
	No	1271 (99%)	326 (99%)	945 (98%)	
	Missing	7 (0%)			
Empyema					
	Yes	25 (2%)	10 (3%)	15 (2%)	0.0942
	No	1263 (98%)	319 (97%)	944 (98%)	
	Missing	7 (0%)			
End Stage Renal Disease					
	Yes	121 (9%)	41 (12%)	80 (8%)	0.0271
	No	1167 (91%)	288 (88%)	879 (92%)	
	Missing	7 (0%)			
Hip Fracture					
	Yes	29 (2%)	10 (3%)	19 (2%)	0.2642
	No	1259 (98%)	319 (97%)	940 (98%)	
	Missing	7 (0%)			
Interstitial Lung Disease					
	Yes	204 (16%)	53 (16%)	151 (16%)	0.8761
	No	1084 (84%)	276 (84%)	808 (84%)	
	Missing	7 (0%)			
Other Neurological Disorders					
	Yes	99 (8%)	29 (9%)	70 (7%)	0.3733
	No	1189 (92%)	300 (91%)	889 (93%)	
	Missing	7 (0%)			
Peptic Ulcer					
	Yes	82 (6%)	23 (7%)	59 (6%)	0.5909
	No	1206 (94%)	306 (93%)	900 (94%)	
	Missing	7 (0%)			
Pleural Effusion					
	Yes	203 (16%)	57 (17%)	146 (15%)	0.3668
	No	1085 (84%)	272 (83%)	813 (85%)	
	Missing	7 (0%)			
Sleep Apnea					
	Yes	133 (10%)	37 (11%)	96 (10%)	0.525
	No	1155 (90%)	292 (89%)	863 (90%)	
	Missing	7 (0%)			
Stroke					
	Yes	277 (22%)	79 (24%)	198 (21%)	0.1998
	No	1011 (78%)	250 (76%)	761 (79%)	
	Missing	7 (0%)			

Altered Mental Status					
	Yes	68 (5%)	23 (7%)	45 (5%)	0.1077
	No	1220 (95%)	306 (93%)	914 (95%)	
	Missing	7 (0%)			
Previous Hospitalization for Pneumonia					
	Yes	620 (48%)	173 (53%)	447 (47%)	0.0614
	No	668 (52%)	156 (47%)	512 (53%)	
	Missing	7 (0%)			
Organ Transplantation					
	Heart	22 (2%)	9 (3%)	13 (1%)	0.4583
	Kidney	54 (4%)	11 (3%)	43 (4%)	
	Liver	22 (2%)	7 (2%)	15 (2%)	
	Lung	26 (2%)	5 (1%)	21 (2%)	
	Other	65 (5%)	18 (6%)	47 (5%)	
	None	1099 (85%)	279 (85%)	820 (86%)	
Inotropes Given During Hospitalization					
	Yes	169 (13%)	58 (18%)	111 (12%)	0.0048
	No	1113 (86%)	269 (82%)	844 (88%)	
	Missing	13 (1%)			
Time until First Administered Antibiotics		1034.0 (859.95)	1117.84 (1049.01)	1005.01 (783.10)	0.097
Aspirin					
	Yes	439 (34%)	108 (33%)	331 (35%)	0.5742
	No	837 (65%)	218 (67%)	619 (65%)	
	Missing	19 (1%)			
Plavix Prescribed at Discharge					
	Yes	82 (6%)	23 (7%)	59 (72%)	0.5915
	No	1194 (93%)	303 (93%)	891 (94%)	
	Missing	19 (1%)			
Coumadin Prescribed at Discharge					
	Yes	164 (13%)	61 (19%)	103 (11%)	0.0002
	No	1112 (86%)	265 (81%)	847 (89%)	
	Missing	19 (1%)			
Sulfonylureas Prescribed at Discharge					
	Yes	36 (3%)	7 (2%)	29 (3%)	0.3943
	No	1240 (96%)	319 (98%)	921 (97%)	
	Missing	19 (1%)			
Long acting insulin Prescribed at Discharge					
	Yes	340 (27%)	102 (31%)	238 (25%)	0.028
	No	936 (72%)	224 (69%)	712 (75%)	
	Missing	19 (1%)			
DPP4 Prescribed at Discharge					
	Yes	17 (1%)	5 (1%)	12 (1%)	0.7131

	No	1259 (98%)	321 (99%)	938 (99%)	
	Missing	19 (1%)			
Oral Steroids Prescribed at Discharge					
	Yes	488 (38%)	139 (43%)	349 (37%)	0.0585
	No	788 (61%)	187 (57%)	601 (63%)	
	Missing	19 (1%)			
Inhaled Short-acting Beta-agonist Prescribed at Discharge					
	Yes	825 (64%)	209 (64%)	616 (65%)	0.8115
	No	451 (35%)	117 (36%)	334 (35%)	
	Missing	19 (1%)			
Inhaled Steroids Prescribed at Discharge					
	Yes	309 (24%)	72 (22%)	237 (25%)	0.298
	No	967 (75%)	254 (78%)	713 (75%)	
	Missing	19 (1%)			
Inhaled Anticholinergics Prescribed at Discharge					
	Yes	529 (41%)	136 (42%)	393 (41%)	0.912
	No	747 (58%)	190 (58%)	557 (59%)	
	Missing	19 (1%)			
Inhaled Long-acting Beta-agonist Prescribed at Discharge					
	Yes	179 (14%)	40 (12%)	139 (15%)	0.2894
	No	1097 (85%)	286 (88%)	811 (85%)	
	Missing	19 (1%)			
Benzodiazepine Prescribed at Discharge					
	Yes	359 (28%)	109 (33%)	250 (26%)	0.0136
	No	917 (71%)	217 (67%)	700 (74%)	
	Missing	19 (1%)			
Antibiotic Prescribed at Discharge					
	Yes	1244 (96%)	319 (98%)	925 (97%)	0.6294
	No	32 (3%)	7 (2%)	25 (3%)	
	Missing	19 (1%)			
Antiarrhythmic Prescribed at Discharge					
	Yes	152 (12%)	48 (15%)	104 (11%)	0.0693
	No	1124 (87%)	278 (85%)	846 (89%)	
	Missing	19 (1%)			
Lasix Prescribed at Discharge					
	Yes	431 (34%)	129 (40%)	302 (32%)	0.0104
	No	845 (65%)	197 (60%)	648 (68%)	
	Missing	19 (1%)			
Opioids Prescribed at Discharge					
	Yes	755 (58%)	225 (69%)	530 (56%)	<0.0001
	No	521 (41%)	101 (31%)	420 (44%)	

	Missing	19 (1%)			
Mode of O ₂ Delivery on Admission					
	Nasal Cannula	499 (39%)	134 (41%)	365 (38%)	0.2184
	Room Air	675 (52%)	159 (49%)	516 (54%)	
	Ventilator	43 (3%)	14 (4%)	29 (3%)	
	Other	62 (5%)	20 (6%)	42 (5%)	
	Missing	16 (1%)			
Mode of O ₂ Delivery on Discharge					
	Nasal Cannula	420 (33%)	131 (40%)	289 (31%)	0.0004
	Room Air	832 (64%)	184 (56%)	648 (68%)	
	Ventilator	21 (2%)	10 (3%)	11 (1%)	
	Other	6 (0%)	2 (1%)	4 (0%)	
	Missing	16 (1%)			
Min FiO ₂ within First 24 Hours		25.15 (7.65)	25.90 (7.06)	24.90 (7.82)	0.0002
	Missing	50 (4%)			
Max FiO ₂ within First 24 Hours		34.60 (16.62)	35.77 (17.37)	34.20 (16.35)	0.083
	Missing	50 (4%)			
Min FiO ₂ within Last 24 Hours		23.56 (5.14)	24.28 (5.99)	23.31 (4.79)	0.0044
	Missing	27 (2%)			
Max FiO ₂ within Last 24 Hours		27.27 (8.17)	27.87 (7.96)	27.07 (8.24)	0.0253
	Missing	27 (2%)			
Min Systolic Blood Pressure within First 24 Hours		107.4 (18.34)	107.34 (18.77)	107.41 (18.20)	0.9656
	Missing	89 (7%)			
Max Systolic Blood Pressure within First 24 Hours		147.1 (24.77)	146.22 (25.22)	147.39 (24.63)	0.2883
	Missing	89 (7%)			
Min Systolic Blood Pressure within Last 24 Hours		112.6 (16.68)	112.41 (15.00)	112.69 (17.21)	0.9148
	Missing	32 (2%)			
Max Systolic Blood Pressure within Last 24 Hours		141.5 (21.19)	141.15 (20.53)	141.66 (21.42)	0.6365
	Missing	32 (2%)			
Min Diastolic Blood Pressure within First 24 Hours		58.43 (10.68)	58.81 (11.15)	58.30 (10.53)	0.7304
	Missing	89 (7%)			
Max Diastolic Blood Pressure within First 24 Hours		81.48 (13.15)	81.56 (14.27)	81.45 (12.76)	0.5855
	Missing	89 (7%)			
Min Diastolic Blood Pressure within Last 24 Hours		61.47 (9.87)	60.87 (9.75)	61.67 (9.91)	0.2986
	Missing	32 (2%)			
Max Diastolic Blood Pressure within Last 24 Hours		79.3 (11.61)	78.83 (10.87)	79.46 (11.45)	0.4696
	Missing	32 (2%)			

Min Pulse within First 24 Hours		75.98 (14.16)	77.98 (16.01)	75.30 (13.42)	0.0384
	Missing	87 (7%)			
Max Pulse within First 24 Hours		101.6 (18.18)	102.49 (18.72)	101.29 (17.99)	0.3588
	Missing	87 (7%)			
Min Pulse within Last 24 Hours		74.24 (12.87)	75.75 (13.01)	73.74 (12.79)	0.0328
	Missing	32 (2%)			
Max Pulse within Last 24 Hours		90.62 (15.13)	92.41 (15.77)	90.02 (14.87)	0.0262
	Missing	32 (2%)			
Min Temperature within First 24 Hours		96.95 (1.08)	96.98 (1.13)	96.94 (1.06)	0.6308
	Missing	95 (7%)			
Max Temperature within First 24 hours		99.52 (1.62)	99.26 (1.50)	99.61 (1.65)	0.0015
	Missing	95 (7%)			
Min Temperature within Last 24 hours		96.77 (0.89)	96.84 (0.92)	96.75 (0.88)	0.1457
	Missing	35 (3%)			
Max Temperature within Last 24 hours		98.4 (0.85)	98.39 (0.79)	98.40 (0.86)	0.7343
	Missing	35 (3%)			
Min Respiratory Rate within First 24 hours		17.91 (2.20)	18.01 (2.33)	17.87 (2.16)	0.6219
	Missing	92 (7%)			
Max Respiratory Rate within First 24 hours		23.46 (6.75)	23.49 (7.52)	23.45 (6.47)	0.2379
	Missing	92 (7%)			
Min Respiratory Rate within Last 24 hours		18.34 (1.66)	18.29 (1.69)	18.36 (1.65)	0.3614
	Missing	33 (3%)			
Max Respiratory Rate within Last 24 hours		20.46 (3.83)	20.48 (3.37)	20.45 (3.97)	0.8912
	Missing	33 (3%)			
Previous Pneumonia Vaccine					
	Yes	402 (31%)	101 (31%)	301 (32%)	0.8146
	No	878 (68%)	226 (69%)	652 (68%)	
	Missing	15 (1%)			
Min BUN within First 24 hours		21.04 (16.09)	23.39 (17.91)	20.25 (15.35)	0.0039
	Missing	46 (4%)			
Max BUN within First 24 hours		24.19 (17.81)	26.79 (19.74)	23.31 (17.03)	0.0032
	Missing	58 (4%)			
Min BUN within Last 24 hours		19.35 (15.00)	20.98 (16.67)	18.79 (14.34)	0.0338
	Missing	168 (13%)			
Max BUN within Last 24 hours		21.2 (16.47)	23.70 (18.32)	20.35 (15.71)	0.0012
	Missing	168 (13%)			
Min Chloride within First 24 hours		99.68 (5.37)	99.54 (5.14)	99.72 (5.45)	0.3463
	Missing	46 (4%)			
Max Chloride within First 24 hours		102 (5.27)	101.73 (5.34)	102.04 (5.25)	0.1574
	Missing	46 (4%)			
Min Chloride within Last 24 hours		101.7 (5.08)	101.10 (5.68)	101.93 (4.84)	0.0471
	Missing	171 (13%)			
Max Chloride within Last 24 hours		101.9 (5.10)	101.48 (5.74)	102.10 (4.86)	0.1513

	Missing	171 (13%)			
Min Sodium within First 24 hours		135.8 (4.63)	135.79 (4.80)	135.81 (4.58)	0.6908
	Missing	116 (9%)			
Max Sodium within First 24 hours		138 (4.36)	137.88 (4.25)	137.99 (4.40)	0.833
	Missing	45 (3%)			
Min Sodium within First 24 hours		138.1 (3.53)	137.51 (4.06)	138.26 (3.31)	0.0046
	Missing	177 (14%)			
Max Sodium within Last 24 hours		138.3 (3.55)	137.81 (4.10)	138.44 (3.33)	0.0192
	Missing	45 (3%)			
Min Potassium within First 24 hours		3.83 (0.57)	3.88 (0.58)	3.81 (0.56)	0.1082
	Missing	45 (3%)			
Max Potassium within First 24 hours		4.25 (0.77)	4.31 (0.77)	4.24 (0.76)	0.0902
	Missing	50 (4%)			
Min Potassium within Last 24 hours		4.04 (0.50)	4.05 (0.51)	4.04 (0.49)	0.7858
	Missing	168 (13%)			
Max Potassium within Last 24 hours		4.08 (0.52)	4.09 (0.52)	4.07 (0.52)	0.3521
	Missing	170 (13%)			
Min Glucose within First 24 hours		101.9 (32.86)	98.53 (34.68)	103.05 (32.16)	0.033
	Missing	33 (3%)			
Max Glucose within First 24 hours		169.3 (93.02)	175.41 (104.86)	167.25 (88.58)	0.98
	Missing	33 (3%)			
Min Glucose within Last 24 hours		100.4 (31.68)	101.42 (30.74)	100.06 (32.01)	0.1435
	Missing	117 (9%)			
Max Glucose within Last 24 hours		153.3 (89.31)	161.56 (89.80)	150.43 (89.01)	0.0069
	Missing	117 (9%)			
Min Creatinine within First 24 hours		1.47 (1.89)	1.54 (1.70)	1.44 (1.95)	0.01489
	Missing	46 (4%)			
Max Creatinine within First 24 hours		1.66 (2.35)	1.72 (2.12)	1.64 (2.43)	0.3892
	Missing	113 (9%)			
Min Creatinine within Last 24 hours		1.48 (1.80)	1.55 (1.63)	1.46 (1.85)	0.1614
	Missing	170 (13%)			
Max Creatinine within Last 24 hours		1.40 (1.49)	1.52 (1.52)	1.36 (1.48)	0.174
	Missing	190 (15%)			
Min Hemoglobin within First 24 hours		10.60 (2.05)	10.04 (1.93)	10.79 (2.05)	<0.0001
	Missing	76 (6%)			
Max Hemoglobin within First 24 hours		11.37 (2.04)	10.83 (1.87)	11.55 (2.06)	<0.0001
	Missing	76 (6%)			
Min Hemoglobin within Last 24 hours		10.48 (1.85)	9.91 (1.62)	10.67 (1.89)	<0.0001
	Missing	187 (14%)			
Max Hemoglobin within Last 24 hours		10.57 (1.84)	10.00 (1.63)	10.77 (1.87)	<0.0001
	Missing	187 (14%)			
Min Albumin within First 24 hours		3.22 (0.58)	3.10 (0.58)	3.26 (0.57)	0.0002
	Missing	296 (23%)			

Max Albumin within First 24 hours		3.39 (0.59)	3.25 (0.57)	3.43 (0.58)	0.0001
	Missing	296 (23%)			
Min Albumin within Last 24 hours		3.11 (0.54)	3.00 (0.55)	3.15 (0.53)	0.0007
	Missing	559 (43%)			
Max Albumin within Last 24 hours		3.13 (0.53)	3.03 (0.54)	3.17 (0.52)	0.001
	Missing	559 (43%)			
Min MCV within First 24 hours		89.17 (7.23)	89.61 (7.00)	89.03 (7.30)	0.2007
	Missing	88 (7%)			
Max MCV within First 24 hours		89.95 (7.35)	90.39 (7.03)	89.80 (7.45)	0.2102
	Missing	88 (7%)			
Min MCV within Last 24 hours		89.74 (6.97)	90.11 (6.58)	89.62 (7.10)	0.3676
	Missing	189 (15%)			
Max MCV within Last 24 hours		89.88 (6.97)	90.25 (6.54)	89.75 (7.11)	0.3243
	Missing	189 (15%)			
Min INR within First 24 hours		1.32 (0.75)	1.42 (0.85)	1.28 (0.71)	<0.0001
	Missing	403 (31%)			
Max INR within First 24 hours		1.38 (0.88)	1.48 (0.94)	1.35 (0.86)	<0.0001
	Missing	403 (31%)			
Min INR within Last 24 hours		1.38 (0.66)	1.45 (0.63)	1.34 (0.68)	0.0001
	Missing	760 (59%)			
Max INR within Last 24 hours		1.38 (0.68)	1.46 (0.63)	1.35 (0.69)	0.0001
	Missing	760 (59%)			
Min ALT within First 24 hours		33.93 (124.79)	26.21 (22.34)	36.49 (143.38)	0.5241
	Missing	300 (23%)			
Max ALT within First 24 hours		38.42 (163.18)	29.17 (27.00)	41.49 (187.62)	0.4336
	Missing	300 (23%)			
Min ALT within Last 24 hours		35.89 (52.13)	33.89 (36.82)	36.57 (56.45)	0.519
	Missing	572 (44%)			
Max ALT within Last 24 hours		36.2 (52.47)	34.05 (36.77)	36.93 (56.89)	0.5244
	Missing	572 (44%)			
Min AST within first 24 hours		40.96 (207.71)	31.73 (40.86)	44.02 (238.49)	0.7161
	Missing	299 (23%)			
Max AST within First 24 hours		49.01 (262.92)	36.82 (52.74)	53.05 (301.81)	0.6354
	Missing	299 (23%)			
Min AST within Last 24 hours		32.17 (37.58)	32.08 (38.04)	32.20 (37.46)	0.9567
	Missing	572 (44%)			
Max AST within Last 24 hours		35.56 (37.70)	32.31 (37.97)	32.64 (37.64)	0.9027
	Missing	572 (44%)			
Min Total Bilirubin within First 24 hours		0.53 (0.56)	0.51 (0.43)	0.54 (0.60)	0.6029
	Missing	299 (23%)			

Max Total Bilirubin within First 24 hours	0.69 (1.00)	0.64 (0.65)	0.71 (1.09)	0.5147
Missing	299 (23%)			
Min Total Bilirubin within Last 24 hours	0.50 (0.79)	0.50 (0.46)	0.50 (0.88)	0.6527
Missing	571 (44%)			
Max Total Bilirubin within Last 24 hours	0.51 (0.80)	0.51 (0.46)	0.52 (0.88)	0.5064
Missing	571 (44%)			
Allergies to Antibiotics				
Penicillin	227 (18%)	61 (19%)	166 (17%)	0.1539
Other	83 (6%)	28 (8%)	55 (6%)	
None	985 (76%)	241 (73%)	744 (77%)	
Missing	0 (0%)			
All Prior Admissions	8.94 (14.10)	13.11 (20.01)	7.51 (11.05)	<0.0001
Missing	0 (0%)			
Number of Admissions within One Year Prior	3.01 (4.31)	4.76 (5.37)	2.41 (3.70)	<0.0001
Missing	0 (0%)			
Number of Admissions within Six Months Prior	1.84 (2.89)	2.96 (3.12)	1.46 (2.70)	<0.0001
Missing	0 (0%)			

DPP4: Dipeptidyl peptidase-4 Inhibitor

COPD: Chronic Obstructive Pulmonary Disease

O₂: Oxygen

FiO₂: Fraction of inspired oxygen

BUN: Blood urea nitrogen

MCV: Mean corpuscular volume

INR: International normalized ratio of prothrombin time

ALT: Alanine transaminase

AST: Aspartate transaminase