

Supplemental Appendix

Table of contents

Supplemental Table 1 - Comparison Survivors versus Non-survivors.....	2
Supplemental Methods	5
Supplemental Table 2 - Comparison Spring Vs Winter.....	6
Supplemental Table 3 - Initial Laboratory Blood Tests.....	9
Supplemental Table 4 - Therapies Administered during the Admission	11
Supplemental Figure 1 - Distribution of Propensity Score	12

Supplemental Table 1 - Comparison Survivors versus Non-survivors

	Survivors (n=5953)		Non-survivors (n=1437)		p-value
	Sample	Value	Sample	Value	
Demographics					
Age (IQR) - yr	5953	64 (52 - 75)	1437	73 (65 - 82)	<0.001
Male sex - no (%)	5953	2989 (50.2)	1437	846 (58.9)	<0.001
Black race and / or Hispanic ethnicity – no (%)	5953	4472 (75.1)	1437	1013 (70.5)	<0.001
Body Mass Index (IQR) - kg/m ²	5679	28.4 (24.6 - 33.2)	1352	27.9 (23.8 - 32.6)	<0.001
Hospital bed saturation (IQR) - %	5953	94.1 (86.5 - 104.8)	1437	99.3 (87.5 - 107.6)	<0.001
Past Medical History					
Hypertension - no (%)	5953	4365 (73.3)	1437	1169 (81.4)	<0.001
Sleep apnea - no (%)	5953	688 (11.6)	1437	178 (12.4)	0.38
Hyperlipidemia - no (%)	5953	3366 (56.5)	1437	975 (67.8)	<0.001
Atrial fibrillation - no (%)	5953	557 (9.4)	1437	224 (15.6)	<0.001
Chronic kidney disease - no (%)	5953	1559 (26.2)	1437	622 (43.3)	<0.001
Heart failure - no (%)	5953	1181 (19.8)	1437	456 (31.7)	<0.001
Coronary artery disease - no (%)	5953	1653 (27.8)	1437	587 (40.8)	<0.001
Asthma/COPD - no (%)	5953	1842 (30.9)	1437	464 (32.3)	0.32
Diabetes mellitus - no (%)	5953	3168 (53.2)	1437	933 (64.9)	<0.001
Vitals at Presentation					
Temperature (IQR) - F	5926	99 (98 - 100)	1427	99 (98 - 100)	0.35
SBP (IQR) - mmHg	5932	132 (117 - 148)	1430	127 (107 - 146)	<0.001

DBP (IQR) - mmHg	5926	76 (67 - 85)	1428	71 (60 - 81)	<0.001
HR (IQR) – bpm	5927	96 (83 - 110)	1429	100 (85 - 114)	<0.001
Oxygen saturation (IQR) - %	5922	96 (93 - 98)	1430	92 (84 - 96)	<0.001
Respiratory Rate (IQR) - bpm	5928	19 (18 - 21)	1428	22 (19 - 26)	<0.001
Laboratory Markers					
Hemoglobin (IQR) - g/dL	5823	12.9 (11.4 - 14.1)	1408	12.6 (10.9 - 14.2)	0.006
Platelet count (IQR) -k/ μ L	5825	198 (137 - 264)	1408	172 (88 - 246)	<0.001
White blood cell count (IQR) - k/ μ L	5823	6.9 (5.1 - 9.5)	1408	8.3 (6.0 - 11.9)	<0.001
Absolute lymphocyte count (IQR) - k/ μ L	5880	1.1 (0.7 - 1.5)	1423	0.9 (0.6 - 1.2)	<0.001
Sodium (IQR) – mEq/L	5879	137 (134 - 140)	1428	138 (134 - 143)	<0.001
Potassium (IQR) – mEq/L	5845	4.2 (3.8 - 4.6)	1426	4.4 (4.0 – 5.0)	<0.001
Chloride (IQR) – mEq/L	5864	100 (96 - 103)	1423	100 (95 - 104)	0.28
Bicarbonates (IQR) – mEq/L	5879	24 (21 - 27)	1428	22 (18 - 25)	<0.001
Creatinine (IQR) - mg/dL	5876	1.0 (0.8 - 1.5)	1427	1.6 (1 - 2.9)	<0.001
Glucose (IQR) - mg/dL	5879	126 (104 - 179)	1428	156 (121 - 236)	<0.001
Aspartate aminotransferase (IQR) - U/L	5416	35 (24 - 55)	1312	52 (33 - 81)	<0.001
Alanine aminotransferase (IQR) - U/L	5614	26 (16 - 42)	1376	28 (18 - 46)	<0.001
Lactic acid (IQR) – mmol/L	5097	1.9 (1.4 - 2.6)	1347	2.6 (1.8 - 3.9)	<0.001
Lactate dehydrogenase (IQR) - mmol/L	4017	384 \pm 219	926	518 (371 - 706)	<0.001
Creatine Kinase (IQR) – U/L	4714	336 (253 - 454)	1218	777 \pm 2657	<0.001
D-dimer (IQR) - μ g/mL	3850	1.2 (0.7 - 2.5)	763	2.5 (1.3 - 6.9)	<0.001
Procalcitonin (IQR) – ng/mL	2800	0.1 (0.1 - 0.3)	615	0.6 (0.2 - 2.4)	<0.001
Troponin T* (IQR) - ng/mL	2365	0.01 (0.01 - 0.03)	302	0.03 (0.01 - 0.1)	<0.001
Troponin I* (IQR) – ng/mL	2684	0.01 (0.01 – 0.02)	981	0.02 (0.01 - 0.08)	<0.001

Interleukin-6 (IQR) – pg/mL	1752	17 (6 - 40)	287	68 (26- 154)	<0.001
Fibrinogen (IQR) – mg/dL	2478	570 (448 - 690)	460	621 (506 - 761)	<0.001
Ferritin (IQR) – ng/mL	3395	521 (224 - 1112)	659	1021 (514 - 2161)	<0.001

COPD = Chronic obstructive pulmonary disease; DBP = Diastolic blood pressure; HR = Heart rate; IQR = Interquartile range; SBP = Systolic blood pressure. * Troponin T was available only until June 2020, Troponin I was available only after June 2020.

Supplemental Methods

Covariate Selection Method for Multivariable Competing Risk Proportional Hazard Models for in-hospital Death between Patients Spring and Winter Patients

The covariates in the multivariable analyses included factors present in > 90% of our dataset, are known to be associated with in-hospital COVID-19 mortality based on prior literature or with a univariate association between admission season (exposure) or in-hospital mortality (outcome) ($p < 0.05$) and a clinical (relative difference >5%) difference between the spring and winter patients (**Supplemental Table 2**). These variables included: age, sex, BMI, vital signs at presentation, white cell count, creatinine, glucose, alanine transaminase, history of hypertension, dyslipidemia, chronic kidney disease (CKD), heart failure, coronary artery disease, asthma/chronic obstructive pulmonary disease, diabetes mellitus and statin use. Also in this model, lactic acid level and percent of hospital bed saturation were forced into the model as marker of illness severity and level of hospital stress, respectively.

Supplemental Table 2 - Comparison Spring Vs Winter

	Spring (n=4495)		Winter (n=2254)		P-value
	Sample	Value	Sample	Value	
Demographics					
Age (IQR) - yr	4495	66 (55 - 77)	2254	67 (56 - 77)	0.051
Male sex - no (%)	4495	2377 (52.9)	2254	1122 (49.8)	0.016
Black race and / or Hispanic ethnicity - no (%)	4495	3345 (74.4)	2254	1635 (72.5)	0.098
Body Mass Index (IQR) - kg/m ²	4229	28.4 (24.6 - 33)	2194	28.2 (24.4 - 33.1)	0.433
Hospital bed saturation (IQR) - %	4495	97.4 (86.5 - 107.6)	2254	95.3 (91.9 - 101.8)	<0.001
Past Medical History					
Hypertension - no (%)	4495	3370 (75)	2254	1713 (76)	0.357
Sleep apnea - no (%)	4495	521 (11.6)	2254	270 (12)	0.640
Hyperlipidemia - no (%)	4495	2609 (58)	2254	1380 (61.2)	0.012
Atrial fibrillation - no (%)	4495	449 (10)	2254	267 (11.8)	0.019
Chronic kidney disease - no (%)	4495	1406 (31.3)	2254	620 (27.5)	0.001
Heart failure - no (%)	4495	980 (21.8)	2254	519 (23)	0.254
Coronary artery disease - no (%)	4495	1316 (29.3)	2254	721 (32)	0.022
Asthma/COPD - no (%)	4495	1371 (30.5)	2254	753 (33.4)	0.015
Diabetes mellitus - no (%)	4495	2522 (56.1)	2254	1244 (55.2)	0.475
Vitals at Presentation					
Temperature (IQR) - F	4463	98.9 (98.2 - 100)	2254	98.7 (98.1 - 99.8)	<0.001
SBP (IQR) - mmHg	4469	131 (114 - 148)	2254	132 (117 - 148)	0.002
DBP (IQR) - mmHg	4465	75 (65 - 84)	2252	75 (67 - 84)	0.117
HR (IQR) - bpm	4467	98 (85 - 112)	2253	95 (82 - 107)	<0.001

Oxygen saturation (IQR) - %	4463	95 (91 - 98)	2253	96 (92 - 98)	<0.001
Respiratory Rate (IQR) - bpm	4466	20 (18 - 22)	2254	19 (18 - 22)	<0.001
Laboratory Markers					
Hemoglobin (IQR) - g/dL	4372	12.8 (11.2 - 14.1)	2228	12.9 (11.5 - 14.2)	0.030
Platelet count (IQR) -k/ μ L	4372	188 (116 - 260)	2228	196 (143 - 259)	<0.001
White blood cell count (IQR) - k/ μ L	4372	7.5 (5.6 - 10.6)	2228	6.4 (4.7 - 8.8)	<0.001
Absolute lymphocyte count (IQR) - k/ μ L	4420	1 (0.7 - 1.4)	2246	1 (0.7 - 1.4)	0.062
Sodium (IQR) – mEq/L	4414	137 (134 - 141)	2253	137 (134 - 140)	<0.001
Potassium (IQR) – mEq/L	4389	4.3 (3.9 - 4.8)	2243	4.1 (3.8 - 4.5)	<0.001
Chloride (IQR) – mEq/L	4394	98 (95 - 103)	2253	101 (98 - 104)	<0.001
Bicarbonates (IQR) – mEq/L	4414	24 (20 - 26)	2253	24 (21 - 27)	<0.001
Creatinine (IQR) - mg/dL	4410	1.1 (0.8 - 2)	2253	1.1 (0.8 - 1.5)	<0.001
Glucose (IQR) - mg/dL	4414	134 (108 - 197)	2253	126 (104 - 184)	<0.001
Aspartate aminotransferase (IQR) - U/L	4045	40 (27 - 65)	2084	35 (24 - 55)	<0.001
Alanine aminotransferase (IQR) - U/L	4206	27 (17 - 44)	2171	26 (17 - 44)	0.292
Lactic acid (IQR) – mmol/L	3981	2.1 (1.6 - 3)	1913	1.9 (1.4 - 2.5)	<0.001
Lactate dehydrogenase (IQR) - mmol/L	2935	384 (285 - 535)	1563	341 (254 - 468)	<0.001
Creatine Kinase (IQR) – U/L	3453	168 (83 - 401)	1957	126 (67 - 282)	<0.001
D-dimer (IQR) - μ g/mL	2204	1.8 (0.9 - 3.9)	1907	1.2 (0.7 - 2.3)	<0.001
Procalcitonin (IQR) – ng/mL	1789	0.2 (0.1 - 0.9)	1252	0.1 (0.1 - 0.3)	<0.001
Troponin T* (IQR) - ng/mL	0	NA	2106	0.01 (0.01 - 0.03)	NA
Troponin I* (IQR) – ng/mL	3662	0.01 (0.01 - 0.03)	0	NA	NA
Interleukin-6 (IQR) – pg/mL	1056	34 (14 - 75)	710	11 (4 - 26)	<0.001
Fibrinogen (IQR) – mg/dL	1552	624 (491 - 750)	1040	536 (434 - 652)	<0.001

Ferritin (IQR) – ng/mL	1969	716 (335 - 1498)	1637	510 (230 - 1094)	<0.001
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COPD = Chronic obstructive pulmonary disease; DBP = Diastolic blood pressure; HR = Heart rate; IQR = Interquartile range; SBP = Systolic blood pressure. * Troponin T was available only until June 2020, Troponin I was available only after June 2020.

Supplemental Table 3 - Initial Laboratory Blood Tests

	Spring (n=4495)	Summer (n=264)	Fall (n=377)	Winter (n=2254)
Hemoglobin (IQR) - g/dL	12.8 (11.2 - 14.1)	12.4 (10.7 - 13.9)	13 (11.6 - 14.3)	12.9 (11.5 - 14.2)
Platelet count (IQR) - k/ μ L	188 (116 - 260)	228 (169 - 300)	200 (144 - 257)	196 (143 - 259)
White blood cell count (IQR) - k/ μ L	7.5 (5.6 - 10.6)	8 (5.8 - 11)	6.6 (5.1 - 8.9)	6.4 (4.7 - 8.8)
Absolute lymphocyte count (IQR) - k/ μ L	1 (0.7 - 1.4)	1.2 (0.9 - 1.8)	1.1 (0.8 - 1.5)	1 (0.7 - 1.4)
Sodium (IQR) – mEq/L	137 (134 - 141)	138 (135 - 141)	137 (135 - 140)	137 (134 - 140)
Potassium (IQR) – mEq/L	4.3 (3.9 - 4.8)	4.2 (3.8 - 4.6)	4 (3.8 - 4.4)	4.1 (3.8 - 4.5)
Chloride (IQR) – mEq/L	98 (95 - 103)	103 (100 - 105)	101 (99 - 104)	101 (98 - 104)
Bicarbonates (IQR) – mEq/L	24 (20 - 26)	24 (21 - 27)	25 (22 - 27)	24 (21 - 27)
Creatinine (IQR) - mg/dL	1.1 (0.8 - 2)	1 (0.8 - 1.5)	1 (0.8 - 1.3)	1.1 (0.8 - 1.5)
Glucose (IQR) - mg/dL	134 (108 - 197)	121 (100 - 171)	122 (102 - 173)	126 (104 - 184)
Aspartate aminotransferase (IQR) - U/L	40 (27 - 65)	26 (20 - 38)	31 (21 - 47)	35 (24 - 55)
Alanine aminotransferase (IQR) - U/L	27 (17 - 44)	21 (14 - 32)	25 (16 - 41)	26 (17 - 44)
Lactic acid (IQR) – mmol/L	2.1 (1.6 - 3)	1.9 (1.4 - 2.7)	1.8 (1.3 - 2.5)	1.9 (1.4 - 2.5)
Lactate dehydrogenase (IQR) - mmol/L	384 (285 - 535)	254.5 (196 - 340)	300 (225 - 383)	341 (254 - 468)
Creatine Kinase (IQR) – U/L	168 (83 - 401)	97 (57 - 176)	116 (60 - 213)	126 (67 - 282)
D-dimer (IQR) - μ g/mL	1.8 (0.9 - 3.9)	1.1 (0.5 - 2.2)	0.8 (0.5 - 1.6)	1.2 (0.7 - 2.3)
Procalcitonin (IQR) – ng/mL	0.2 (0.1 - 0.9)	0.1 (0.1 - 0.4)	0.1 (0.1 - 0.2)	0.1 (0.1 - 0.3)
Troponin T* (IQR) - ng/mL	NA	0.01 (0.01 - 0.03)	0.01 (0.01 - 0.02)	0.01 (0.01 - 0.03)
Troponin I* (IQR) – ng/mL	0.01 (0.01 - 0.03)	0.01 (0.01 - 0.01)	NA	NA
Interleukin-6 (IQR) – pg/mL	33.6 (13.8 - 75.2)	11.7 (3 - 43.1)	11 (4.7 - 22.2)	10.8 (4.3 - 25.6)
Fibrinogen (IQR) – mg/dL	624 (491 - 750)	448 (370 - 583)	540 (436 - 663)	535.5 (434 - 652)

Ferritin (IQR) – ng/mL	716 (335 - 1498)	228 (90 - 562)	364 (166 - 785)	510 (230 - 1094)
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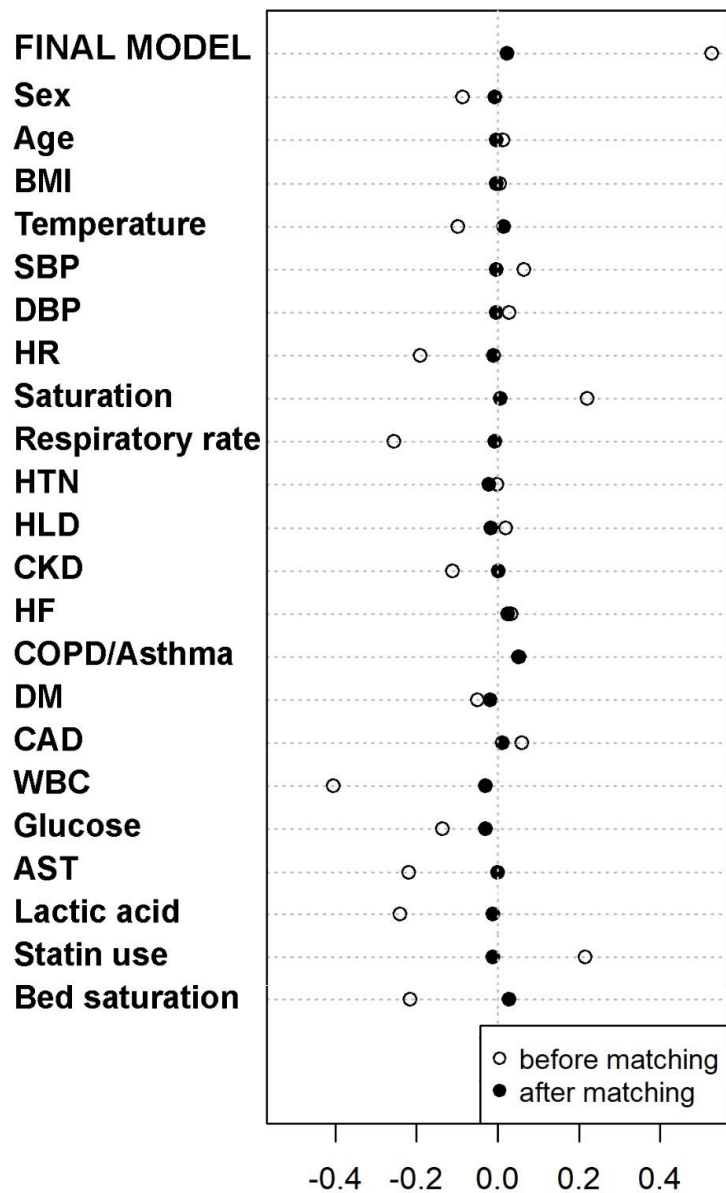
IQR = Interquartile range. * Troponin T was available only until June 2020, Troponin I was available only after June 2020

Supplemental Table 4 - Therapies Administered during the Admission

	Spring (n=4495)	Summer (n=264)	Fall (n=377)	Winter (n=2254)
Hydroxychloroquine - no (%)	3007 (66.9)	1 (0.4)	2 (0.5)	8 (0.4)
Azithromycin - no (%)	1322 (29.4)	51 (19.3)	118 (31.3)	374 (16.6)
Other antibiotics - no (%)	3382 (75.2)	160 (60.6)	214 (56.8)	1082 (48)
Steroids - no (%)	1485 (33)	71 (26.9)	195 (51.7)	1462 (64.9)
Angiotensin-converting-enzyme Inhibitors - no (%)	318 (7.1)	36 (13.6)	51 (13.5)	269 (11.9)
Angiotensin II receptor blockers - no (%)	264 (5.9)	23 (8.7)	32 (8.5)	212 (9.4)
Statin - no (%)	1478 (32.9)	109 (41.3)	129 (34.2)	1002 (44.5)
Therapeutic anticoagulation - no (%)	1041/4496 (31.2)	76 (28.8)	98 (26.0)	772 (34.3)
Remdesivir* - no (%)	78 (1.7)	37 (14)	134 (35.5)	1224 (54.3)
Lopinavir/Ritonavir – no (%)	40 (0.9)	0 (0)	0 (0)	0 (0)
Ivermectin – no (%)	11 (0.2)	1 (0.4)	0 (0)	34 (1.5)

* 45 patients listed as remdesivir recipients in the spring season were part of a 1:1 double-blind, placebo-controlled study. Instead, all the patients in summer, fall, and winter seasons listed as remdesivir recipients received the actual medication.

Supplemental Figure 1 - Distribution of Propensity Score



AST = aspartate transaminase; BMI= body mass index; CAD= coronary artery disease; COPD = chronic obstructive pulmonary disease; CKD = chronic kidney disease; DBP= diastolic blood pressure; DM = Diabetes mellitus; HF= heart failure; HLD = hyperlipidemia; HNT = hypertension; HR = heart rate; SBP = systolic blood pressure; WBC = white blood cell count