Relationship Between Patient Characteristics and Critical Illness in Patients Admitted for CoVID-19

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Abstract

Background
While several studies have explored hospitalization risk factors with the novel coronavirus (COVID-19) infection, the risk of poor outcomes during hospitalization has primarily relied upon laboratory or hospital-acquired data. Our goal was to identify clinical characteristics associated with intubation or death within 7 days of admission.
Methods
The first 436 patients admitted to the University of Colorado Hospital (Denver metropolitan area) with confirmed CoVID-19 were included. Demographics, comorbidities, and select medications were collected by chart abstraction. Missing height for calculating body mass index (BMI) was imputed using the median height for patients' sex and race/ethnicity. Adjusted odds ratios (aOR) were estimated using multivariable logistic regression and a minimax concave penalty (MCP) regularized logistic regression explored prediction.
Results
Participants had a mean(SD) age 55(17), BMI 30.9(8.2), 55% were male and 80% were ethnic/racial minorities. Unadjusted comparisons by outcome are shown (Table 1). Male sex (aOR: 1.60, 95% CI (1.02, 2.54)), increasing age (aOR: 1.25(1.08, 1.47); per 10 years), higher BMI (aOR 1.03(1.00, 1.06) and poorly controlled diabetes (hemoglobin A1C ≥8) (aOR 2.33(1.27, 4.27) were significantly ($p < 0.05$) associated with greater odds of intubation or death. Minority status tended to be associated with higher odds (aOR:1.8(1.01,3.36); p=0.052). Surprisingly, need for hospital interpreter was associated with decreased odds (OR: 0.58(0.35, 0.95)) of intubation/death. Our final MCP model included indicators of A1C≥8, age >65, sex and minority status, but predicted intubation/death only slightly better than random chance (AUC= 0.61(0.56, 0.67)).
Conclusion
In a hospitalized patient cohort with COVID-19, male sex, poorly controlled diabetes, increasing age and BMI were significantly associated with early intubation or death. These results complement larger cohort studies and highlight risk differences across metropolitan areas with varying COVID-19 prevalence, demographics, and comorbid disease burden. Notably, our predictive model had limited success, which may suggest unmeasured factors also contribute to disease severity differences.

Background

- Previous studies have explored risk factors for critical illness in CoVID-19.
- Most predictive modeling of CoVID-19 critical illness relied on hospital-acquired data (such as laboratory values or imaging) and variable definitions of "critical" or "severe".
- Populations at highest risk for severe disease, such as institutionalized individuals, may not have this data available.
- The goal of this study was to identify risk factors from readily available clinical or demographic factors to create a predictive model for critical illness.

Methods

- We completed a retrospective chart review of the first 436 consecutive patients with a positive CoVID-19 PCR, requiring admission to the University of Colorado.
- Variables were stratified based on intubation or death within one week of admission as the primary outcome.
- Categorical and continuous variables were compared using chi-square tests or t-tests, respectively.
- Regression model was used to explore associations between primary outcome and predictors, which included age, body mass index (BMI), gender/sex, racial/ethnic minority, non-type 2 diabetes mellitus (DM2) vs DM2 w/A1c <8 vs DM2 w/A1c ≥8, cardiovascular disease, current/former smoker, hypertension, and need for hospital interpreter (proxy for non-English speaking).
- Minimax concave penalty regularized logistic regression was used to build a predictive model using the above variables.

Results

Table 1: Selected Baseline Demographics and Stratified Demographics by Intubation and/or Death within 1 Week

Clinical Characteristics	Overall (N=436)	Not Intubated/Alive (N=308)	Intubated/Dead (N=128)	P-value
Age*, mean (SD)	55.42 (17.30)	54.50 (17.46)	57.65 (16.76)	0.083
Female, (%)	198 (45.4)	146 (47.4)	52 (40.6)	0.235
Racial/Ethnic Minority, (%)	348 79.8)	242 (78.6)	106 (82.8)	0.382
Current/Former Smoker, (%)	110 (25.2)	82 (26.6)	28 (21.9)	0.358
Unknown, (%)	12 (3.0)	6 (1.9)	7 (5.5)	
Alcohol Use, (%)	103 (23.6)	75 (24.4)	28 (21.9)	0.667
Unknown, (%)	47 (10.8)	25 (8.1)	22 (17.2)	
Marijuana Use, (%)	21 (4.8)	16 (5.2)	5 (3.9)	0.744
Unknown, (%)	64 (14.7)	40 (13.0)	24 (18.8)	
BMI*, mean (SD)	31.14 (8.40)	30.76 (7.98)	31.98 (9.24)	0.180
Hypertension, (%)	208 (47.7)	147 (47.7)	61 (47.7)	1.000
Respiratory Disease, (%)	97 (22.2)	70 (22.7)	27 (21.2)	0.805
Hyperlipidemia, (%)	88 (20.2)	62 (20.1)	26 (20.3)	1.000
Cardiovascular Disease, (%)	65 (14.9)	41 (13.3)	24 (18.8)	0.192
AI Disease, Cancer, or IS, (%)	50 (11.5)	33 (10.7)	17 (13.3)	0.548
Chronic Kidney Disease, (%)	25 (5.7)	16 (5.2)	9 (7.0)	0.600
Type 2 Diabetes, (%)	142 (32.6)	93 (30.2)	49 (38.3)	0.126
Most Recent Hemoglobin A1c (Diabetics only) *, median [IQR]	7.70 [6.70, 10.10]	7.50 [6.50, 9.50]	8.50 [7.30, 10.50]	**0.022**
ARB/ACE-I Use, (%)	111 (25.5)	73 (23.7)	38 (29.7)	0.236
Chronic Steroid Use, (%)	17 (3.9)	10 (3.2)	7 (5.5)	0.403
Statin Use, (%)	116 (26.8)	75 (24.4)	41 (32.5)	0.107
Days Hospitalized*, median [IQR]	6.00 [3.00, 12.00]	5.00 [2.00, 8.00]	15.50 [8.25, 28.75]	**<0.001**
Intubated, (%)	126 (28.9)	6 (1.9)	120 (93.8)	**<0.001**
Days Intubated*, median [IQR]	10.00 [6.00, 18.50]	10.00 [6.00, 11.00]	10.00 [6.00, 20.00]	0.552
Death within One Week, (%)	23 (5.3)	0 (0.0)	23 (18.0)	**<0.001**
Death, (%)	47 (10.8)	7 (2.3)	40 (31.2)	**<0.001**

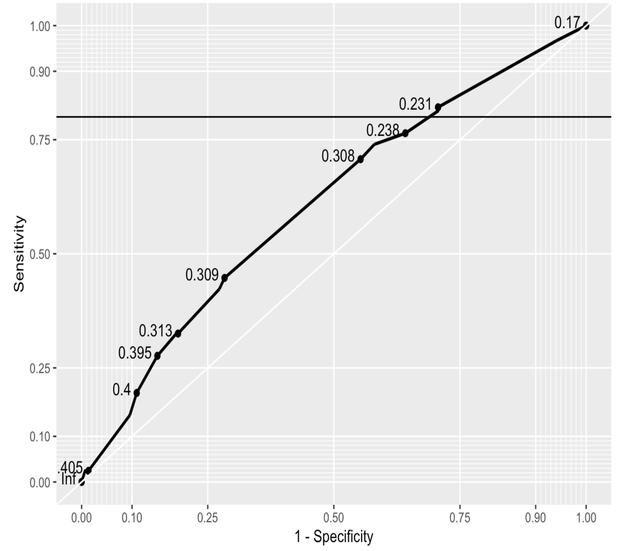
Abbreviations: SD: Standard Deviation, BMI: Body Mass Index, AI: Autoimmune, IS: Immunosuppression, ARB: Angiotensin Receptor Blocker, ACE-i: Angiotensin Converting Enzyme Inhibitor, IQR: Interquartile Range
Key: Variables marked with * were analyzed as continuous variables with T-Tests, variables marked with ^ were analyzed with Mann-Whitney U Test, while all other variables were analyzed as categorical variables.

Table 2: Multivariable Logistic Regression of Odds of Intubation/Death within 1 Week

Variable	OR	95% CI	p-value
Age, per decade	1.26	(1.08, 1.47)	**0.004**
BMI, per 1kg/m²	1.03	(1.00, 1.06)	**0.033**
Racial/Ethnic Minority	1.82	(1.01, 3.36)	0.052
DM2 with an A1c ≥8 vs non-diabetic	2.32	(1.26, 4.25)	**0.006**
Male sex	1.61	(1.02, 2.56)	**0.04**

Results

Figure 1: ROC of Predictive Model for Intubation and/or Death within 1 Week (AUC = 0.6071)



Conclusions

- Although many factors appeared to be increased amongst the primary outcome group in univariable analysis, only age, higher BMI, DM, and male sex were associated with the primary outcome in multivariable analysis.
- Multivariable analysis showed hemoglobin A1c ≥8 with an OR of 2.3 (95% CI 1.3, 4.3) as compared to non-diabetics for the primary outcome as the strongest positive relationship.
- Our predictive model had minimal predictive ability for the outcome with an AUC of 0.6071 [0.56, 0.67].
- Our results compliment other studies addressing risk for critical illness in CoVID-19 patients.
- Previously, A1c has been linked to hospitalization rates of CoVID-19 but this is the first direct link between previous A1c and critical illness in CoVID-19.
- The limited success of our predictive model illustrates the need for further research into easily obtainable risk factor for critical illness in CoVID-19.
- Next steps include investigation into additive or multiplicative effect of multiple comorbidities on predicting critical illness