Predicting clinical outcome of Covid19 patients based on haematological admission data

Anuja Rasarathnam[1], WS Wassif[1], Terrence Haynes-Smith[1], Michael S Dodd[2]

1. Bedford Hospital, Bedfordshire Hospitals NHS Foundation Trust

2. Centre for Sport, Exercise and Life Sciences, Institute of Health and Wellbeing, Coventry University

Aim

To determine if intensive care status and mortality due to Covid19 could be predicted based on initial admission haematological and biochemical markers. Aiming to improve stratification of cases admitted to hospital with Covid19

Introduction

As of September 2021, the World Health Organisation (WHO) has reported 226,236,577 confirmed cases of Sars-Cov-2 and 4,654,548 confirmed deaths worldwide. On 31st of December 2019, Wuhan Municipal Health Commission, China, reported a cluster of pneumonia cases of unknown aetiology to the WHO (Fan et al, 2020). WHO announced the viral disease caused by SARS-CoV-2 would be named as coronavirus disease 2019 (Covid19). Whilst clinical presentation of Covid19 varies, most common symptoms are fever, dry cough, shortness of breath, dyspnoea, loss of smell or taste, fatigue, muscle pain and pneumonia.

Methodology

The haematology and biochemical results for Sars-Cov-2 positive patients (based on PCR test) were extracted from Bedford Hospital's database (ICE). Following initial exclusion criteria, 157 patients were included in this study, from admissions between 21st March 2020 and 19th July 2020, these were split into four groups: Non-ITU – Survived (50), Non-ITU – Passed away (50), ITU – Survived (26) and ITU – Passed away (32). Analysis was performed using these groups, to either look at survival or if a patient would be admitted to ITU.

The following analytes and results were extracted from the ICE database: Platelets, Mean Corpuscular Haemoglobin Concentration (MCHC), Lymphocyte, Neutrophils, Neutrophil to Lymphocyte Ratio (NLR), Activated Partial Thromboplastin Time (APTT), Prothrombin Time, C-Reactive Protein (CRP), Adjusted Calcium, Albumin, Alanine Aminotransferase (ALT), Alkaline Phosphatase (ALP), Urea, Glucose, Total Bilirubin, Potassium, Sodium, Creatinine

Univariate and multivariate logistic analysis (Graphpad Prism 9) was performed on admission results to generate a model and determine whether individual or combination of analytes were able to predict either ITU admission or mortality. Analytes from the univariate analysis which had a p value < 0.1, were used in the multivariate logistic regression analysis. ROC analysis was performed and area under the curve (AUC), positive predictive and negative predictive power calculated. Both Hosmer-Lemeshow and Log-likelihood ratio (G squared) were used to assess goodness of fit for the logistic regression models used here.

	Non-ITU						ITU					
	Survived			Passed away			Survived			Passed away		
	Median	LQR	UQR	Median	LQR	UQR	Median	LQR	UQR	Median	LQR	UQR
Age	76	62.75	82.25	82	74.75	90.25	60	51	66.5	65	59	75.5
Platelets	229.5	161.25	305.25	210.5	163.5	319.5	217	157	304.75	219.5	189.75	292
MCHC	360	341.5	373	349	338	357.25	357	343	366.5	357	344	364
Lymphocyte	1.10	0.70	1.40	0.80	0.58	1.22	0.90	0.68	1.20	1.00	0.60	1.30
Neutrophils	6.35	3.88	8.93	7.75	4.68	11.40	7.80	4.65	13.10	7.35	4.65	10.88
NLR	6.24	3.50	8.72	10.92	5.63	16.96	8.22	5.72	16.07	8.51	5.15	12.31
APTT	28	25	32	29.5	26.75	36.25	26	23.75	31	29	25.75	33
Prothrombin Time	12	11	14	12	11.75	15	12	11	13	11.5	11	13.25
CRP	62.00	17.75	155.75	81.00	48.75	126.50	81.00	49.20	172.50	131.00	47.25	241.50
Adjusted Calcium	2.30	2.17	2.39	2.31	2.25	2.38	2.26	2.15	2.42	2.23	2.16	2.33
Albumin	34.00	29.75	39.00	30.00	27.75	35.00	36.50	32.75	40.50	37.00	33.25	40.00
ALT	24	15	39	24	13	34	42.00	26.50	59.50	26.5	17	51.25
ALP	73.00	51.25	93.25	97.50	72.00	138.25	82.00	59.00	138.00	79.00	61.50	116.50
Urea	5.65	3.65	9.13	8.15	4.90	12.10	7.40	5.40	13.00	6.40	5.15	12.10
Glucose	6.30	4.98	7.78	6.90	5.60	8.70	8.10	5.80	11.70	6.80	6.00	10.50
Total Bilirubin	9.00	7.00	13.00	10.00	6.00	14.00	11.50	7.75	14.00	8.00	6.00	14.75
Potassium	4.0	3.58	4.30	4.0	3.70	4.63	4.3	3.75	4.55	4.1	3.90	4.45
Sodium	137.5	135.00	140.00	140.0	136.75	143.00	137.5	134.00	141.00	136.0	133.25	138.75
Creatinine	81.50	72.00	98.50	94.00	70.50	128.00	88.50	68.75	120.75	96.50	78.00	122.25

Table 1: Median, lower and upper quantile range for all the analytes measured in this study.

Modelling survival on admission data

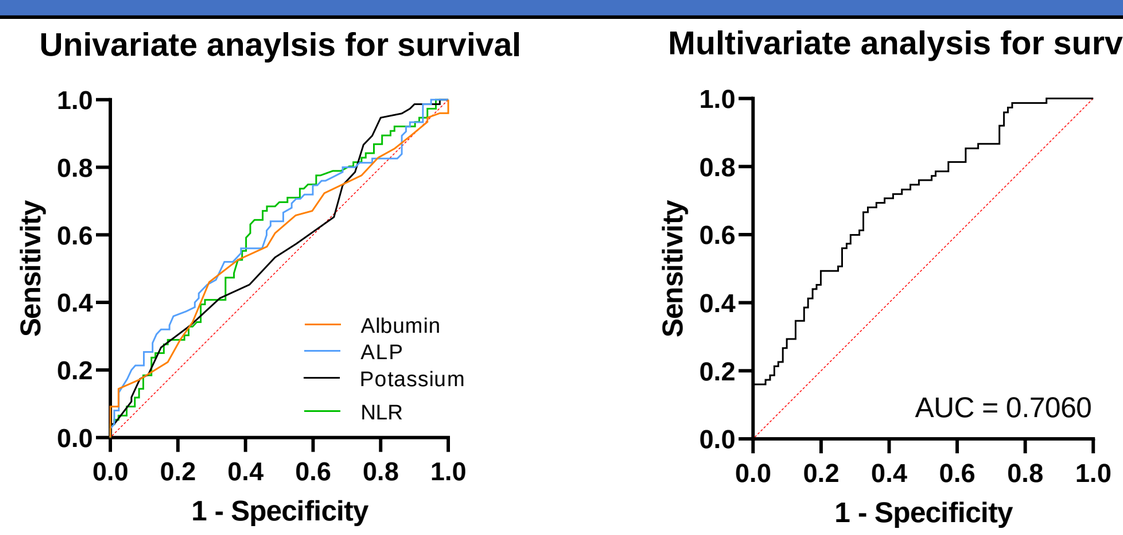

Figure 1: A) Univariate logistic regression analysis was performed to distinguish survival status independent of ITU status. It was revealed that age [Odds ratio (OR) 0.9624 (95% CI: 0.9389 to 0.9849) P < 0.001], NLR [0.958 (0.9143 to 0.9966), p <0.05], ALP [0.9953 (0.9896 to 0.9996) p<0.05] and potassium [0.5711 (0.3215 to 0.9723)] were significantly associated with increased survival (Table 3). Using analytes from the univariate analysis which had a p value < 0.1, we were able to generate a model of survival using multivariate logistic regression analysis. B) The area under the ROC curve was 0.706 +/- 0.04117 (p < 0.001), the model had a negative predictive power 66.67% and positive predicative power 64.86%. This analysis further revealed that hyperkaliaemia, along with being an older male, raised NLR and ALP, whist lower albumin were linked to decreased survival.

Modelling ITU status on admission data

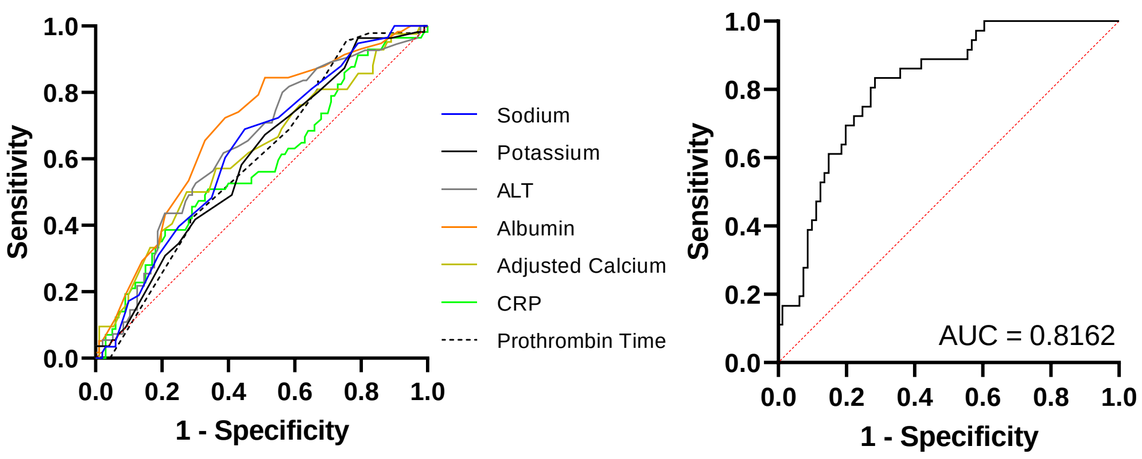

Figure 2: Assessing whether admission data could predict whether a patient went to ITU or not. A) Univariate logistic analysis revealed that age [0.9205 (0.8911 to 0.9475) p<0.001], adjusted calcium [0.04211 (0.002024 to 0.6830) p<0.05], Albumin [1.127 (1.061 to 1.203) p<0.001], potassium [1.776 (1.034 to 3.165) p<0.05] and sodium [0.9223 (0.8603 to 0.9830) p<0.05] were significantly associated with being in ITU. B) The area under the ROC was 0.8169 +/- 0.0403 (p<0.001 – Figure 2) with a negative predictive power 63.33% and a positive predictive value 80.46%. This analysis again revealed that being male increased your chances of being in ITU, but that ITU was associated with younger patients. Increased albumin and potassium, whilst decrease in prothrombin time, adjusted calcium, ALT and sodium were associated with a greater risk of being admitted to ITU.

Conclusion

In this retrospective study we have used Initial admission data to model the risk of death or ITU admission. We have demonstrated that older males, who were hyperkalaemic, with elevated NLR and ALP were at great risk of death from Covid19. Furthermore the need for ITU admission was well predicted by measuring prothrombin time, CRP, adjusted calcium, albumin, ALT potassium and sodium and correcting for age and sex. The hope that with these initial markers, that additional clinical assessments, such as O_2 saturation would provide much more robust models for the risk of death and the need for ITU in patients with Covid19.

Reference

Fan et al 2020 doi: 10.1007/s42058-020-00031-5