Haematological and biochemical pathology markers for predictive model for ITU admission and death from COVID 19 – A retrospective study in Bedford Hospital NHS Trust

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BACKGROUND

Coronavirus disease (COVID-19) is caused by SARS-CoV-2 is currently a pandemic affecting over 200 countries. 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 (COVID-19). Whilst clinical presentation of COVID-19 varies, most common symptoms are fever, dry cough, shortness of breath, dyspnoea, loss of smell or taste, fatigue, muscle pain and pneumonia. Changes in haematological characteristics in patients with COVID-19 are emerging as important features of the disease.

AIM

To determine if intensive care status and mortality due to COVID-19 could be predicted based on initial admission haematological and biochemical markers. Aiming to improve stratification of cases admitted to hospital with COVID-19.

METHODOLOGY

According to the interim guidance from WHO, patients' throat swab is tested using real-time reverse transcriptase-polymerase chain reaction, which detects the presence of SARS-CoV-2 RNA, are classed as COVID-19 positive (World Health Organization, 2020). The haematology and biochemical results for SARS-CoV-2 positive patients were extracted from Bedford Hospital's database (ICE). All patients who were included in the study had a positive swab results on admission to Accident and Emergency. 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. 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.

RESULTS

Modelling survival on admission data

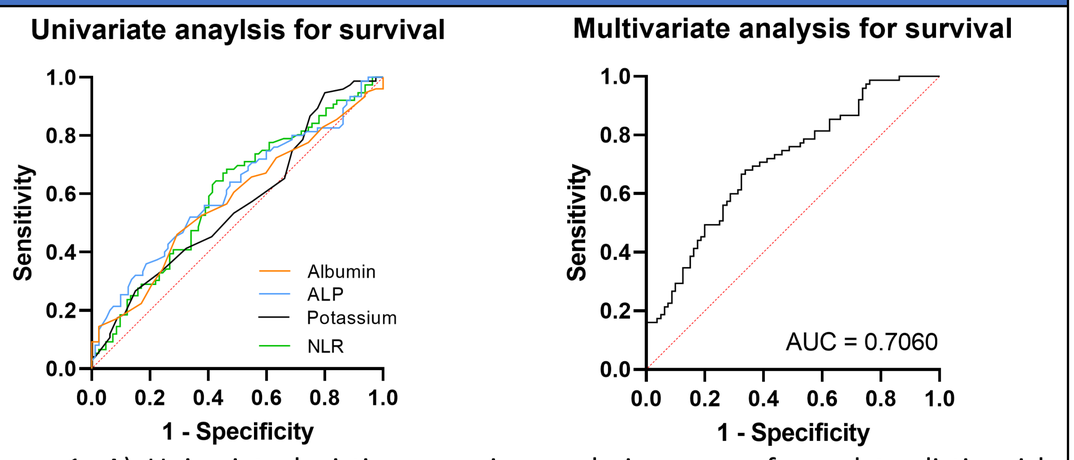

Figure 1: A) Univariate logistic regression analysis was performed to distinguish survival status independent of ITU status. It was revealed that age [Odds ratio (OR) 0.9624 (95% CI: 0.9389 to 0.9849) P < 0.001], NLR [0.958 (0.9143 to 0.9966), p <0.05], ALP [0.9953 (0.9896 to 0.9996) p<0.05] and potassium [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

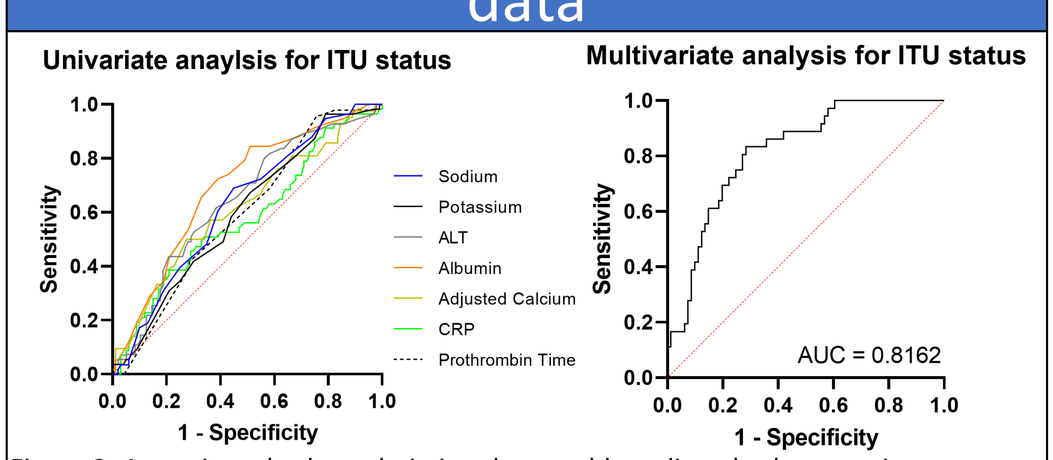

Figure 2: Assessing whether admission data could predict whether a patient went to ITU or not. A) Univariate logistic analysis revealed that age [0.9205 (0.8911 to 0.9475) p<0.001], adjusted calcium [0.04211 (0.002024 to 0.6830) p<0.05], Albumin [1.127 (1.061 to 1.203) p<0.001], potassium [1.776 (1.034 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 O2 saturation would provide much more robust models for the risk of death and the need for ITU in patients with COVID-19.

REFERENCES

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