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HOSPITAL STAY IN COVID-19 PATIENTS: THE ROLE OF CLINICAL CHARACTERISTICS AND PHYSIOTHERAPY INTERVENTIONS

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Abstract

The outbreak of coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) in 2020 prompted a global health crisis. COVID-19 can manifest as mild flu-like symptoms or progress to severe respiratory tract infections, with varying degrees of severity. As the pandemic unfolded, the demand for healthcare resources, particularly in terms of hospitalization and intensive care, posed significant challenges. This study seeks to investigate the impact of clinical characteristics and physiotherapeutic interventions on the length of hospital stay in discharged COVID-19 patients. With a growing understanding of the virus and its effects, physiotherapists have become integral members of multidisciplinary teams working to restore lung and motor function, which can be impaired by the inflammatory response to the viral infection. The duration of hospitalization for COVID-19 patients is a crucial metric affecting patient turnover and healthcare system capacity, making it essential to explore the factors that influence it. This study aims to shed light on the role of physiotherapeutic interventions and patient characteristics in this context.

Introduction

In February 2020, the World Health Organization named coronavirus disease 2019 (COVID-19), a highly contagious disease caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) and the seventh known coronavirus to infect humans[1].

Covid-19 manifests as flu and may evolve to respiratory tract infection with fever (89%), cough (68%), fatigue (38%), and shortness of breath (19%). Cases may be asymptomatic (80%), moderate to severe (15%), or severe (5%), and patients may need ventilatory support[1],[2],[3]. Acute respiratory distress syndrome is present in severe COVID-19 and may lead to changes in the relationship between ventilation and perfusion, causing hypoxemia, severe dyspnea, respiratory failure, and need for intubation and ventilatory support[4]. Advanced age and associated diseases are considered risk factors for severe COVID-19[5].

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Physiotherapists have an essential role within multi-professional team assistance to reestablish lung and motor function impaired by the inflammatory process from viral infection[6],[7]. Hospital stay may be longer in patients with severe COVID-19 than intensive care unit (ICU) patients, compromising patient turnover and access to hospitalization[1],[5]. Therefore, this study aimed to analyze the influence of clinical characteristics and physiotherapeutic procedures on hospital length of stay of discharged COVID-19 patients.

Methods

This cross-sectional and quantitative study was conducted in a university hospital of the João Pessoa Brazil with data of discharged COVID-19 patients over 18 years of age.

Data were collected from medical and physiotherapy records the Influenza Epidemiological Surveillance Information System (SIVEP-Gripe) of the Ministry of Health, and University Hospitals Management Application (program created for the internal of management of university hospital information). Health records from COVID-19 patients older than 18 years, with confirmed test for COVID-19 (notified in SIVEP-Gripe) between March 2020 and January 2021, assisted by the hospital physiotherapy, and discharged were included in this study. Records and documents with incomplete or inconsistent data and those kept in the billing service were excluded.

An objective guide for data collection was developed with questions related to hospital length of stay (days), presence of risk factors, signs and symptoms, days of hospitalization, place of admission, ventilatory support at admission (invasive, noninvasive, or no ventilatory support), physiotherapeutic classification regarding admission, regarding general condition at admission, duration of ventilatory support (days), and physiotherapeutic procedures. Primary outcome was hospital length of stay (according to median - up to 14 days and more than 14 days), whereas clinical conditions and physiotherapeutic assistance were independent explanatory variables.

Regarding clinical conditions, the following variables were considered: gender, number of symptoms, associated diseases, duration of ventilatory support, place of admission (ICU or ward), type of ventilatory support (invasive and noninvasive), and physiotherapeutic classification. The latter was considered as very severe, severe, moderate, and reasonable based on hemodynamic stability, respiratory distress, level of consciuousness, need for ventilator support, vital signs, place of admission, and duration of ventilatory support)[8],[9],[10],[11]. The following physiotherapeutic assistance were considered: alveolar recruitment, suctioning, manual positive pressure ventilation (PPV), prone position, expansion maneuvers, early mobilization, bronchial hygiene, and ventilatory adjustments (respiratory rate, fraction of inspired oxygen, inspiratory pressure, expiratory pressure, inspiratory time).

Number of symptoms represented the sum of signs and symptoms per patient, whereas associated diseases were the sum of associated diseases per patient. Regarding type of support, zero (0) corresponded to “no support”; one (1) to noninvasive support, including non-rebreathing mask, venturi mask, bag valve mask, and nasal catheter; and two (2) to invasive support, including orotracheal tube.

Statistical Analysis

Data were inserted in electronic spreadsheets using Microsoft Excel Windows® (version 2010). Statistical Package for the Social Sciences software® (SPSS- IBM Corp., USA, version 20.0) and R software® (Oceania, New- Zealand, version 3.6.1) were used for analysis. Significance level was set at 0.05, 95% CI. Weight of evidence (WoE) binary classification model was also used for statistical analysis. This model evaluates discriminatory power of categorical variables to verify the influence of each explanatory variable on a given outcome and obtain the information value as metric of adjustment[12],[13]. In this study, WoE provided theoretical basis to elucidate the influence of clinical characteristics and physiotherapeutic procedures on hospital length of stay.

Reference values considering WoE statistical model were used to interpret analysis. This model was also associated with odds ratio to verify relationships between independent explanatory variables and hospital length of stay. Odds ratio is the likelihood of an event occurring between two groups and was calculated using SPSS software, version 20, according to the following equation: $OR = \frac{p}{1-p}$.

Information value as predictor capable of influencing the outcome was classified as not useful for predictor (<0.02), weak predictive power (between 0.02 and 0.1), strong predictive power (>0.10), and very strong predictive power (>0.30)[12,13]. When the result is very high and considered suspicious (i.e., values >0.9 are considered suspicious, and researchers must investigate whether the model adequately captured the variable it as very important. In this case, expert opinion will decide whether information is valid[14,15]. Herein, these cases were accepted and considered as very strong predictors due to the context portrayed by the set of information found in the WoE model[14].

Results

According to inclusion and exclusion criteria, 128 records were initially included, after applying the criteria, 73 health records were used for analysis.

Results showed a slight predominance of males and high number of cardiovascular diseases (Table 1). Fever, cough, and dyspnea were the most frequent symptoms. Patients aging ≥60 years were more prevalent. Hospital length of stay ranged from 4 to 60 days (median of 14 days).

Table 1 – Explanatory independent variables regarding clinical profile: gender, age, signs and symptoms, and associated diseases.

Clinical Profile	Frequency	Percentage
Female	34	46.6
Male	39	53.4
Age (years)		
1 to 18	2	2.7
19 to 44	21	28.8
45 to 59	21	28.8
≥ 60	29	39.7
Associated diseases		
Cardiovascular	39	53.4
Diabetes	22	30.1
Respiratory	12	16.4
Renal	12	16.4
Neuropathy	10	13.6
Mental	7	9.5
Thyroid	7	9.5
Oncology	4	5.4
Autoimmune	4	5.4
Unspecified	1	1.3
Signs/symptoms		
Cough	57	78.1
Fever	51	69.9
Dyspnea	32	43.8
Respiratory discomfort	20	27.4
Oxygen saturation below 95%	15	20.6

Myalgia	14	19.2		

Table 2 - Explanatory independent variables considering 14 or more days of hospitalization: gender, number of symptoms, associated diseases, ventilatory support, place of admission, and odds ratio. Legend: 95%CI (confidence interval), ICU (intensive care unit).

	≤14 days	>14 days		95%CI
Female, n (%)	23 (67.6)	11 (32.4)		
Male, n (%)	14 (35.9)	25 (64.1)	3.74	1.41 to 9.88
Number of symptoms				
1 to 3, n (%)	24 (49)	25 (51)	1.11	0.57 to 1.44
4 to 5, n (%)	13 (54.2)	11 (45.8)		
Associated diseases				
None, n (%)	9 (90)	1 (10)	1	-
1 or 2, n (%)	23 (46.9)	26 (53.1)	8.83	1.46 to 232.69
> 2, n (%)	5 (35.7)	9 (64.3)	13.06	1.67 to 392.93
Ventilatory Support				
No support, n (%)	5 (83.3)	1 (16.7)	1	-
Noninvasive , n (%)	32 (62.7)	19 (37.3)	8.29	1.16 to 230.87
Invasive, n (%)	0 (0.0)	16 (100)	9.78	1.36 to 274.02
Place of Admission				
ICU, n (%)	10 (24.4)	31 (75.6)	13.02	3.85 to 50.0
Ward, n (%)	27 (84.4)	5 (15.6)		

Data showed 92% of patients required ventilatory support, of which 70% were admitted with noninvasive support. All patients hospitalized for more than 14 days received invasive support. Moreover, patients admitted with ventilatory support had a higher chance of prolonged hospital length of stay than those admitted without ventilatory support. Those admitted with invasive support had 9.78-fold higher chance of prolonged hospital stay than patients admitted with noninvasive support. Regarding place of admission, patients admitted to the ward had 13.02-fold less chance of prolonged hospital length of stay.

Figure 1 shows and associated diseases had a more substantial influence on hospital length of stay). WoE statistical model (Figure 2) and odds ratio (Table 3) showed a relationship between physiotherapeutic assistance and less chance of hospital length of stay longer than 14 days.

Figure 1- Weight of evidence regarding hospital length of stay.

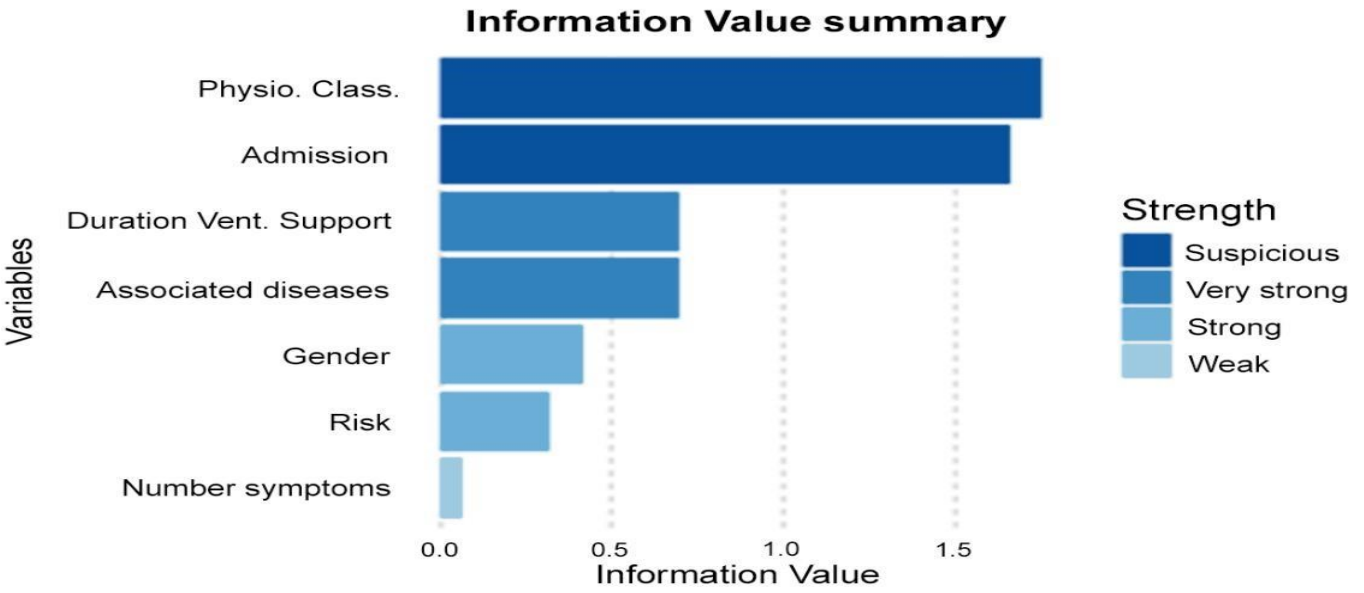

Figure 2 - Weight of evidence of physiotherapeutic assistance according to hospital length of stay.

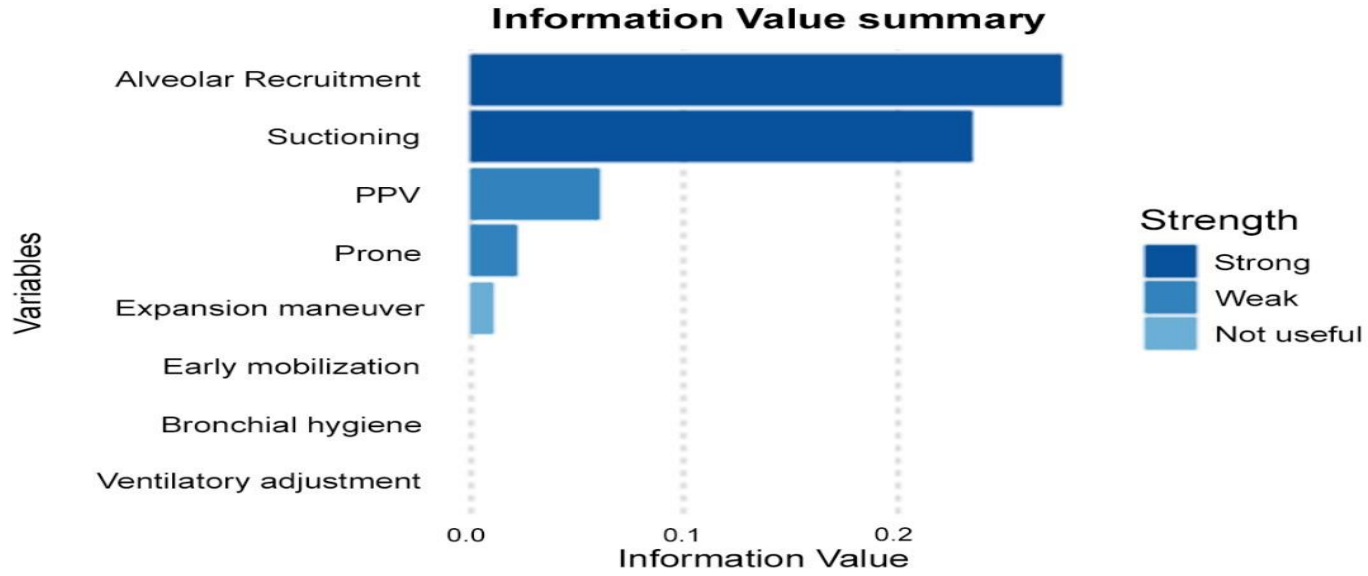

Table 3 - Explanatory independent variables regarding physiotherapeutic assistance considering 14 or more days of hospitalization: alveolar recruitment, suctioning, manual positive pressure ventilation (PPV), expansion maneuvers, and ventilatory adjustments.

	Physiotherapeutic Assistance			
Alveolar Recruitment				
	≤14 days	>14 days	Odds Ratio	95% CI
Yes, n (%)	12 (36.4)	33 (49.3)	4 2.06	0.35 to 12.02
No, n (%)	25 (62.5)	(66.7)		
Suctioning				
Yes, n (%)	30 (56.6)	23 (43.4)	3.04	1.01 to 9.14
No, n (%)	6 (30.0)	14 (70.0)		
PPV				
Yes, n (%)	20 (55.6)	16 (44.4)	1.64	0.65 to 4.14

No, n (%)	16 (43.2)	21 (56.8)		
Expansion Maneuver				
Yes, n (%)	27 (50.9)	26(49.1)	1.27	0.45 to 3.56
No, n (%)	9 (45.0)	11 (55.0)		
Ventilatory Adjustments				
Yes, n (%)	34 (50.7)	33 (49.3)	2.06	0.35 to 12.02
No, n (%)	2 (33.3)	4 (66.7)		

Influence value for hospital length of stay at admission was higher than physiotherapeutic assistance (Figure 1 and 2).

Discussion

Patients aged ≥60 years were predominant (39.7%), supporting previous studies demonstrating age as risk factor for moderate to severe COVID-19[3],[4]. Moreover, odds ratio showed males were more susceptible to longer hospital length of stay than females, corroborating with studies showing males are more likely to develop severe COVID-19 with higher mortality and prevalence of infection (54.7%)[16]. Another study showed males presented high hospitalization rates for Covid-19 in Brazil (53.3%)[17]. This may be explained by greater responsibility of females towards measures of prevention and combat of Covid-19 than males[18],[19]. Therefore, the reason males have higher vulnerability to contamination might be related to behavioral characteristics.

Studies[3],[6] reported most patients infected with Sars-CoV-2 are asymptomatic and do not require tertiary care. In our study, cough (78.1%), fever (69.9%), and dyspnea (43.8%) were the most prevalent symptoms (Table 1), although number of symptoms did not influence hospital length of stay significantly. Symptoms may vary and affect respiratory and other systems (e.g., cardiac, renal, nervous, and digestive)[20],[22]. Therefore, symptoms reported by patients are relevant to determine COVID-19 severity and guide appropriate assistance and intervention[23].

Data showed cardiovascular disease was highly prevalent (53.4%) compared with other associated diseases. In a cohort study with 200 hospitalized Covid-19 patients, 81.5% had at least one chronic disease, while cardiovascular diseases and diabetes mellitus were the most prevalent[24] In this study, comorbidities were important factors for longer hospital length of stay since they increased patient vulnerability[25].

In this study, most patients needed ventilatory support, depending upon the presence of comorbidities. For example, patients with cardiovascular diseases associated with Covid-19 are candidates for noninvasive (43.6%) and invasive ventilatory support (22%)[26]. Demand for ventilatory support was also confirmed in a comparative study of patients with and without pneumonia due to COVID-19. The latter presented rapid inflammatory lung infiltration and increased dependence on oxygen supplementation[27].

Covid-19 ICU and ward were available for admission of Covid-19 patients in the hospital. Data showed 41 patients (56%) were directly admitted to ICU, highlighting the severity imposed by COVID-19 pandemic. Therefore, place of admission may be an important predictor for planning and organizing health services, reflecting patients' needs[4],[24]. Indeed, WoE model showed this factor was the second-highest influence for longer hospital length of stay.

General health status of patients during admission was classified as very severe, severe, moderate, or reasonable; this variable was assessed in all patients because it is standard for ICU and ward admissions and showed the highest[27],[28]. WoE regarding hospital length of stay (Figure 1). At admission, physiotherapists perform hemodynamic, neurological, and respiratory assessment; calculate ideal total lung volume and PaO_2

(partial pressure of oxygen); collect vital signs; use Glasgow and RASS (Richmond Agitation-Sedation Scale) scales; adjust and organize ventilatory assistance; and perform complementary tests to classify patients[8,11].

A study conducted in China with Covid-19 patients also found a median of 14 days of hospital length of stay. However, this number may be lower for patients who died (four to 21 days) and higher for those who survived (four to 53 days)[5]. However, mean hospital length of stay for non-COVID-19 patients in public and private hospitals was 6.7 and 5.34 days, respectively, according to studies that evaluated 32,906 hospitalizations[5,29,30].

Regarding physiotherapeutic assistance, alveolar recruitment with PEEP titration had the highest WoE regarding hospital length of stay. Patients who received alveolar recruitment were 2.92-fold more likely to have shorter hospital length of stay. Alveolar recruitment is applied after patients meet several criteria[11] and may reduce hypercapnia and improve ventilation and perfusion of COVID-19 patients when adequately used[31]. Studies conducted before COVID-19 pandemic showed alveolar recruitment improved lung mechanics, electrolyte balance in $PaCO_2$ control, and PaO_2 in critically ill patients with acute respiratory distress syndrome[32,33].

Suctioning was performed in 87% of patients and showed the second-highest WoE regarding hospital length of stay, demonstrating a 3.04-fold higher chance of shorter hospital length of stay. Studies showed the relevance of suctioning for airway clearance from lower and upper airways, which is essential for adequate gas exchange, reducing work of breathing and complications by obstruction, and preventing ventilator-associated pneumonia[31,32].

PPV with bag valve mask (manual insufflator), consensual in cardiopulmonary resuscitation protocols, is included in protocols for critical patient care because it generates high positive airway pressure and lung oxygenation[11]. It also generates expiratory pressure and must be wisely used in COVID-19 patients. Patient status must be evaluated to avoid aerosol dispersion in the environment since contamination using this maneuver has been previously reported[34]. PPV had the third-highest WoE concerning hospital length of stay, demonstrating 1.64-fold higher chance of reducing hospital length of stay when performed. Although PPV was not significant, other studies highlighted PPV helped critically ill patients stabilize ventilation and improve gas exchange and static and dynamic compliance[35]. Patients were 2.06-fold more likely to have shorter hospital stay when ventilatory adjustments were performed (Table 3), despite it was not highlighted in WoE model. However, expert recommendation agreed with the importance of monitoring and adjusting respiratory support to ensure respiratory autonomy of patients[36,37].

Lung expansion maneuvers had minimal influence on hospital length of stay. However, these maneuvers can be effective in prophylaxis and treatment of lung collapse in several clinical situations[4], reducing risk of lung complication by up to 50%[31,36]. Although bronchial hygiene was not relevant for hospital length of stay, either in odds ratio or WoE, it involves a vast repertoire of noninvasive techniques widely used in physiotherapy practice[37,38]. Prone positing was conducted in 86% of patients and did not show predictive capacity, although it helps distribute lung pressures homogeneously. Indeed, a prospective bicenter study compared gasometric data of COVID-19 patients before and after 16 hours of prone positioning and showed improved gas exchange and lung perfusion[39].

The main limitation of this study, the different approaches performed by the physiotherapist, such as choice of ventilatory parameters, blood gas tests, and extubation. It also be important to monitor the patient over time to measure the effects of physical therapy approaches.

Conclusion

Clinical profile influenced hospital length of stay more than physiotherapeutic assistance. This may reflect the isolated performance of physiotherapists in a context of a multi-professional team, whereas clinical profile variables provide information to guide demands and needs of patients regarding health service. Regarding physiotherapeutic assistance, patients who received alveolar recruitment, suctioning, and manual positive

pressure ventilation presented lower chance of prolonged hospital length of stay, reinforcing that physiotherapy contributes to accelerating recovery of Covid-19 patients. Longitudinal studies with larger samples addressing physiotherapeutic assistance and procedures in Covid-19 patients should help understand the importance of physiotherapists in reducing hospitalization and related complications.

References

WHO. World Health Organization. (2019) Coronavirus disease 2019 (COVID-19). https://www.who.int/emergencies/diseases/novel-coronavirus-2019; Accessed 17 July 2021.

Grasselli G, Pesenti A, Cecconi M.(2020). Critical Care Utilization for the COVID-19 Outbreak in Lombardy, Italy: Early Experience and Forecast During an Emergency Response. *JAMA.* 323(16):1545-1546.

Guan WJ, Ni ZY, Hu Y, et al. (2020). Clinical Characteristics of Coronavirus Disease 2019 in China. *N Engl J Med.* 382(18):1708-1720.

Lazzeri M, Lanza A, Bellini R, et al. (2020). Respiratory physiotherapy in patients with COVID-19 infection in acute setting: a Position Paper of the Italian Association of Respiratory Physiotherapists (ARIR). *Monaldi Arch Chest Dis.*90(1).

Rees EM, Nightingale ES, Jafari Y, et al. (2020). COVID-19 length of hospital stay: a systematic review and data synthesis. *BMC Med.*18(1):270.

Li K, Wu J, Wu F, et al. (2020). The Clinical and Chest CT Features Associated With Severe and Critical COVID19 Pneumonia. *Invest Radiol.* 55(6):327-331.

Thomas P, Baldwin C, Bissett B, et al. (2020). Physiotherapy management for COVID-19 in the acute hospital setting: clinical practice recommendations. *J Physiother*. 66(2):73-82.

Empresa Brasileira de Serviços Hospitalares and Universidade Federal da Paraíba. POP: Procedimento Operacional Padrão. Avaliação Fisioterapêutica em UTI.(2019) https://www.gov.br/ebserh/ptbr/hospitais-universitarios/regiao-nordeste/hulw-ufpb/acesso-a-informacao/gestao-documental/popprocedimento-operacional-padrao/2019-1/urto-unidade-de-reabilitacao-de-terapia-ocupacional; Accessed 10 June 2021.

Empresa Brasileira de Serviços Hospitalares and Universidade Federal do Triângulo Mineiro. (2017). POP: Procedimento Operacional Padrão de Aspiração Endotraqueal versão 2.0. http://www2.ebserh.gov.br/documents/17082/3086452/POP+012+Fisioterapia+Hospitalar+Adulto+Respirat%C3%B3ria+-+alterar.pdf/f5ce86cb-285b-42f6-b82b-1c74e6cf168a;. Accessed 06 June 2021.

Empresa Brasileira de Serviços Hospitalares and Universidade Federal do Triângulo Mineiro.(2018). POP: Procedimento Operacional Padrão 27, Mobilização precoce no paciente crítico. Versão 2.0. http://www2.ebserh.gov.br/documents/147715/0/POP+27+%282016%29+mobiliza%C3%A7%C3%A3o+precoce+2.pdf/a1355330-60db-4882-a0b9-26b88c3fec61; Accessed 06 June 2021.

Hospital Geral de Fortaleza and Secretaria de Saúde do Estado do Ceará.(2018). Protocolo da Fisioterapia do Hospital Geral de Fortaleza. http://extranet.hgf.ce.gov.br/jspui/bitstream/123456789/327/1/2018_Protocolo_Fisioterapia_PDF.pdf ; Accessed 06 June 2021.

Sicsú AL.(2010). Credit Scoring: desenvolvimento, implantação, acompanhamento. 1st ed. São Paulo, SP: Blucher.

Siddiqi, N. (2006). Credit risk scorecards: Developing and implementing intelligent credit scoring. Hoboken, NJ: John Wiliey & Sons.

Alvarez-Melis D, Daumé H, Vaughan J, Wallach H. (2019). Weight of Evidence as a Basis for Human-Oriented Explanations. *Workshop on Human-Centric Machine Learning at the 33rd Conference on Neural Information Processing Systems. arXiv:191013503v1*.

Forti M. (2018). Técnicas de machine learning aplicadas na recuperação de crédito do mercado brasileiro. São Paulo, Escola de Economia de São Paulo.

Jin JM, Bai P, He W, et al. (2020). Gender Differences in Patients With COVID-19: Focus on Severity and Mortality. *Front Public Health.* 8:152.

Gonçalves Souza L, Randow R, Cristina Lima Siviero P. (2020). Reflexões em tempos de COVID-19: diferenciais por sexo e idade. *Comun Ciência Saúde.*31:75-83.

Pei G, Zhang Z, Peng J, et al. (2020). Renal Involvement and Early Prognosis in Patients with COVID-19 Pneumonia. *J Am Soc Nephrol.* 31(6):1157-1165.

De la Vega R, Ruiz-Barquin R, Boros S, Szabo A. (2020). Could attitudes toward COVID-19 in Spain render men more vulnerable than women? *Glob Public Health.* 15(9):1278-1291.

Lau ST, Yu WC, Mok NS, Tsui PT, Tong WL, Cheng SW. (2005). Tachycardia amongst subjects recovering from severe acute respiratory syndrome (SARS). *Int J Cardiol.*100(1):167-169.

Ryan, WM. (2020). There's a new symptom of coronavirus, doctors say: Sudden loss of smell or taste. https://www.usatoday.com/story/news/health/2020/03/24/coronavirus-symptoms-loss-smelltaste/2897385001/; Accessed 17 June 2021. Accessed.

Giacomelli A, Pezzati L, Conti F, et al. (2020). Self-reported Olfactory and Taste Disorders in Patients With Severe Acute Respiratory Coronavirus 2 Infection: A Cross-sectional Study. *Clin Infect Dis.*71(15):889-890.

Qu G, Chen J, Huang G, et al. (2021). A quantitative exploration of symptoms in COVID-19 patients: an observational cohort study. *Int J Med Sci.*18(4):1082-1095.

Pareek M, Singh A, Vadlamani L, et al. (2021). Relation of Cardiovascular Risk Factors to Mortality and Cardiovascular Events in Hospitalized Patients With Coronavirus Disease 2019 (from the Yale COVID19 Cardiovascular Registry). *Am J Cardiol.* 146:99-106.

Migliaccio MG, Di Mauro M, Ricciolino R, et al.(2021). Renal Involvement in COVID-19: A Review of the Literature. *Infect Drug Resist.*14:895-903.

Zhao D, Yao F, Wang L, et al. (2020). A Comparative Study on the Clinical Features of Coronavirus 2019 (COVID-19) Pneumonia With Other Pneumonias. *Clin Infect Dis.*71(15):756-761.

Shi S, Qin M, Shen B, et al. (2020). Association of Cardiac Injury With Mortality in Hospitalized Patients With COVID-19 in Wuhan, China. *JAMA Cardiol.* 5(7):802-810.

Guia C, Biondi R, Sotero S, Lima A, Almeida K, Amorim F. (2019). Epidemiological profile and predictors of mortality in an intensive care unit in a general hospital in Distrito Federal. *Comun Ciênc Saúde.* 26(1/2):919.

Franca EB, Ishitani LH, Teixeira RA, et al. (2020). Deaths due to COVID-19 in Brazil: how many are there and which are being identified? *Rev Bras Epidemiol.* 23:e200053.

Gupta S, Hayek SS, Wang W, et al. (2020). Factors Associated With Death in Critically Ill Patients With Coronavirus Disease 2019 in the US. *JAMA Intern Med.* 180(11):1436-1447.

Martins M, Blais R, Leite C. (2004). [Hospital mortality and length of stay: comparison between public and private hospitals in Ribeirao Preto, Sao Paulo State, Brazil]. *Cad Saude Publica.* 20 Suppl 2:S268-282.

Cammarota G, Simonte R, De Robertis E. (2021). PEEP-induced alveolar recruitment in patients with COVID19 pneumonia: take the right time! *Crit Care.* 25(1):163.

Pinto A, Reis M, Teixeira C, Junior R, Lino A. (2015). Recrutamento alveolar: em quem? como? quando? *Rev Med Minas Gerais.* 25(supl 4)).

Ball L, Robba C, Maiello L, et al. (2021). Computed tomography assessment of PEEP-induced alveolar recruitment in patients with severe COVID-19 pneumonia. *Crit Care.*25(1):81.

Christian MD, Loutfy M, McDonald LC, et al. (2004). Possible SARS coronavirus transmission during cardiopulmonary resuscitation. *Emerging infectious diseases.* 10(2):287-293.

Nandita Y, Sakshi A, Mangalam K, Megha Y, Jyoti S. (2020). Knowledge and awareness about use of manual hyperinflation in ICU patients amongst physiotherapy students in Delhi NCR, India. *Int J All Res Edu Sci Method.* 8(11).

Houze MH, Deye N, Mateo J, et al. (2020). Predictors of Extubation Failure Related to Aspiration and/or Excessive Upper Airway Secretions. *Respir Care.* 65(4):475-481.

Corrêa TD, Matos GFJd, Bravim BA, et al.(2020). Recomendações de suporte intensivo para pacientes graves com infecção suspeita ou confirmada pela COVID-19. *Einstein (São Paulo).*18.

Vollenberg R, Matern P, Nowacki T, et al.(2021). Prone Position in Mechanically Ventilated COVID-19 Patients: A Multicenter Study. *J Clin Med.*10(5).