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The impact of *Candida* isolation in sputum cultures on the clinical, radiological, and laboratory findings of pneumonia

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Abstract:

BACKGROUND AND AIM: This study aims to investigate the clinical, radiological, and laboratory findings of community-acquired pneumonia cases with reported *Candida* growth in sputum cultures and the impact of this condition on prognosis.

METHODS: Clinical-demographic, radiological, and laboratory features, CURB-65 (Confusion, Urea, Respiratory rate, Blood pressure, age ≥65 years) and Pneumonia Severity Index (PSI), hospitalization duration, and treatment success status of patients admitted with a diagnosis of community-acquired pneumonia between December 2021 and January 2024 were recorded. The cases were divided into two groups: Group 1, consisting of cases with only bacterial growth in sputum cultures, and Group 2, consisting of cases with *Candida* growth, either alone or in combination with bacterial agents. The data of the two groups were compared.

RESULTS: The study included a total of 86 cases, with a median age of 74 years (range: 19-97), of which 35 (40.7%) were female. There were 41 cases (47.7%) in Group 1 and 45 cases (52.3%) in Group 2. In Group 2, it was observed that the cases were predominantly older and female, with a significantly higher prevalence of hypertension (HT) and diabetes mellitus (DM) ($p<0.05$). No statistically significant differences were found in the laboratory and radiological features, CURB-65, and PSI index scores between the two groups ($p>0.05$).

CONCLUSIONS: The impact of *Candida* growth in sputum cultures on the clinical, radiological, and laboratory findings, as well as the prognosis of community-acquired pneumonia cases, is not definitively known.

Keywords:

Candida, pneumonia, prognosis

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Introduction

Fungal infections, such as *Aspergillus*, *Candida*, *Cryptococcus*, and *Mucor*, are primarily observed in immunocompromised individuals and constitute approximately 8% of all hospital-acquired infections, with *Candida* accounting for around 80% of these cases.[1] *Candida* species, a type of yeast fungus, are commonly found in the flora in the oral cavity, gastrointestinal tract, genitourinary system, skin, and mucous membranes of humans. The most prevalent species forming the normal microbiota and potentially causing infections include *Candida albicans*, *Candida glabrata*, *Candida krusei*, *Candida tropicalis*, and *Candida parapsilosis*.[2]

The term "invasive candidiasis" refers to the presence of infection in an organ or system that is normally sterile and encompasses conditions such as candidemia. The diagnosis of invasive candidiasis is established through the "gold standard" of positive cultures or the demonstration of *Candida* in histopathological samples obtained from normally sterile areas.[3] Due to its presence as a component of the gastrointestinal flora, the isolation of *Candida* species in respiratory secretions, such as sputum cultures, is frequently encountered. However, the isolation of *Candida* from sputum cultures, nasotracheal or endotracheal aspirates, and bronchoscopic samples in immunocompetent individuals does not always indicate active candidemia; it may only represent colonization in the tracheobronchial tree.[4]

Most studies investigating the relationship between *Candida* isolation in the respiratory tract and pneumonia focus on ventilator-associated pneumonia in intensive care unit patients. These studies generally emphasize that *Candida* isolation is an independent determinant of increased mortality and longer hospital stays.[5–7] Some studies suggest that the effects of *Candida* isolation on the immune system, such as inhibition of alveolar macrophages, could facilitate bacterial pneumonia.[8] In one of the few studies concerning the relationship between *Candida* and community-acquired pneumonia, it was emphasized that *Candida* isolation might be more common, particularly in cases with chronic respiratory disease and a history of chronic aspiration.[9]

This study aims to investigate the clinical, radiological, and laboratory findings of cases admitted to the chest diseases clinic due to community-acquired pneumonia and reported *Candida* growth in sputum cultures, whether in conjunction with bacterial agents or not. Additionally, the impact of these findings on pneumonia prognosis is explored.

Materials and Methods

Our study, designed as a center-based, cross-sectional, retrospective investigation, adhered to the principles of the international Helsinki Declaration and obtained approval from the Istanbul Medeniyet University Göztepe Training and Research Hospital Ethics Committee (Approval Number: 2023/0869, Date: 13/12/2023). Written informed consent was obtained from all subjects. All cases meeting the inclusion criteria and admitted to the chest diseases service with a diagnosis of community-acquired pneumonia between December 2021 and January 2024 were included in the study (Appendix 1). The medical records of the cases and existing files in the hospital automation system were thoroughly examined. We did not use artificial intelligence in the production of the submitted works.

Evaluation of clinical, radiological, laboratory, and demographic characteristics of cases

Demographic information such as age, gender, comorbidities, smoking history, and hospitalization duration, as well as clinical indicators like fever, heart rate (HR), respiratory rate (RR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and oxygen saturation (SpO_2) measured by pulse oximetry, were documented.

Laboratory values collected during the hospitalization of the cases were reviewed. Hematological parameters, including white blood cell count (WBC), procalcitonin (PCT), C-reactive protein (CRP), and biochemical parameters such as urea, creatinine, electrolytes, lactate dehydrogenase (LDH), alanine aminotransferase (ALT), aspartate aminotransferase (AST), and albumin values, were recorded.

Additionally, the presence of growth in the submitted sputum culture, the results of bacterial and/or fungal agents, and findings in chest computed tomography (CT) scans (if requested and performed during hospitalization) were documented, including ground-glass opacity, air bronchograms, consolidation, pleural effusion, and the number of involved segments.

Prognostic assessment of cases

CURB-65 (Confusion, Urea, Respiratory rate, Blood pressure, age ≥65 years) scores evaluated during the hospitalization of the cases were recorded (Appendix 2).[10] Additionally, the Pneumonia Severity Index (PSI) developed by Fine et al.[11] for the prognostic evaluation of pneumonia was documented (Appendix 3).

Cases were divided into two groups: Group 1, consisting of cases with only bacterial growth in the submitted sputum culture, and Group 2, consisting of cases with reported *Candida* growth, either alone or in conjunction with bacterial agents. The clinical, radiological, laboratory, and demographic characteristics, hospitalization duration, and treatment outcomes (discharge, transfer to the intensive care unit (ICU), or death) of both groups, as well as their CURB-65 and PSI scores, were compared.

Sputum Cultures: In our clinic, sputum cultures are always obtained before initiating antibiotic therapy, preferably after gargling with sterile water or isotonic sodium chloride solution, if possible, and the samples are promptly delivered to the laboratory. Samples that cannot be delivered to the laboratory within 2 hours are stored at 2–8°C.

Statistical analysis

Statistical analysis was conducted using SPSS 17.0 (IBM Inc., released 2008, SPSS Statistics for Windows, Chicago, USA) software. Descriptive statistics for continuous variables with normal distribution were presented as mean ± standard deviation, and for variables not following normal distribution, values were given as median (min-max). Categorical variables were expressed as percentages. The Kolmogorov-Smirnov test was used for normality testing. Data for groups were evaluated using the Chi-square test, independent sample t-test, and Mann-Whitney U test when necessary. A significance level of $p<0.05$ was accepted for all tests.

Results

Between December 2021 and January 2024, the records of 178 cases admitted to the Chest Diseases clinic with a diagnosis of community-acquired pneumonia were reviewed. Of these, 92 cases without reported growth in cultures were excluded from the study. A total of 86 cases, with an average age of 74 years [19–97] (median [min-max]), including 35 (40.7%) females and 51 (59.3%) males, with reported growth in sputum cultures, were included in the study. Among them, 41 (47.7%) cases in Group 1 had only bacterial growth in sputum culture, while 45 (52.3%) cases in Group 2 had *Candida* growth, either alone or in conjunction with bacterial agents.

In terms of comorbidities, 82 cases (95.3%) had additional diseases, with hypertension (HT) being the most frequently identified comorbidity in 50 cases (58.1%). Smoking history was present in 52 cases (60.4%), with an average smoking history of 27.5 [0–150] pack-years. The mean or median clinical parameters were as follows: temperature, 36.6°C [36–38]; HR, 88 beats per minute [57–140]; RR, 17 breaths per minute [15–21]; SBP, 127.7±22.7 mmHg; DBP, 77 mmHg [47–110]; and SpO_2, 94% [78–98]. The mean hospitalization duration was 9.5 days [2–42]. Statistically significant differences were observed between the groups in terms of age, gender, and some comorbidities (diabetes mellitus, hypertension) ($p<0.05$). The clinical, demographic, and laboratory characteristics of both groups are presented in Table 1.

Laboratory values at admission showed mean WBC, PCT, CRP, urea, creatinine, and LDH values as 14,200 / μL [3,200–34,400], 0.277 μg/L [0.02–33.2], 146.6 mg/dL [4.25–498.1], 43 mg/dL [10–161], 0.8 mg/dL [0.3–3.73], and 256 U/L [144–936], respectively. No statistically significant differences were found between the laboratory values of both groups (Table 2).

Radiological findings revealed no significant differences between Group 1 and Group 2 cases, except for a statistically significant increase in the presence of ground-glass opacity in chest CT scans in Group 1 cases ($p<0.05$). Radiological features of both groups are shown in Table 3.

When questioned about antibiotic use in the three months prior to hospital admission, 33 (38.4%) cases had used antibiotics. Among these cases, *Candida* growth was reported in 16 (48.4%), while it was not reported in 17 (51.6%) cases ($p=0.905$).

The mean CURB-65 score was 1.7±0.86, and the mean PSI score was 98.6±32. Group 1 cases had a mean CURB-65 score of 1.6±0.98, while Group 2 cases had a mean CURB-65 score of 1.7±0.75 ($p=0.789$). The mean PSI score was 104.4±35 for Group 1 cases and 93.3±28.4 for Group 2 cases ($p=0.111$) (Table 4).

When examining the distribution of cultured agents in the 41 cases with only bacterial growth and no reported *Candida* growth, *Pseudomonas aeruginosa* was the most frequently isolated bacterial agent. Details of the cultured agents are presented in Table 5.

All cases in both groups were discharged with recovery, and there were no cases transferred to the ICU or cases with mortality ($p>0.05$).

Table 1: Clinical and demographic characteristics of cases

Parameters	Sputum sample candida negative (group 1; n=41)	Sputum sample candida positive (group 2; n=45)	p
Age (median [min-max])	75 [30–90]	69 [19–97]	**0.033**
Sex, n (%)			
Female	12 (29.3)	23 (51.1)	
Male	29 (70.7)	22 (48.9)	**0.039**
Smoking history, n (%)			
Yes	25 (60.9)	27 (60)	0.982
No	16 (39.1)	17 (40)	
Smoking (median [min-max]) (pack-year)	30 [0–150]	8 [0–120]	0.831
Comorbidities, n (%)			
Comorbidities			
Yes	38 (92.7)	44 (97.8)	0.262
No	3 (7.3)	1 (2.2)	
HT	17 (41.5)	33 (73.3)	**0.003**
DM	7 (17.1)	21 (46.7)	**0.003**
Chronic heart disease	14 (34.1)	16 (35.6)	0.891
Chronic pulmonary diseases	27 (65.9)	26 (57.8)	0.442
Chronic neurological diseases	6 (14.6)	13 (28.9)	0.112
Chronic renal diseases	5 (12.2)	4 (8.9)	0.617
Collagen tissue diseases	–	3 (6.7)	0.092
Lung cancer	1 (2.4)	1 (2.2)	0.947
Extrapulmonary cancers	–	2 (4.4)	0.172
Fever (°C, median [min-max])	36.6 [36.1–38]	36.6 [36–38]	0.293
Heart rate (/min, median [min-max])	88 [57–121]	83 [61–140]	0.208
RR (/min, median [min-max])	22 [16–24]	21 [18–22]	0.271
Systolic BP (mmHg, mean±SD)	124.7±24.4	129.4±20.9	0.337
Diastolic BP (mmHg, median [min-max])	70 [52–92]	71 [47–110]	0.549
Hospital admission Saturation (%)	94 [87–99]	94 [78–98]	0.148
Hospitalization days (median [min-max])	10 [2–42]	9 [2–21]	0.418

HT: Hypertension, DM: Diabetes mellitus, RR: Respiratory rate, BP: Blood pressure, SD: Standard deviation

Table 2: Laboratory characteristics of cases

Parameters	Sputum sample candida negative (group 1; n=41)	Sputum sample candida positive (group 2; n=45)	p
Laboratory results			
WBC ($10^3/\mu$L, median [min-max])	15,000 [3,700–34,400]	13,600 [3,200–30,000]	0.278
HB (g/dL, mean±SD)	11.8±2.4	11.9±2.1	0.819
PLT ($10^3/\mu$L, median [min-max])	250,000 [351,000–580,000]	240,000 [13,900–940,000]	0.868
Sodium (mEq/L, median [min-max])	137 [126–152]	136 [126–181]	0.774
Potassium (mEq/L, median [min-max])	4.1 [2.9–5.3]	4.2 [2.9–9.6]	0.209
CRP (mg/dL, median [min-max])	123.3 [4.02–340]	86 [3.08–444.3]	0.534
PRC (μg/L, median [min-max])	0.233 [0.02–33.2]	0.286 [0.04–13.56]	0.688
LDH (U/L, median [min-max])	252 [144–936]	258 [172–544]	0.865
Urea (mg/dL, median [min-max])	45 [19–161]	38 [10–105]	0.103
Creatinine (mg/dL, median [min-max])	0.82 [0.32–3.73]	0.75 [0.39–2.89]	0.445
ALT (U/L, median [min-max])	18 [5–404]	20 [9–69]	0.529
AST (U/L, median [min-max])	12 [5–102]	13 [5–69]	0.445
Albumin (g/L, median [min-max])	36.2 [17.7–49.1]	36.5 [26.7–47]	0.923

WBC: White blood cell, HB: Hemoglobin, SD: Standard deviation, PLT: Platelet, CRP: C-reactive protein, PRC: Procalcitonin, LDH: Lactate dehydrogenase, ALT: Alanine aminotransferase, AST: Aspartate aminotransferase

Discussion

In this study, where we investigated the clinical, radiological, and laboratory differences in pneumonia cases with reported *Candida* proliferation in sputum cultures, it was observed that cases in the group with reported *Candida* proliferation were relatively older and predominantly female. Hypertension and diabetes mellitus (DM) were sig-

Table 3: Radiological features of cases

Thoracic CT signs	Sputum sample candida negative (group 1; n=41)		Sputum sample candida positive (group 2; n=45)		p
	n	%	n	%	
Pleural effusion					
Yes	9	21.9	17	37.7	0.110
No	32	78.1	28	62.3	
Ground-glass appearance					
Yes	34	82.9	27	60	**0.019**
No	7	17.1	18	40	
Air bronchogram					
Yes	29	70.7	31	68.8	0.853
No	12	29.3	14	31.2	
Consolidation					
Yes	29	70.7	34	75.5	0.614
No	12	29.3	11	24.5	
Number of affected segments (mean±SD)	4.5±2.5		3.9±3.1		0.329

CT: Computed tomography, SD: Standard deviation

Table 4: Distribution of patients according to CURB-65 score and PSI scores in cases

Parameters	Sputum sample candida negative (group 1; n=41)	Sputum sample candida positive (group 2; n=45)	p
CURB- 65 (mean±SD)	1.6±0.98	1.7±0.75	0.789
PSI (mean±SD)	104.4±35	93.3±28.4	0.111

CURB-65: Confusion-urea-respiratory rate-blood pressure-65, PSI: Pneumonia severity index, SD: Standard deviation

Table 5: Bacterial agents cultured in sputum of group 1 and group 2 cases

Cultured bacterial agent	Sputum sample candida negative (group 1; n=41)	Sputum sample candida positive (group 2; n=45)
Pseudomonas aeruginosa	9	1
Staphylococcus aureus	5	1
Haemophilus influenzae	5	-
Moraxella catarrhalis	3	-
Streptococcus pneumoniae	1	2
Klebsiella pneumoniae	3	3
Acinetobacter baumannii	1	-
Escherichia coli	1	-
Streptococcus mitis	3	2
Streptococcus constellatus	1	-
Staphylococcus epidermidis	1	-
Others		
Stenotrophomonas maltophilia	1	2
Rothia mucilaginosa	1	-
Proteus mirabilis	1	-
Achromobacter xylosoxidans	1	-
Total	41	11

nificantly more prevalent in this group. Apart from these findings, no statistically significant differences were detected between the two groups in terms of laboratory features, most radiological characteristics, CURB-65, and PSI scores.

Candida species are commonly colonized in the oral mucosa and can be easily isolated from the flora of healthy individuals, with 80% of the human population being asymptomatic carriers. The control of a wide spectrum

of clinical behavior, ranging from asymptomatic carriage to invasive widespread disease, is influenced by changes in the host immune system.[12] Many studies have hypothesized that disruptions or impairments in the host immune system can enhance the virulence of *Candida* species, leading to invasive candidiasis in the host. Numerous predisposing factors have been identified through studies that contribute to the transition of a harmless commensal *Candida* to a pathogenic state. These factors include poor oral hygiene, smoking, the use of oral topical steroids and broad-spectrum antibiotics, and immunosuppressive diseases or treatments.[13–15]

Studies have also supported the possibility of a mutualistic relationship between *Candida* and oral flora bacteria, in addition to the commensal relationship with the human organism. Research has indicated a relationship between high levels of *Candida* and two bacteria (*Porphyromonas gingivalis* and *Fusobacterium nucleatum*), which lead to periodontitis and tooth decay and exhibit a chronic and aggressive course.[16,17] Another study on *Candida* with the ability to form biofilm suggested that *Candida* with insufficient biofilm and hyphal formation, when isolated together with *Streptococcus gordonii*, shows lower tolerance to antibiotic treatment.[18] This implies that *Candida* may protect bacteria in mixed biofilms. Additionally, studies have demonstrated that mice colonized with *C. albicans* and *S. aureus* experience high morbidity and mortality due to systemic bacterial infection,[19] supporting the notion that *Candida* species may have a relationship with bacterial agents and enhance their virulence. Kong et al.[20] showed the initiation of systemic infection with *Staphylococcus aureus*, leading to high morbidity and mortality, in animals with oropharyngeal candidiasis. This further supports the idea of a connection between *Candida* species and bacterial agents, suggesting that bacterial agents may enhance virulence.

Studies questioning the relationship between *Candida* species and oral flora bacteria, and their association with pneumonia, exist. One of these studies, conducted by Delisle et al.,[21] focused on ventilator-associated pneumonia. They found that *Candida* species isolated from lower respiratory tract secretions were associated with higher intensive care unit and hospital mortality, longer mechanical ventilator usage, and prolonged hospital stay. Numerous studies have demonstrated that the presence of *Candida*, even without being the causative agent, negatively affects the prognosis of pneumonia.[22,23] In these studies, authors hypothesized that *Candida* may promote bacterial pneumonia by inhibiting bacterial phagocytosis by alveolar macrophages through its impact on T-helper cells.[8]

In a study by Taşbakan et al.,[24] aimed at investigating the impact of isolating *Candida* species from respiratory samples on pneumonia, they concluded that the isolation of *Candida* species from pneumonia cases had a negative effect on prognosis and mortality. In this study, *Candida* pneumonia was present in only one case, while the remaining 46 cases were considered *Candida* colonization. Additionally, the majority of the cases included in the study (59.6%) had immunosuppression. In a recent study, Yu et al.[25] found that the CD4+Th lymphocyte count and immunoglobulin A (IgA) concentration were higher in the group without *Candida* colonization compared to the group with colonization. Additionally, they reported that beta-glucan found in the cell wall of yeast cells could potentially cause dysfunction in alveolar macrophages. Moreover, in a recent study by Avkan-Oğuz et al.[26] on fungal colonization in Coronavirus Disease 2019 (COVID-19) patients in intensive care units, an increase in colonization was observed in patients admitted to the ICU; however, they found that this did not have an effect on mortality. While many studies have shown that *Candida* isolation adversely affects pneumonia prognosis, our study, in contrast to the literature, suggests that the lack of difference in scoring systems such as CURB-65 and PSI, which indicate poor prognosis, as well as in clinical, radiological, and laboratory values, may be due to the homogeneity of the case group we included in terms of immunosuppressive diseases, hematologic malignancies, and other systemic and organ malignancies.

Upon reviewing the literature, one of the few studies supporting our results is Williamson et al.,[27] who investigated ventilator-associated pneumonia (VAP) patients. They showed that cases with isolation of *Candida* species from respiratory secretions did not have a significant difference in systemic inflammatory markers (CRP, procalcitonin [PRC], Interleukin-6) compared to the control group. The authors of this study, based on their findings, reported rejecting the null hypothesis that the presence of *Candida* isolation in respiratory secretions is associated with low-level systemic inflammation.

One of the significant findings of our study is the comorbidities of the cases. While there was no statistically significant difference between the two groups in terms of malignancy and chronic neurological diseases that could impair

oral hygiene, DM and HT were significantly more prevalent in the group with reported *Candida* proliferation. In DM, insulin resistance, hyperglycemia, cellular disorders, hyperlipidemia, acidosis, insufficient immune response, inflammation, and susceptibility to infection are known to ocur.[28] Hypertension, especially in patients with DM, is known to increase the levels of soluble adhesion molecules that play an important role in the onset of inflammation, such as E-selectin and vascular cell adhesion molecule 1 (VCAM-1), and therefore, it can play a role in inflammation.[29] We believe that the higher incidence of DM and HT in the group with reported *Candida* proliferation, or conversely, the higher incidence of *Candida* in the group with more HT and DM, may be related to the increased susceptibility of individuals with DM and HT to both oral and systemic infections.

Another finding consistent with the literature is the significance of advanced age. In elderly cases, an increase in oral *Candida* is expected due to factors such as medication use, denture use, additional diseases, and deterioration of general health status.[30,31]

This study is relatively small in terms of the number of cases, conducted in a single center, and retrospective in nature. Therefore, it has some limitations that should be considered when interpreting the results. The findings cannot be generalized due to the small sample size and the fact that they reflect a single-center experience. Due to its retrospective nature, there are significant data gaps, one of which is the lack of standardization in the sputum cultures. Another limitation is the unexplained radiological difference in ground-glass opacities between the two groups. Ground-glass opacities are more commonly associated with viral and atypical pneumonia etiologies. The absence of this valuable data due to the retrospective design of the study is a significant limitation.

Conclusion

In conclusion, this study is one of the few that demonstrates the presence of clinically insignificant *Candida* isolation in community-acquired pneumonia cases, where antifungal treatment is not initiated, and shows that *Candida* isolation does not affect the clinical, radiological, and laboratory outcomes of the cases. As Pendleton et al.[32] aptly stated, "The final word on the isolation of *Candida* from the respiratory tract has not yet been spoken." Whether *Candida* is merely an observer or an active participant will be revealed by future studies.

Ethics Committee Approval

The study was approved by the Istanbul Medeniyet University Göztepe Training and Research Hospital Ethics Committee (No: 2023/0869, Date: 13/12/2023).

Authorship Contributions

Concept – C.D.; Design – C.D.; Supervision – S.İ.; Funding – H.İ.U.; Materials – Y.E.T.; Data collection &/or processing – H.İ.U.; Analysis and/or interpretation – C.D.; Literature search – S.D.T.; Writing – C.D.; Critical review – C.D.

Conflicts of Interest

There are no conflicts of interest.

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Appendix 1: Inclusion and exclusion criteria for the study

Inclusion criteria

1. Cases diagnosed with community-acquired pneumonia
2. Cases with growth reported in sputum culture

Exclusion criteria

1. Pregnant patients
2. Patients under 18 years old
3. Hospital-acquired pneumonia
4. Ventilator-associated pneumonia
5. Fungal pneumonias (*Candida* or *Aspergillus*)
6. Immunosuppressed/long-term glucocorticosteroid users

Appendix 2: CURB-65 score

1. Confusion
2. Urea >42.8 mg/dL, [BUN >20 mg/dL (7 mmol/L)]
3. Respiratory rate ≥30/min
4. Blood pressure (Systolic <90 mmHg or Diastolic ≤60 mmHg)

Age ≥65 years

Each criterion is scored as 1 point.

0–1 Point: Low risk (<3% Mortality)

2 Points: Moderate risk (3–15% Mortality)

3–5 Points: High risk (>15% Mortality)

CURB-65: Confusion, Urea, Respiratory rate, Blood pressure, age ≥65 years, BUN: Blood urea nitrogen

Appendix 3: Pneumonia severity index (PSI)

Criterion	Points	Criterion	Points
Demographic characteristics		Laboratory findings	
Age		BUN ≥30 mg/dL	20
Male	Age	Na <130 mmol/L	20
Female	Age-10	Glucose ≥250 mg/dL	10
Comorbid conditions		Htc <30%	10
Malignancy	30	Chest X-Ray	
Liver Diseases	20	Pleural effusion	10
CHF	10	Oxygenation	
CVD-SVD	10	Arterial pH <7.35	30
Renal diseases	10	PaO_2 <60 mmHg	10
Vital signs		SaO_2 <90%	10
Confusion	20		
RR ≥30/min	20		
Systolic BP <90 mmHg	20		
Fever <35°C or ≥40°C	15		
Heart rate ≥125/min	10		
STAGE I: Age <50, no comorbidities			
STAGE II: <70 points			
STAGE III: 71–90 points			
STAGE IV: 91–130 points			
STAGE V: 130 points			

BUN: Blood urea nitrogen, Na: Sodium, Htc: Hematocrit, CHF: Congestive heart failure, CVD-SVD: Cardiovascular and cerebrovascular disease, pH: Power of Hydrogen, PaO_2: Oxygen partial pressure, SaO_2: Oxygen saturation, RR: Respiratory rate, BP: Blood pressure