

Introduction

- Hospital-acquired pneumonia (HAP) and ventilator-associated pneumonia (VAP) can be serious complications of coronavirus disease 19 (COVID-19).
- Co-infections may worsen outcomes and prolong hospitalization.
- This risk may be exacerbated by systemic corticosteroids and other adjunctive therapies.

Methods

- We reviewed the records of all adults admitted to Stony Brook University Hospital, NY, from 3/1 to 4/15, 2020 with severe COVID-19 pneumonia, requiring high-flow O2 (non-rebreather mask, Venturi mask with FiO2 >50%, or high-flow nasal cannula).
- We excluded patients who received mechanical ventilation (MV) or died within 24h.
- Patients were followed until death or hospital discharge.
- We reviewed positive sputum cultures (PSC) for pathogenic microorganisms and calculated the incidence of HAP and VAP (nosocomial pneumonia, [NP]), rates of MV and impact on mortality. Fungi isolated from sputum were considered colonization unless associated with fungemia.
- We also examined the impact of adjunctive therapies with immunosuppressive potential (steroids and tocilizumab), on HAP or VAP.

Results

- Among 469 patients (Table 1); 199 (42.4%) required intensive care and 172 (36.7%) MV.
- Median length of stay was 13 days (8-22).
- 105 (22.4%) patients had PSC; 59 were considered true pathogens (HAP: 11, VAP: 48), with predominance of *S. aureus* (MSSA) 38.9%, *Enterobacteriaceae* 33.8% and *Pseudomonas species* 18.6%, and 39 isolates were considered colonization (Table 2).
- Patients with PSC <48h (N=7) from admission, were not considered NP.
- The incidence of NP was 7.0 per 1000 patient-days (95%CI 5.5-8.5). Of 11 patients with HAP, 9 needed MV.
- NP was more frequent among patients receiving steroids (9.0 vs 5.7 per 1000 patient-days; P=0.023). Use of tocilizumab was not associated with NP (6.2 vs 8.4; P=0.11).
- Mortality was non-significantly higher in patients with (20/59, 33.9%) vs. without (103/410, 25.1%) NP (P=0.16).
- Intubation and length of stay were the strongest predictors of NP in multivariable models.

Table 1. Baseline Patient Characteristics (N=469)

Characteristic	Value
Age, years	61 (50-73)
Female	166 (35.4%)
White	249 (53.1%)
Black	31 (6.6%)
Asian	29 (6.2%)
Hispanic	158 (33.7%)
Body mass index, kg/m ²	29.3 (26.1, 33.9)
Duration of symptoms, days	7.0 (3.5, 9.0)
O ₂ saturation, %	91 (87, 93)
Temperature, °C	38.1 (37.5, 39.0)
Hypertension	265 (56.5%)
Diabetes	155 (33.1%)
Coronary artery disease	71 (15.1%)
Atrial fibrillation	58 (12.4%)
Chronic lung disease	49 (10.4%)
Chronic kidney disease	48 (10.2%)
Congestive heart failure	45 (9.6%)
Asthma	36 (7.7%)
Immunocompromised	35 (7.5%)
Statins	180 (38.4%)
Angiotensin-converting enzyme inhibitors	74 (15.8%)
Angiotensin receptor blockers	73 (15.6%)
NT-proBNP pg/mL	205 (56, 991)
Troponin, ng/mL	0.01 (0.01, 0.01)
Creatine phosphokinase, IU/L	163 (80, 375)
Erythrocyte sedimentation rate, mm/h	54 (31, 80)
C-reactive protein, mg/dL	11.9 (6.4, 19.3)
D-Dimer, ng/mL	362 (241, 747)
Procalcitonin, ng/mL	0.21 (0.13, 0.49)
Ferritin, ng/ml	919 (489, 1534)
Lactate dehydrogenase, IU/L	407 (305, 538)
Interleukin-6, pg/mL	63 (30, 112)
Lymphocyte count, K/uL	0.8 (0.6, 1.1)
Creatinine, mg/dL	1.0 (0.8, 1.3)
Alanine transaminase, IU/L	34 (21, 55)
Aspartate aminotransferase, IU/L	46 (32, 70)
International normalized ratio	1.2 (1.1, 1.3)
Corrected QT interval on ECG, ms	437 (418, 460)

Values are N (%) or median (25th, 75th percentile)

Table 2. Distribution of Microorganisms In Positive Sputum Cultures

True pathogens		
VAP N= 48	HAP N=11	
Staphylococcus aureus (MSSA)	21 Staphylococcus aureus (MSSA)	2
Pseudomonas aeruginosa	8 Pseudomonas aeruginosa	2
Klebsiella (enterobacter) aerogenes	6 Staphylococcus aureus (MRSA)	2
Klebsiella pneumoniae	5 Aspergillus fumigatus	2
Stenotrophomonas (Xanthomonas) maltophilia	3 Klebsiella pneumoniae	1
Klebsiella pneumoniae MDR	2 Klebsiella (enterobacter) aerogenes	1
Staphylococcus aureus (MRSA)	2 Candida albicans	1
Candida tropicalis		2
Escherichia coli		2
Candida albicans		1
Streptococcus agalactiae (group B) beta hemolytic		1
Streptococci (group C) beta hemolytic		1
Burkholderia cepacia complex		1
Acinetobacter baumannii complex		1
Proteus mirabilis		1
Klebsiella oxytoca MDR		1
Escherichia coli MDR		1
Citrobacter farmeri MDR		1
Citrobacter koseri (Citrobacter diversus)		1
Candida dubliniensis		1
Candida parapsilosis		1
Streptococcus pneumoniae		1
Pseudomonas putida		1
Colonization		
Candida albicans	34	
Candida tropicalis	6	
Candida parapsilosis	5	
Candida krusei	1	
Candida dubliniensis	1	

MDR: Multidrug resistant; MRSA: Methicillin-resistant *Staphylococcus aureus*; MSSA: Methicillin-sensitive *Staphylococcus aureus*

Conclusion

- Among high risk COVID-19 patients, NP is a common complication. MSSA and *Enterobacteriaceae* were the most frequent isolates.
- The risk increases with intubation, longer hospital stay and use of steroids but not tocilizumab.