Pattern of Hospital-Acquired Pneumonia in Qena University Hospitals

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Abstract

Background: Hospital-acquired pneumonia (HAP) is a significant concern in ICU patients, with a higher morbidity, decease rate, and increased resource use.

Objectives: The study aimed to identify the causative bacteria, antibiotic sensitivity, and resistance among the cases with hospital-acquired pneumonia in Qena university hospitals.

Patients and methods: A cross-sectional study including 70 HAP patients at QUH during the period of one year. The demographics, full clinical evaluations, laboratory investigations, and radiography were collected.

Results: This study involved 70 cases with positive cultures, Elderly patients with chronic chest disease, and COPD exacerbation was the main reason for admission. Bilateral lung consolidation was the commonest radiological finding. Gram-negative bacilli were the most prevalent strain among the study cohort. Gentamycin, chloramphenicol, and amikacin were the most effective antibiotics against blood culture organisms, while imipenem and meropenem were the most effective antibiotics against the sputum culture organisms. Resistance was observed with various antibiotics. The decease rate was 21.43%.

Conclusion: Hospital-acquired pneumonia (HAP) mainly affects older individuals, Gram-negative bacilli were commonly found in cultures, emphasizing their importance in diagnosis. Antibiotic sensitivity and resistance patterns varied, highlighting the necessity for tailored antibiotic selection based on microbiology results.

Keywords: ICU; HAP; Lung,; Antibiotics.

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Introduction

Intensive care unit (ICU) patients often develop hospital-acquired pneumonia (HAP) **(Yakoub et al., 2023).** A lung infection that develops 48 hours after hospital admission is a prominent cause of death, morbidity, and resource use in hospitalized patients, especially in ICUs **(Sartelli et al., 2021).** HAP affects 5–10% of hospitalized patients and 9%–24% of ICU patients. Elderly, immunocompromised, and surgical patients had greater HAP rates **(Dongol et al., 2021).**

Aspiration or inhalation of aerosolized particles containing Pseudomonas aeruginosa, Enterobacter species, Klebsiella pneumoniae, Escherichia coli, Serratia marcescens, and Proteus species causes HAP. The common bacteria implicated in HAP include Pseudomonas aeruginosa, Staphylococcus aureus (including methicillin-susceptible and methicillin-resistant strains), Klebsiella pneumoniae, and Escherichia coli. The guidelines suggest that hospitals should regularly create and distribute a local antibiogram **(Luyt et al., 2018)**. Preventing, diagnosing, and treating HAP requires understanding its patterns and risk factors **(Jean et al., 2020).**

HAP therapy begins with broad-spectrum empiric antibiotics, followed by microbiological-based narrow-spectrum regimens. Since the bacteria causing HAP is frequently unknown, each ICU should create its own treatment plan based on microbiological results. This customized strategy affects morbidity, mortality, and treatment costs **(Chaïbi et al., 2022).**

The main aim of the study was to identify the causative bacteria, antibiotic sensitivity and resistance pattern of all the hospitalized cases with HAP in Qena University Hospital.

Patients and methods

This is a cross-sectional study that was conducted in the Chest and Internal Medicine department at QUH from May 2022 to May 2023. The study included 70 patients diagnosed with Hospital-Acquired Pneumonia (HAP).

Inclusion Criteria: Patients with HAP according to IDSA/ATS at an age of > 18 years **(Kalil et al., 2016).** The American Thoracic Society criteria for diagnosing Hospital-Acquired Pneumonia (HAP) necessitate the existence of at least two of the following conditions: fever (body temperature increase >1°C or >38.3°C), leukocytosis (25% increase and a value >10.0 × 109/L) or leukopenia (25% decrease and a value <5.0 × 109/L), and purulent tracheal secretions (with >25 neutrophils per high-power field). Additionally, one or more of the following criteria must be met: new or persistent infiltrates on chest radiographs, isolation of the same microorganism from pleural fluid and tracheal secretions, radiographic cavitation, histopathological evidence of pneumonia and positive cultures from bronchoalveolar lavage (BAL) with >104 colony-forming units (cfu)/mL.

Exclusion Criteria: Mechanically ventilated patients, patients with community or post-operative hospital-acquired pneumonia and those with negative cultures

All the following data were collected

1) The demographic data including age, sex, BMI, smoking status, and comorbidities (diabetes, hypertension, heart problems, and chronic chest disorders).

2) Clinical Assessment: Each subject's baseline and cause of admission were extensively reviewed.

3) Laboratory Investigations: CBC via (The German Sysmex XP300 CBC Analyzer). ABG via (The Danish ABL800 FLEX blood gas analyzer).

4) Blood and sputum cultures were taken in nutrient media bottles for bacterial or fungal growth. The lab processed the patient's

coughed-up sputum. If cultures grew, organisms were identified.

Culture Procedure

Blood cultures were collected using aseptic techniques. We performed venipuncture to draw blood into a pair of culture bottles, comprising an aerobic and an anaerobic bottle. These bottles contained specialized nutrient media for microbial growth. After blood collection, the blood culture bottles were immediately inoculated with the blood samples. Gentle mixing ensured thorough contact between the blood and the culture medium. The inoculated blood culture bottles were placed in an incubator set at a controlled temperature. Incubation was extended over a period of 5-7 days to facilitate the detection of slow-growing or fastidious microorganisms. In the event of microbial growth, a sample was extracted from the culture bottle and streaked onto appropriate agar plates. These cultures were then subjected to Gram staining, biochemical tests, and molecular techniques to identify the specific pathogens.

Sputum cultures were obtained by instructing the patient to cough deeply and forcefully to bring up mucus from their lower respiratory tract. The collected sputum was expectorated directly into sterile containers. It was ensured that the containers used for sputum collection were clean and uncontaminated to maintain sample integrity. We aseptically inoculated the sputum onto specific agar plates or into nutrient media bottles designed to support microbial growth. The inoculated sputum samples were incubated at a controlled temperature (typically around 37°C) for a period of 24-48 hours, allowing bacteria or fungi present in the sputum to grow. In cases of observed growth, sub-cultures were prepared on selective media to obtain pure cultures. Subsequently, these pure cultures underwent various biochemical and molecular tests to identify the specific pathogens. We used Gram staining for bacteria classification and employed biochemical tests such as catalase, oxidase, sugar fermentation, indole, urea hydrolysis, and other tests as needed.

5) Antibiotics susceptibility testing was done, and findings were reported.

6) CT Scan

Ethical Considerations:

- The study was approved by the Scientific Ethical Committee of the Faculty of Medicine, South Valley University. Ethical Code: **SVU-MED-CHT019-1-22-2-339.**
- Informed written consent was taken from all of the participants in the study.

Statistical analysis

Data analysis were done using SPSS (Statistical Package for Social Science) software program version 21.0 (SPSS Inc., Chicago, IL).

Results

This study included 70 cases who had positive culture results as 16 cases were excluded due to their negative culture. The Mean age was 67.27 years, Males represented 30 cases (42.86%). Chronic chest disease was the most prevalent co-morbidity 61 (87.14%). COPD exacerbation was the most prevalent cause of admission in 38 (54.29%) patients**.** Bilateral lung consolidation was the most common radiological finding, observed in 58 cases (82.86%). Of all 70 cases only 15 (21.43%) cases died as shown in **(Table .1).** The CBC data were disclosed **in (Table .2).**

Table 1. Demographic and baseline characteristics of the study cohort

Variables	N = (70)
Age (years)	67.27 ± 13.4
Sex	
• Female	40 (57.14%)
• Male	30 (42.86%)
BMI (Kg/m^2)	21.73 ± 2.68
Special habits	
Smoking status	
• Smoker	10 (14.29%)
• Ex Smoker	20 (28.57%)
Bird breeder	33 (47.14%)
Comorbidities	
• Diabetes Mellitus (DM)	27 (38.57%)
• Hypertension (HTN)	11 (15.71%)
• Cardiac troubles	2 (2.86%)
• Chronic chest disease	61 (87.14%)
Cause of admission	
• COPD exacerbation	38 (54.29%)
• Hypersensitivity pneumonitis	10 (14.29%)
• Pulmonary embolism	5 (7.14%)
• Pneumothorax	8 (11.43%)
• Acute kidney injury	4 (5.71%)
• Acute Myocardial Infarction	3 (4.29%)
• Acute pancreatitis	2 (2.86%)
Temperature (^{o}C)	38.11 ± 1.44
CT Finding (n (%))	
• Right lower lobe consolidation	4 (5.71%)
• Hyperinflation	5 (7.14%)
• Effusion	13 (18.57%)
• Interstitial shadows	8 (11.43%)
• Bilateral lung consolidation	58 (82.86%)
• GGO	15 (21.43%)
Survival outcome	
• Survive	55 (78.57%)
• Decease	15 (21.43%)

BMI: Basal Metabolic Index, HTN: Hypertension, DM: Diabetes Mellitus. GGO (ground-glass opacity)

Table 2. CBC findings of the study cohort

Variables	Mean±SD
TLC (*10^3cells/microliter)	16.15 ± 6.96
HB (g/dL)	11.44 ± 2.28
PLT (*10^3cells/microliter)	199.64 ± 99.97

Neutrophils (*10^3cells/microliter)	12.77 ± 6.6
Basophils (*10^3cells/microliter)	0.08 ± 0.13
Eosinophils (*10^3cells/microliter)	0.07 ± 0.07
Lymphocytes (*10^3cells/microliter)	2.39 ± 3.37

TLC (Total leukocyte count), PLT (Platelet count)

Regarding the blood culture results, Gram-negative bacilli were the predominant strain, (50%), Less prevalent strains included Staphylococcus hominis, Klebsiella ozaenae, Staphylococcus haemolyticus, and Acinetobacter baumannii as shown in **Table (3).** While regarding the sputum culture results, the most frequently identified strains were Escherichia coli and gram-negative bacilli, (30% and 34.29%). While, the least commonly identified strain was Citrobacter freundii, (2.86%) as shown in (**Table .3).**

Table 3. Blood and sputum cultures results of the study cohort

Sample	**(N = 70)**
Blood culture	
• Gram negative Bacilli	35 (50%)
• Staph Aureus	10 (14.29%)
• Gram Positive cocci	13 (18.57%)
• Staph Hominis	4 (5.71%)
• Klebsiella Ozaenae	3 (4.29%)
• Staph. Haemolyticus	3 (4.29%)
• Actinetobacter Baumami	2 (2.86%)
Sputum culture	
• Gram negative Bacilli	24 (34.29%)
• Streptococus Viridans	10 (14.29%)
• E. coli	21 (30%)
• Gram positive Cocci	13 (18.57%)
• Citrobacter Freundii	2 (2.86%)

The Sensitivity and resistance pattern of diverse antibiotics in blood culture results were illustrated in (**Table .4).** The Sensitivity and resistance pattern of diverse antibiotics in sputum culture results were disclosed in (**Table .5). (Table .6)** illustrated that, within the blood culture results, gram negative Bacilli, Staph Hominis, Staph. Haemolyticus and Actinetobacter Baumami were significantly prevalent all strains among the decease group. While, within the sputum culture results, only the frequency of Citrobacter freundii was ominously higher in the deceased group.

Table 4. Sensitivity and resistance pattern of the diverse antibiotics in blood culture

Variables	**Sensitivity (N = 70)**	**Resistance (N = 70)**
Amoxicillin	13 (18.57%)	51 (72.86%)
Ceftazidime	2 (2.86%)	38 (54.29%)
Ciprofloxacin	15 (21.43%)	1 (1.43%)

Clavulanic	13 (18.57%)	38 (54.29%)
Clindamycin	12 (17.14%)	1 (1.43%)
Gentamycin	51 (72.86%)	1 (1.43%)
Imipenem	13 (18.57%)	35 (50%)
Linezolid	18 (25.71%)	1 (1.43%)
Nitrofuranton	16 (22.86%)	35 (50%)
Rifampicin	35 (50%)	3 (4.29%)
Sulfamethoxazole	2 (2.86%)	4 (5.71%)
Tetracycline	5 (7.14%)	2 (2.86%)
Tigecycline	3 (4.29%)	12 (17.14%)
Trimethoprim	2 (2.86%)	16 (22.86%)
Vancomycin	17 (24.29%)	2 (2.86%)
Amikacin	38 (54.29%)	-
Ampicillin	-	17 (24.29%)
Azithromycin	-	35 (50%)
Aztreonam	-	13 (18.57%)
Bacitracin	-	48 (68.57%)
Cefazolin	-	3 (4.29%)
Cefoprazone	-	35 (50%)
Cefotaxime	35 (50%)	-
Ceftolozane/tazobactam	-	3 (4.29%)
Ceftriaxone	-	15 (21.43%)
Cefuroxime	-	3 (4.29%)
Chloramphenicol	48 (68.57%)	-
Daptomycin	1 (1.43%)	-
Doxycycline	35 (50%)	-
Ertapenem	-	3 (4.29%)
Erythromycin	-	48 (68.57%)
Levofloxacin	34 (48.57%)	-
Meropenem	-	35 (50%)
Minocycline	13 (18.57%)	-
Moxifloxacin	5 (7.14%)	-
Mupirocin	1 (1.43%)	-
Ofloxacin	34 (48.57%)	-
Oxacillin	-	13 (18.57%)
Piperacillin	2 (2.86%)	-
Tazobactam	-	3 (4.29%)
Teicoplanin	13 (18.57%)	-
Trimethoprimsulphate	-	12 (17.14%)

Table 5. Sensitivity and resistance pattern of diverse antibiotics in sputum culture

Variables	Sensitivity (N = 70)	Resistance (N = 70)
Ampicillin	21 (30%)	37 (52.86%)
Cefotaxime	10 (14.29%)	36 (51.43%)
Ceftriaxone	10 (14.29%)	24 (34.29%)
Doxycycline	13 (18.57%)	23 (32.86%)
Gentamycin	2 (2.86%)	35 (50%)
Imipenem	45 (64.29%)	15 (21.43%)
Levofloxacin	21 (30%)	15 (21.43%)
Meropenem	45 (64.29%)	15 (21.43%)
Nitrofuranton	2 (2.86%)	23 (32.86%)
Trimethoprim	2 (2.86%)	10 (14.29%)
Amikacin	-	13 (18.57%)
Amoxicillin	-	48 (68.57%)
Azithromycin	-	46 (65.71%)
Bacitracin	-	36 (51.43%)
Cefaclor	10 (14.29%)	-
Cefalexin	-	13 (18.57%)
Cefazolin	-	2 (2.86%)
Cefepime	-	24 (34.29%)
Cefoprazone	-	23 (32.86%)
Ceftazidime	-	60 (85.71%)
Ceftolozane	-	2 (2.86%)
Cefuroxime	-	2 (2.86%)
Chloramphenicol	-	36 (51.43%)
Ciprofloxacin	-	2 (2.86%)
Clarithromycin	-	13 (18.57%)
Clavulanic	-	48 (68.57%)
Ertapenem	-	2 (2.86%)
Erythromycin	-	46 (65.71%)
Minocycline	13 (18.57%)	-
Norfloxacin	-	13 (18.57%)
Ofloxacin	-	15 (21.43%)
Penicillin	-	10 (14.29%)

Piperacillin	-	24 (34.29%)
Rifampicin	-	13 (18.57%)
Sulfamethoxazole	2 (2.86%)	-
Tazobactam	-	2 (2.86%)
Tetracycline	13 (18.57%)	-
Tigecycline	21 (30%)	-

Table 6. Relationship between the culture results and the mortality outcome among the study group

Variables	Survivor (n = 55)	Non-Survivor (n = 15)	P. Value
Blood Culture			
• Gram negative Bacilli	31 (56.36%)	4 (26.67%)	0.04145*
• Staph Aureus	8 (14.55%)	2 (13.33%)	0.90534
• Gram Positive cocci	13 (23.64%)	0 (0%)	0.0564
• Staph Hominis	0 (0%)	4 (26.67%)	0.0015*
• Klebsiella Ozaenae	3 (5.45%)	0 (0%)	0.98
• Staph. Haemolyticus	0 (0%)	3 (20%)	0.0435*
• Actinetobacter Baumami	0 (0%)	2 (13.33%)	0.0083*
Sputum Culture			
• Gram negative bacilli	18 (32.73%)	6 (40%)	0.59889
• Streptococus viridans	8 (14.55%)	2 (13.33%)	0.90534
• E. coli	16 (29.09%)	5 (33.33%)	0.75062
• Gram positive cocci	13 (23.64%)	0 (0%)	0.0564
• Citrobacter freundii	0 (0%)	2 (13.33%)	0.0083*

*P<0.05 Statistically Significant

Discussion

Our research included 70 patients; their mean age was 67.27. Older patients had a higher incidence of hospital-acquired pneumonia (HAP) due to immune system alterations and respiratory infections **(Yang et al., 2021)**. Of all cases, 30 cases (42.86%) were males. In harmony with this study, **Despotovic et al. (2020)** conducted their study on 355 hospitalized patients from which 190 (53.5%) were males and 165 (46.5%) were females. Their mean age was 63.1 ± 16.5 years.

In this study, chronic chest disease was the most prevalent co-morbidity in 61 cases (87.14%). COPD exacerbation was the most prevalent cause of admission in 38 (54.29%) patients. In a tertiary care hospital, **Kumar et al. (2018)** found chronic lung illness in 15 of 153 HAP and VAP patients, COPD in 14, and asthma and bronchiectasis in one. Lung illnesses were found in 46 (14%) of 329 Italian teaching hospital patients with hospital-acquired respiratory infections **(Maurici et al., 2022).** According to **(Elkholy et al., 2023)** people with different chronic chest disorders, HAP is more common in AE. COPD patients. HAP was found in 36.00% of AE. COPD patients. Medical admission, admission following emergency surgery or trauma, COPD, and underlying chronic disease were individually related with a greater risk of infection in the EPIC trial **(Torres, 2006).**

In this study, the decease rate was 21.43%. In harmony, **Yin et al. (2021)** disclosed higher decease rates in HAP patients with older age, active immunosuppression, and diabetes. However, **Feng et al. (2021)** reported lower (14.5%) mortality rate (21.43%). This variance may be due to sample size, patient characteristics, and research techniques.

Gram-negative bacilli dominated our blood and sputum cultures. deceased cases had more Gram-negative bacilli, Staphylococcus hominis, S. haemolyticus, and A. baumannii than survivors. Citrobacter freundii killed sputum cultures. In accordance with this study**, Sangmuang et al. (2019)**, disclosed that about 27.1% of their cultures were non-fermenting Gram-negative bacilli among death cases. Similarly, **Herkel et al. (2016)** observed that Enterobacteriaceae and isolates of Pseudomonas aeruginosa, Burkholderia cepacia complex, and Stenotrophomonas maltophilia caused 86% of HAP cases. In **Yin et al. (2021),** gram-negative isolates (84.6%) out-numbered gram-positive isolates (15.4%). Klebsiella pneumoniae (15.4%), Acinetobacter baumannii (25.6%), and P. aeruginosa (20.1%) were most prevalent. Furthermore, **Costa et al. (2019)** summarized that the incidence of Staphylococcus aureus, Pseudomonas aeruginosa and Acinetobacter baumannii was 26.2%, 20.0% and 9.2%, respectively. Patients with late-onset hospital-acquired pneumonia (≥ 7 days) showed a higher frequency of non-fermenting Gram-negative bacilli isolates, and methicillin-resistant S. aureus.

We found a variable antibiotic sensitivity and resistance patten in blood and sputum cultures. Against our study in **(Bhadade et al., 2017),** they reported different antibiotic sensitivity patterns, with the highest sensitivity found for piperacillin + tazobactam (58.8%), followed by imipenem (49.5%) and meropenem (41.8%). Their study also highlighted maximum antibiotic resistance to cefepime (95.1%), ceftazidime, and amoxicillin (91.2%).

Similarly, **(Goel et al., 2012)** found colistin to be the most effective antibiotic, followed by the piperacillin/tazobactam combination and imipenem.

This study had limitations including First: its small sample size. A bigger sample size would provide more reliable results and improve the study's external validity. Second: it is a single center study. This raises questions regarding how well our results may be applied to communities or healthcare settings with differing demographics and healthcare practices. Third: the races and organisms found in various centers vary. Fourth: No scoring system was used to evaluate severity of pneumonia and related consquences, Fifth: lack of testing for viruses and atypical organisms and lack of invasive sampling procedure, and bronchoalveolar lavage (BAL) and endotracheal aspirate (ETA). Finally, while we explored patterns of antibiotic sensitivity and resistance, we did not go into great detail on the causes or consequences of antimicrobial resistance in the setting of HAP in this research. To fully understand this feature of HAP and its implications for treatment plans, further study is required.

Conclusion

We summarized that HAP predominantly affected older individuals. Gram-negative bacilli were the most commonly identified strain in both blood and sputum cultures. This highlights the importance of considering these pathogens in the diagnosis and management of HAP. We also observed a variable sensitivity and resistance patterns to diverse antibiotics tested in blood and sputum cultures, emphasizing the necessity for appropriate

antibiotic selection based on the specific microbiological profile.

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