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Mass gathering medicine (Hajj Pilgrimage in Saudi Arabia): The clinical pattern of pneumonia among pilgrims during Hajj

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Abstract The planned annual Hajj to the holy shrines in Makkah, Saudi Arabia, is recognized as one of the largest recurring religious mass gatherings globally, and the outbreak of infectious diseases is of major concern. We aim to study the incidence, etiology, risk factors, length of hospital stay, and mortality rate of pneumonia amongst pilgrims admitted to Al-Ansar general hospital, Madinah, Saudi Arabia during the Hajj period of December 2004—November 2013. A retrospective analysis of all patients diagnosed and admitted as pneumonia was done. Patients were assessed according to the CURB-65 scoring system and admitted to the ward or intensive care unit accordingly. Throat and nasopharyngeal swabs, sputum, and blood culture were collected prior to antibiotic treatment. 1059 patients were included in the study (23% of total hospital admissions and 20% of ICU admissions). The mean age of participants was 56.8 years, the Male:Female ratio was 3:1, and the lengths of stay in the ward and intensive care units were 5 and 14.5 days, respectively. The main organisms cultured from sputum were *Klebsiella Pneumoniae*, *Streptococcus Pneumoniae*, *Haemophilus Influenzae*, *Staphylococcus Aureus*, *Pseudomonas aeruginosa*, and community-acquired MRSA. The mortality rate in the ward was 2.4%, while the rate in the ICU was 21.45%. The organisms which caused pneumonia were found to be different during Hajj. The usual standard guideline for the treatment of pneumonia was ineffective for the causative organisms. Therefore, specific adjustments

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in the guidelines are needed. All efforts should be made to determine the infectious agent. Healthcare workers and pilgrims should adhere to preventive measures.

Introduction

Mass gathering is defined as a group of more than 1000 people present in one location. Most of the published literature mentions much larger numbers (>25,000 people) [1]. A more precise definition is a large number of people attending an event that is focused on specific sites for a finite time. As a consequence, Mass Gathering Medicine has emerged as a new field in the medical and health service specialty that focuses on the health risks due to mass gatherings [2—4]. The World Health Organization (WHO) defines it as ''events attended by a sufficient number of people to strain the planning and response resources of a community, state or nation''[5].

Mass gatherings could be categorized into two types: spontaneous gatherings and planned gatherings. Planned gatherings are recurrent at different locations (e.g. Olympic Games and World Cup football tournament) or recurrent events at the same location (e.g. the Hajj pilgrimage in Saudi Arabia) [6].

One of the crucial concerns regarding mass gatherings is the dissemination of infectious diseases that may result in outbreaks, especially at large events attended by visitors from different regions, nations, and cultures [7]. Infectious diseases associated with mass gatherings may vary according to the type and location of the mass gathering [8]. For example, religious gatherings are commonly associated with respiratory and gastrointestinal diseases.

The planned annual Hajj to the Islamic holy shrines at Makkah in Saudi Arabia is recognized as one of the largest annually recurring mass religious gatherings worldwide. The officially recorded number of pilgrims attending the annual Hajj each year is approximately 3 million, and these pilgrims originate from approximately 184 countries representing all continents of the world [9]. Recently, the number of pilgrims increased substantially from 58,584 pilgrims in 1920 to 3,161,573 in 2012 [10].

Each year between the 8th and 13th day of the 12th month of the Islamic lunar calendar (Dhul-Hijjah), approximately 3 million pilgrims gather from across the world for Hajj in Saudi Arabia. Considered to be one of the largest mass gatherings of its kind, the Hajj pilgrimage faces health challenges. Pilgrims (Hajjis) come from different parts of the world and present diverse socio-demographic characteristics and health backgrounds. These factors result in the manifestation of many health risks to pilgrims and subject them to communicable diseases, injuries, and loss of thousands of lives while attending these large events [9]. During Hajj, most of the pilgrims are over 50 years of age and have concomitant co-morbid illnesses.

Those health risks, particularly infectious diseases, may predispose individuals to infectious diseases such as meningococcal meningitis, respiratory tract infections, and blood-borne diseases [11]. Moreover, outbreaks of infectious diseases, particularly acute respiratory tract infections, diarrheal diseases, and meningococcal meningitis, have frequently been reported among Hajjis [12]. Given that the average Hajj journey ranges between 30 to 45 days, the majority of pilgrims will most likely be at risk for contracting an illness. This pilgrimage consists of a stay of approximately 6 days in Jeddah city, which is the entry point to Saudi Arabia in preparation for the arranged events. Followed by approximately 10 days of special prayers in the city of Madinah. After that, approximately 8 days are spent in Makkah performing important tasks, and, finally, the remainder of the period is spent preparing to return to the starting location [13].

It was well-known that mass gatherings in a confined location, increases the risk of acquiring and spreading infectious diseases, specifically respiratory infections. As a result, respiratory illnesses are the leading cause of visits to primary health centers in Mina, Makkah, and Madinah (the holy shrines locations), and pneumonia is a leading cause of admissions to the hospital [14,15].

In 2009, Gautret et al.[16] published a report based on a survey completed in France that addressed the Hajj-associated health problems. Cough was the main reported complaint and was found to be significantly high in individuals >55 years with an attack rate of 51%. This was followed by headache, heat stress, and fever. In addition, some travelers reported suffering from diarrhea and vomiting.

In 2009, Gautret et al. [17] in another study published in Marseille, France, reported that the attack rate for acute respiratory illnesses was as high as 60% in cohorts who returned from Hajj as pilgrims. Pligrims self-reported that the primary sources of contamination for acute respiratory tract infections were sneezing and coughing (58.1%), dirty hands (43.9%), contact with ill persons (40.5%), saliva (17.2%), promiscuity (17.0%), food (12.1%), drinks (9.1%), air conditioning (3.4%), and contact with animals (0.4%)[18].

Globally, pneumonia is a common illness, especially among individuals at the extremes of age. Pneumonia is the sixth leading cause of death and the cause of 15% of hospital admissions. In one study performed in the USA during an epidemic of influenza, the incidence of pneumonia increased 20%. The outcome of pneumonia was associated with co-morbid diseases [19].

In 2012, the Middle East Respiratory Syndrome emerged due to the Novel Corona Virus (MERS-CoV) in Saudi Arabia [20]. It had an approximately 40% mortality rate. Currently, there are no vaccines or treatment available. This was a global concern at the time because this occurred at the same time as the annual Hajj.

Since the emergence of MERS-CoV in 2012, the guidelines from the ministry of health of Saudi Arabia have been modified to include MERS-CoV. The inclusion criterion for the suspicion of MERS-CoV in 2013 was severe pneumonia with bilateral shadows on a chest X-ray that required intensive care unit (ICU) admission.

Al-Ansar general hospital is located within 1 km of the Prophet's mosque in Al Madinah Al Monawara. As a result, it was the primary referral center for pilgrims in Madinah. Annually, during the Hajj period, 80,000 to 100,000 pilgrims are treated for various diseases, and 600—700 patients are admitted, with 50% being admitted to ICU.

In this paper, we determined the incidence of community-acquired pneumonia amongst pilgrims admitted to Al-Ansar general hospital during the Hajj period (15th Dhul Qaida to 15th Moharram) 1425-1435 AH (December 2004—November 2013 AD), the etiology, risk factors, the length of hospital stay, and mortality rate.

Materials and methods

A retrospective cohort analysis was performed using the clinical data of all pilgrims who attended the emergency department of Al-Ansar general hospital, Madinah, Saudi Arabia during the Hajj days (15th Dhul Qaida to 15th Moharram) of the years 1425 to 1435 H (December 2004—November 2013 AD) with a confirmed diagnosis of pneumonia.

The analyzed data included age, gender, nationality, co-morbid diseases, the length of stay in the hospital (ward and ICU), the result of the sputum cultures, the mode of management, and the outcome of treatment. The collected data were recorded on a digital database file, and statistical analysis was performed using the Statistical Package for Social Science (SPSS) software program (Release 22).

Patients were assessed according to the CURB-65 scoring system; the score is an acronym for each of the risk factors measured. Each risk factor scores one point, for a maximum score of 5:

- Confusion of new onset (defined as an AMTS of 8 or less).
- Blood Urea nitrogen greater than 7 mmol/l (19 mg/dL).
- Respiratory rate of 30 breaths per minute or greater.
- Blood pressure less than 90 mmHg systolic or diastolic blood pressure 60 mmHg or less.
- age 65 or older.

A chest X-ray was performed on all of the patients in the emergency department to collect baseline study. Follow-up X-ray images were performed in the ICU or the radiology department to evaluate the treatment outcome daily. Sputum and blood samples were collected from all patients for culture prior to administration of antibiotics. Samples were tested for bacteria for the possible presence of typical or atypical causative agents.

The treatment protocol consisted of the use of empirical antibiotics after sputum and blood samples, then the antibiotics were replaced according to the specific causative pathogens depending on the culture result.

Results

The total number of admitted patients with a diagnosis of pneumonia during the study period was 1059 (23% of total hospital admission). Among them, 792 (74.8%) patients were males, and 267 (25.2%) were females. The male-to-female ratio

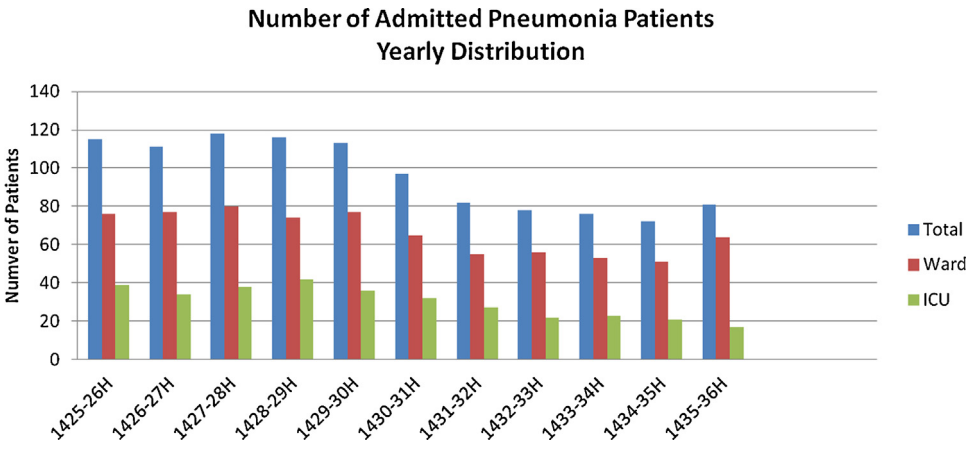

Fig. 1 Annual distribution of pneumonia admission in the ward and ICU.

was 3:1. The mean age was 56.8 years (range 48–64 years). 331 (31%) were admitted to the ICU, and the remaining 728 (69%) were admitted to the ward. Fig. 1 shows the detailed annual distribution of pneumonia admissions in the hospital throughout the study period. In general, ICU admissions gradually declined over the study period (39 to 17 patients) with regards to the need for ventilation. (Fig. 2)

The majority of patients were from Pakistan, India, Bangladesh, Indonesia, and North African countries. This finding could be explained by the fact that there were a larger number of pilgrims from these countries compared to other countries who participated in the Hajj. (Fig. 3)

The main risk factors were age >50 years, chronic obstructive pulmonary disease (COPD) in 76 (7.17%) patients, bronchial asthma in 83 (7.84%), diabetes mellitus in 369 (34.84%), and cardiovascular diseases in 247 (23.32%) patients. The mean duration of symptoms before presentation was 6.46 ± 4.2 days (range 3–11 days). The most common symptoms were: a productive cough in 627 patients (59.2%), dry cough in 319 (30.1%), shortness of breath in 473 (44.7%), sore throat in 284 (26.8%), headache in 194 (18.3%), and myalgias in 167 (15.8%). The most common signs were fever in 671 (63.4%) patients, and hypotension in 183 (17.3%).

The most common laboratory finding was leukocytosis in 748 patients (70.6%). Initial baseline chest X-ray showed bilateral shadows in 381 patients (39.98%) and unilateral shadows in 678 patients (64.02%). The yield of the sputum cultures obtained was positive in 396 (37.4%) patients. The main organisms isolated from sputum cultures were *Staphylococcus aureus* (36.1%), *Klebsiella pneumoniae* (29%), *Haemophilus influenza* (24.3%),

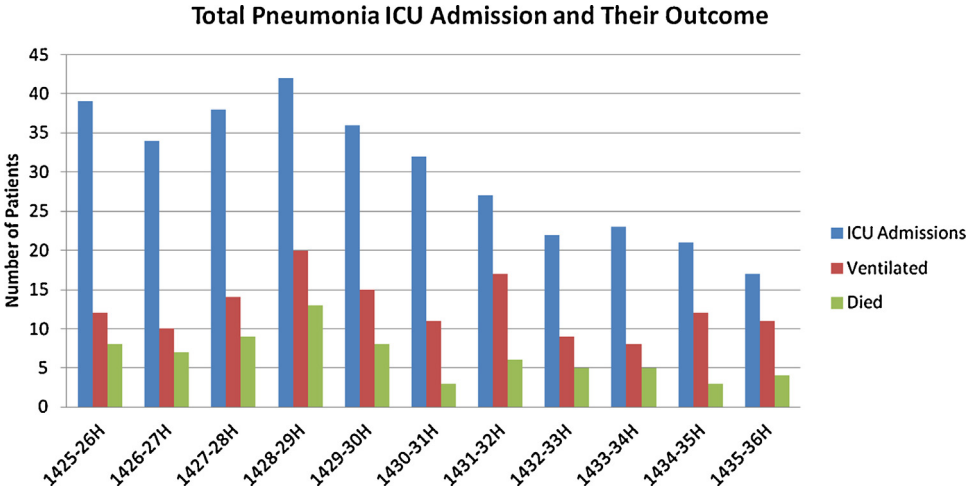

Fig. 2 Annual admission and outcome of ICU pneumonia patients.

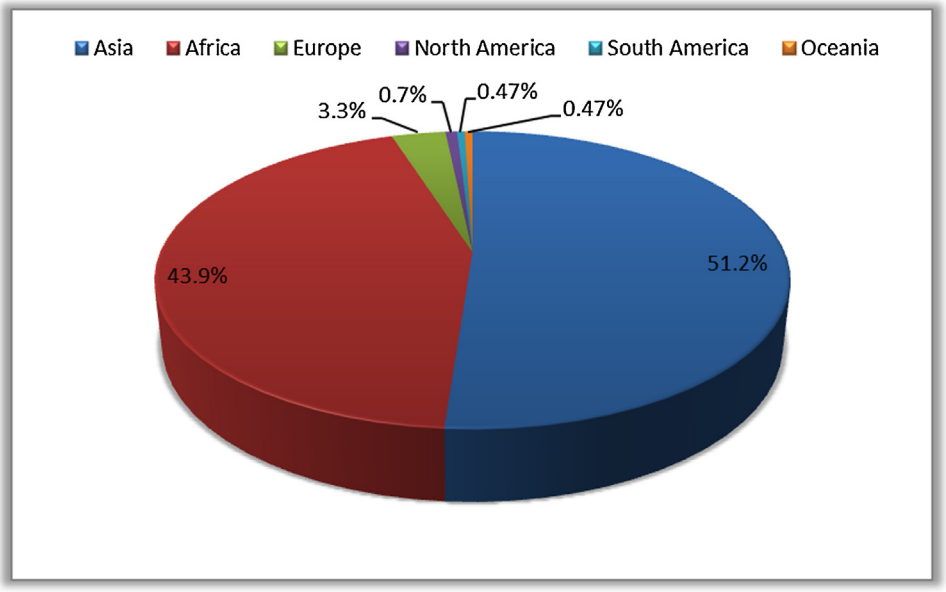

Fig. 3 Geographic distribution of the study population.

community-acquired MRSA (6.5%), *Pseudomonas aeruginosa* (3.1%), and *Streptococcus pneumoniae* (1%). Multiple causative pathogens were isolated in 158 (14.92%) patients.

The association between X-ray findings and positive microbiological test results was statistically significant ($p < 0.05$). The mean length of stay in the ward was 5 days (range 3—7 days) while in the ICU was 14.5 days (range 10—19 days). The mortality rate was 2.4% in the ward and 21.45% in the ICU. (Fig. 4)

Discussion

Pneumonia is the leading cause of hospital admissions and one of the main causes of septicemia and septic shock globally; it accounts for 15% of hospital admissions [21]. In our study, 23% of total admissions to the ward and 20% of all ICU admissions were due to pneumonia. In our study, the male-to-female ratio was 3:1, which is in agreement with many studies that showed that a pneumococcal infection is more frequent in males. It may also be explained by the fact that annually more male pilgrims perform Hajj than female pilgrims. In addition, the mean age was 56.8 years (range 48—64). This may be because the regulations of the Hajj in most Islamic countries prioritize Hajj performance among individuals older than 40 years. Elderly pilgrims are more susceptible to infections due to overexertion, limited sleep and rest; disturbance of dietary schedule and types of food; and the inability to maintain serious medical complications due to decreased immune function. (Fig. 5)

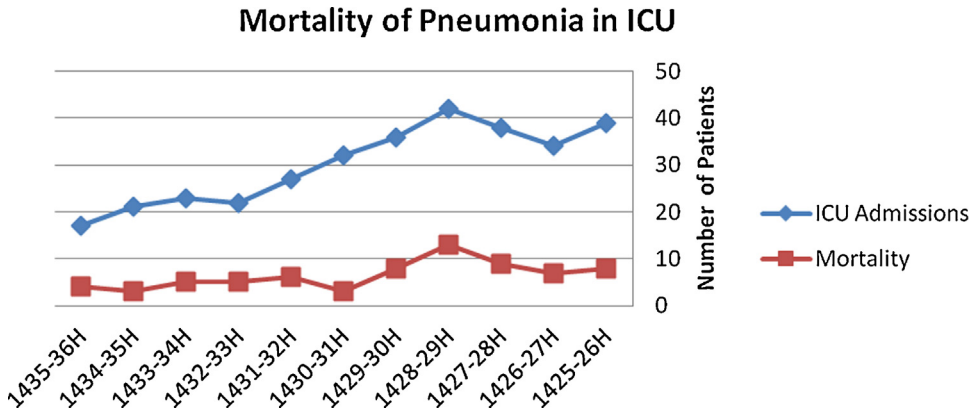

Fig. 4 Annual ICU pneumonia admissions and mortality.

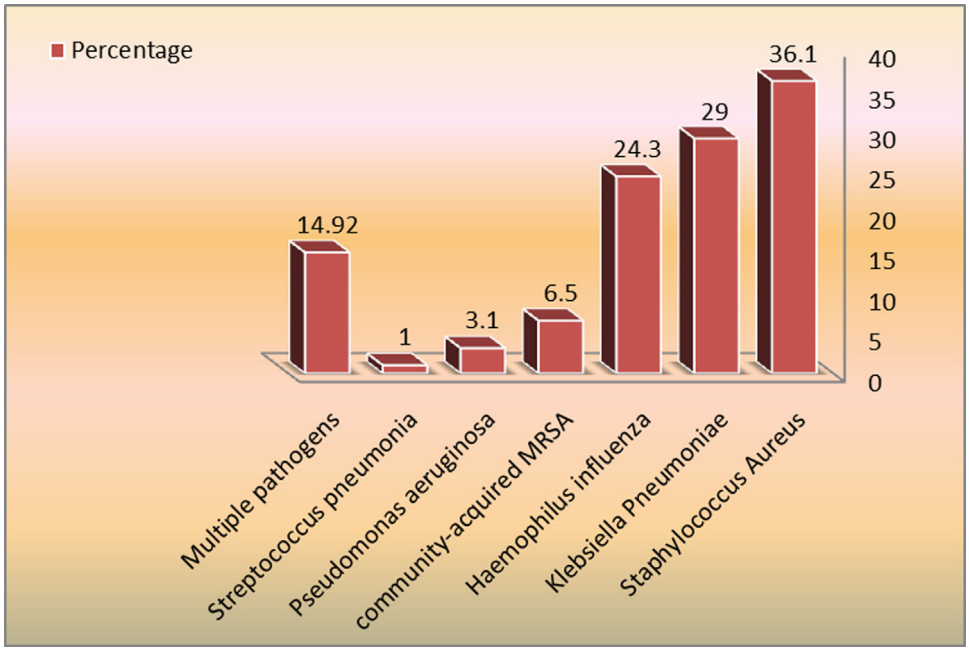

Fig. 5 The percentage of pathogens.

Due to the large numbers of cases seen annually at the holy shrines health care centers, the incidence and prevalence of pneumonia during the Hajj season was the subject of many health studies. Mandourah et al. [22] investigated all critically ill pneumonia patients admitted to 15 hospitals in Makkah and Madinah in the 2009—2010 Hajj seasons. Pneumonia was the cause of critical illnesses in 27.2% of cases, and it accounted for 18.1% of all ICU admissions. Our finding of 23% of cases being admitted is similar and does not reflect a decrease in the incidence. However, our findings that ICU admissions accounted for 31% of cases, is much larger than the figure reported by Mandourah which could reflect an increase in the severity of the disease.

Previous studies during the Hajj season showed that pneumonia is the leading cause of hospital admission during the annual Hajj, which includes admission to ICUs, and is considered a major cause of severe sepsis and septic shock in ICUs during the period of this mass gathering [10—15]. Previously published results from four articles from seven hospitals in the Hajj premises (Mina and Arafat) showed that pneumonia accounted for 19.7% of all hospital admissions for the 2003 Hajj and 22% of ICUs admissions during the 2004 season. It was noted that the incidence of pneumonia during Hajj also increased [20—25]. Our results are consistent with these reports. We observed a steady increase in the incidence and mortality over the period studied, despite a more aggressive medical approach and application of health precautions. This was then followed by a decline in both admission and mortality which is potentially an outcome of the practical steps taken by the health system in Saudi Arabia toward controlling Hajj medical events.

Reports from health missions of other Islamic countries indicated that the incidence among Iranian pilgrims at the 2004 Hajj season was 24 per 10,000 Hajjis, and in 2005, it was 34 per 10,000 Hajjis. This reflects a greater than 50-fold increase in comparison to the 1986 data [23]. The increase in pneumonia in Hajj supports the findings in our paper.

The etiology of pneumonia during the Hajj season is very complex and multifactorial. Predisposing factors include overcrowding, physical exhaustion, old age, the presence of co-morbid diseases, and environmental pollution. As a result of crowding, the estimated space between individuals is on average less than 1 m. Therefore, droplet transmission of infectious diseases is very common during the Hajj [24].

Most patients with pneumonia are treated empirically, and the role of microbiological diagnosis with community-acquired pneumonia is still a matter of debate. However, it is important to identify the pathogens associated with notifiable diseases such as MERS-CoV, Legionnaires, and Tuberculosis, for which microbiological diagnosis is necessary [25]. In our study, the microbiological yield was positive in 396 (37.4%) patients. There are many reasons for the observed low yield. These included prior use of

Table 1 Comparison between our study and some local and international studies showing the difference in pathogens.

Study	Year published	Study period	Patients No.	The most common organisms
Our study	2016	2004–2013	1059	*Staphylococcus Aureus* (36.1%), *Klebsiella Pneumoniae* (29%), *Haemophilus influenza* (24.3%), community-acquired MRSA (6.5%), *Pseudomonas aeruginosa* (3.1%), and *Streptococcus pneumonia* (1%). Multiple causative pathogens in 158 (14.92%) patients.
Mandourah et al.[22]	2012	2009–2010	452	Acinetobacter Species (26.7%), Klebsiella Species (16.7%), *Pseudomonas aeruginosa* (16.7%), *Escherichia Coli* (10%), *Candida Albicans* (6.7%), Tuberculosis (4.9%).
Memish et al.[23]	2014	2013	38	*Haemophilus Influenza* (57.7%), *Streptococcus Pneumoniea* (53%), rhinovirus (51%), Influenza virus (23%).
Marin et al.[32]	2006	2002–2003	4543	*Staphylococcus Aureus* (42%), *Streptococcus Pneumonia* (21%). Escherichia Species (8%), Enterobacter Species (6%) Acinetobacter Species (2%).
Herkel et al.[33]	2016	2013–2014	330	*Klebsiella Pneumoniae* 20.4%, *Pseudomonas aeruginosa* (20.0%), *Escherichia Coli* (10.8%), Enterobacter Species (8.1%), *Staphylococcus Aureus* (6.2%) and *Burkholderia cepacia* complex (5.8%).
Bernstein[34]	1999	1992	273	*Streptococcus Sneumoniae* (20–60%), *Haemophilus Influenzae* (3–10%), Oral anaerobes (6–10%), *Staphylococcus Aureus* (3–5%), Other Gram-negative bacteria (3–10%), Respiratory viruses (2–15%), *Legionella Pneumophila* (2–8%), *Chlamydia Pneumoniae* (5–17%), *Moraxella catarrhalis* (1–3%).
Jones[35]	2010	1997–2008	2942	*Staphylococcus Aureus* (28.0%), *Pseudomonas aeruginosa* (21.8%), Klebsiella Species (9.8%), *Escherichia Coli* (6.9%), Acinetobacter Species (6.8%), and Enterobacter Species (6.3%).

antibiotics and atypical and viral etiologies. In general, *K. pneumonia*, *S. Pneumoniea*, *H. influenza*, *S. aureus*, *P. aeruginosa*, and community-acquired MRSA were the most prevalent among patients with a positive culture.

In the Hajj 2013 season, Memish et al. [23] collected sputum samples from all hospitalized pilgrims in 15 hospitals in two cities of Saudi Arabia: Makkah and Madinah. A total of 68% had positive cultures, of which 80% were positive for more than one pathogen, and 17% were positive for both virus and bacteria. *Haemophilus influenza* was positive in 57.7% of cases, and *S. Pneumoniea* was positive in 53% of cases. Among viruses, rhinovirus was found in 51% of cases, and influenza virus was found in 23% of cases. None of the cases was positive for MERS-CoV. This report is in agreement with our results and reflects that the pathogens detected during Hajj differ from those commonly reported globally. (Table 1)

One of the main concerns of the Saudi ministry of health was whether pilgrims were infected or whether they were carriers of the MERS-CoV. Therefore, 5235 pilgrims were screened. No evidence of MERS-CoV nasal carriage was found among these individuals. ''Two reports on French pilgrims during the 2012 and 2013 Hajj seasons also reported that despite a high rate of respiratory symptoms among the pilgrims screened, there was a lack of MERS-CoV nasal carriage''[26].

In 2005, Asghar et al. [27] conducted a study in Makkah, among which 53% of cases had a positive culture. The most common organism was *Candida Albicans*. It was positive in 28% of cases, followed

by Pseudomonas in 25.8% and Legionella in 14% and Klebsiella in 9.2% of cases. In addition, a report that included different organisms supported our results that found different pathogens during Hajj from those most commonly reported globally.

An earlier study by Al-sheikh et al. [28] performed in Makkah during the 1998 Hajj season reported that *H. influenza*, *K. Pneumoniea*, and *S. Pneumoniea* were the most common organisms found among the 395 sputum samples that were collected.

In 1994 study, Al-zeer [29] collected 64 cases of pneumonia in Makkah, who failed to respond to the initial therapy, and found Tuberculosis in 28% of these cases, followed by gram-negative rods in 26% of cases, *S. Pneumoniea* in 10%, and atypical bacteria in 4%.

The major risk factors found in our study were patients with COPD, bronchial asthma, diabetes mellitus, and chronic heart failure. As many as 34.84% of our patients were diabetic. This finding of diabetic pneumonia cases should be carefully considered in treatment planning because it is scientifically and clinically proven that diabetes mellitus is associated with a poor prognosis of pneumonia because of the increase in the rate of pleural effusion and mortality [30].

The mortality rate of pneumonia cases admitted to the ICU internationally is approximately 35%. In our study, the mortality rate in our ICU was 21.45%. In a study performed in 1986, the mortality rate in intensive care unit was 34% in Makkah. In 1994, the reported mortality rate was 17% in the ICU [31]. Mandourah et al. [20] investigated severe pneumonia during 2009—2010; the overall mortality rate was 19.5%.

Recommendations

Given our findings, we recommended emphasis be given to pilgrim awareness and education regarding basic infection preventive measures. Special seminars should be conducted, or flyers with information on upper respiratory tract infections and their symptoms should be distributed to aid pilgrims in seeking immediate medical assistance.

Additionally, all pilgrims should be vaccinated against flu 15 days prior to their arrival. However, high-risk pilgrims (e.g. COPD, bronchial asthma, chronic heart failure, chronic liver or renal disease, and immune-compromised and elderly) should also receive pneumococcal vaccines. Furthermore, regular screening and chest X-rays should be performed prior to their arrival.

The most common pneumonia-causing organisms during the Hajj period were found to be different than those reported in studies done in other parts of the world and during different seasons in our study and other local studies among pilgrims. Therefore, the standard guidelines for the treatment should be modified according to this local annual data.

It is strongly recommended that Oseltamivir be used empirically for all pneumonia patients.

All diabetic patients should be advised to strongly comply with treatment regimens for diabetes mellitus to keep their blood sugar level controlled.

All pilgrims should be advised to bring their medical records along with their diagnosis and prescriptions. The generic names of the drugs rather than the brand names should also be included.

The medical missions of different countries should transfer the patient information appropriately with a detailed history, with specific information regarding the antibiotic used and history of co-morbid illnesses.

Conclusion

We conclude that the infective pneumonia-causing organisms during Hajj are different from the common causative agents globally. The usual standard guideline for the treatment of pneumonia is ineffective for these causative organisms during the Hajj season; therefore, specific adjustments to the guidelines are needed. All efforts should be made to determine these infective agents. Healthcare workers and pilgrims should strictly adhere to preventive measures. All elderly pilgrims and those at risk (COPD, bronchial asthma, diabetic patients, heart failure patients, chronic liver, or renal disease), and those on immunosuppressives should receive flu and pneumococcal vaccine prior to the Hajj. They should be advised to report to the hospital as soon as they feel ill.

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Competing interests

None declared.

Ethical approval

Not required.

Authors' contributions

All authors have substantially contributed to the paper. OAA supervised the study and participated in the clinical part. SHZ participated in the conduction of the clinical components and the analysis of the data and assisted with editing and designing the paper. AMS participated in the conduction of the clinical portion of the study. BHS wrote and edited the manuscript and analyzed the clinical data. All authors read and approved the final manuscript.

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