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# Treatment outcomes and its associated factors among pneumonia patients admitted to public hospitals in Harar, eastern Ethiopia: a retrospective follow-up study

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## ABSTRACT

**Objective** Although there is a high risk of drug resistance, empiric treatment is a common approach for pneumonia management. In this respect, it is relevant to know treatment outcomes of patients with pneumonia. This study aimed to assess treatment outcomes and its associated factors among pneumonia patients treated at two public hospitals in Harar, eastern Ethiopia.

**Design** Retrospective follow-up study.

**Setting** Jugal General Hospital and Hiwot Fana Specialised University Hospital in Harar, eastern Ethiopia.

**Participants** Patients admitted and treated for pneumonia in the two public hospitals in eastern Ethiopia between April 2020 and April 2021.

**Primary outcome** The primary outcome was unfavourable treatment outcome (died or transferred to intensive care unit) for pneumonia patients.

**Results** A total of 693 patients with pneumonia were included in the study. 88 (12.7%) of these patients had an unfavourable treatment outcome, which included 14 (2%) transfers to the intensive care unit and 74 (10.7%) deaths. Patients with comorbidity (adjusted OR, AOR=2.96; 95% CI: 1.47 to 5.97) and with clinical features including abnormal body temperature (AOR=4.03; 95% CI: 2.14 to 7.58), tachycardia (AOR=2.57; 95% CI: 1.45 to 4.55), bradypnoea or tachypnoea (AOR=3.92; 95% CI:1.94 to 7.92), oxygen saturation below 90% (AOR=2.52; 95% CI:1.37 to 4.64) and leucocytosis (AOR=2.78, 95%, CI:1.38 to 5.58) had a significantly increased unfavourable treatment outcome.

**Conclusion** We found that nearly one out of eight patients with pneumonia had unfavourable treatment outcomes. It was considerably high among patients with comorbidities and apparent abnormal clinical conditions. Therefore, taking into account regionally adaptable intervention and paying close attention to pneumonia patients admitted with comorbidity and other superimposed abnormal conditions might help improve the treatment outcomes of these populations.

## STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study included a relatively modest sample size compared with other studies that assessed such patient groups.
⇒ The study population also involved patient groups of various ages, including children and older adults.
⇒ However, we were unable to collect some relevant patient-related parameters and specific laboratory findings that might influence the direction of the treatment outcomes because of the secondary nature of the data we collected retrospectively.

## BACKGROUND

Acute respiratory infections (ARIs) are the leading health burden in low-income and middle-income countries.[1–3] Pneumonia, one of the ARI, is characterised by acute inflammation of the air sacs in the lungs, and it is most often caused by infectious pathogens.[4] It affects the alveoli of the lungs, making lungs filled with a fluid product of inflammation, and results in painful breathing and reduced oxygen intake.[5] Depending on the time and places, the patients acquired the disease, we may classify pneumonia as community-acquired pneumonia (CAP) (ie, if patients get infected with the disease outside the health facility or within 48 hours of admission to hospital). It would be hospital-acquired pneumonia (HAP) (ie, if patients acquired the disease after 48 hours of hospital admission) and ventilator-associated pneumonia (ie, if pneumonia occurred after 48 hours of endotracheal intubation).[6]

Among infectious pathogens, bacteria, viruses and fungi are the most common causes of infectious pneumonia, with bacteria being the most predominant ones.[7] Among bacterial pathogens that cause pneumonia, *Streptococcus pneumoniae, Chlamydia pneumoniae, Mycoplasma pneumoniae, Haemophilus influenza, Staphylococcus aureus, Pseudomonas aeruginosa, Legionella species* and *Klebsiella pneumoniae* are the most commonly identified pathogens from both CAP and HAP.[8–10]

Pneumonia is a more frequent clinical condition among the geriatric and paediatric population, yet it is a common health problem in adult populations.[7–9] It is one of the leading causes of morbidity and mortality in all age groups around the globe.[10 11] It caused 6.8 million hospital admissions worldwide, with 1.1 million in-hospital deaths among older adults.[11]It had an annual incidence rate of 24.8 instances per 10 000 adults, with increasingly high rates among older adults (ie, above 65 years old).[12–14] Additionally, it is the main reason for paediatric hospitalisation and mortality.[15 16]

According to the WHO office for the African region, pneumonia accounted for 16% of all deaths of under 5 children, with 920 136 deaths in 2015. This proportion was 34% for the East Africa region.[17] In 2015, the death from pneumonia was 49% for India, Nigeria, Pakistan, the Democratic Republic of Congo and Ethiopia.[11] Antimicrobials are the mainstay of pneumonia management. Currently, the rate of adverse treatment outcomes for pneumonia including death, treatment failure and complication following the administration of the antimicrobial drugs is reported, with a mortality of 18.5%, complications of 17%[18] and the combined treatment failure and deaths of 32.98%.[19] Some studies conducted on children suspected of pneumonia also conveyed no significant treatment outcomes between treated and non-treated groups.[16] However, early treatment made a difference among children who received antimicrobials and did not, but not during late treatment.[20] Pneumonia is also the most common cause of mortality among hospitalised children.[15]

Despite the common empiric treatment approach in the country, there were inconsistencies and scant studies conducted regarding pneumonia treatment outcomes and its associated factors in eastern Ethiopia. Hence, we aimed to assess the treatment outcomes and the factors associated with the treatment output of patients with pneumonia admitted to medical or paediatric wards of Hiwot Fana Specialised University Hospital (HFSUH) and Jugal Hospital (JH) in Harar, eastern Ethiopia.

## METHODS

### Study design and settings

We conducted a facility-based retrospective follow-up study at HFSUH and JH in Harar, eastern Ethiopia. Harar is the capital of the Harari region which is 526 km to the East of Addis Ababa, the capital city of Ethiopia. In the area, there are 2 public, 1 private and 1 federal police hospital, 9 health centres (5 urban and 4 rural), 24 health posts and tennon-profit clinics. One of the public hospitals is HFSUH, a teaching hospital of Haramaya University, which serves as a referral hospital for the entire eastern part of the country. Although the two hospitals have various wards and clinics, this study conducted at the medical and paediatric wards of the hospitals from 1 May 1 2021 to 31 May 2021.

### Study participants and sample size

We considered all patients diagnosed with pneumonia and admitted to medical and paediatric wards of HFSUH and JH from April 2020 to April 2021. However, we excluded patients lacked essential information, such as the outcome of interest, and who had received antibiotics for less than 72 hours (ie, patients for whom we cannot assess clinical responses).

To determine the sample size, we considered the outcome variable and factors significantly associated with unfavourable treatment outcomes(ie, male sex, age, presence of tuberculosis as comorbidity, elevated blood urea nitrogen and elevated serum creatinine). We separately calculated the sample size for the outcome of interest and the factors associated with it using a single population proportion formula and double proportion formula, respectively. For the outcome variable, we made the following assumptions: a two-sided 95% confidence level, a sample-to-population margin of error of 0.04 and a proportion of unfavourable treatment outcome (p=0.35). For factors associated with unfavourable treatment outcome, we computed the sample size using Epi Info V.7, in light of a two-sided 95% confidence level, a margin of error of 4%, a power of 80% and a 1;1 ratio of exposed to unexposed. We adjusted the determined sample size by adding 10% contingency and finally considered the one with the largest size, revising works of literature.[9 14 21–23] Accordingly, we sampled 693 patients with complete medical records from those admitted with pneumonia for this study.

We identified and reviewed medical records of patients admitted with pneumonia to medical or paediatric wards of HFSUH and JH between April 2020 and April 2021. We identified a total of 1060 patients with pneumonia from the inpatient patient registration book during this specific period. Next, we allocated the sample size proportionally, building on the individual hospital case burden (ie, HFSUH=405 and JH=288). Then, the patient's medical record number was registered, coded and entered into a computer program (Microsoft Excel) for a lottery method. Finally, we generated a total of 693 medical records of pneumonia patients by applying a simple random sampling method. These were the number of patients we considered for the data collection.

### Patient and public involvement

There were no patients directly involved in this study because the data were collected from a secondary data source. However, the patients were indirectly represented by their medical records. As a result, we abstracted baseline, follow-up and laboratory information of the patients from the document noted in medical records.

### Definition of operational terms

#### Favourable treatment outcome

We considered the treatment outcome of patients as favourable when the patients diagnosed with pneumonia and treated with antimicrobial drugs were discharged

with stable/improved clinical conditions (recorded from discharge summary).

### Unfavourable treatment outcomes

We considered the treatment outcomes of patients as unfavourable when the patients diagnosed with pneumonia and treated with antimicrobials had died (recorded from death report) or transferred to the intensive care unit (recorded from the discharge summary).

We employed a reference book for normal ranges related to clinical characteristics (eg, heart rate, respiratory rate, temperature and blood pressure). Specific data of study participants were collected from medical record cards and interpreted accordingly.

### Data collection methods and procedures

We collected data from the medical records of patients using a structured data abstraction format. The format was prepared by reviewing similar previous studies.[9 18] The data collection tool contained two sections. The first section addressed the sociodemographic (ie, age, sex and place of residency) of patients and the qualification of the prescriber. The second section contained clinical characteristics, laboratory findings and outcomes of treatments (ie, improvement, death and transfer to intensive care unit), the data we recorded from discharge summary, death report and patient progression notes. Six pharmacists were involved in the data collection. Before actual data collection, we conducted a pretest study on 5% of the calculated sample size at Federal Police Hospital to enhance the validity and reliability of the data collection format. Subsequently, we removed some parameters from the data collection tool due to the unavailability of the variables from medical record cards. Again, the principal investigator monitored the data collection process and the completeness of the collected data. Data were cleaned and checked for any missed data through the running of frequency before analysis and missed data were rechecked and entered before we proceeded to further data analysis.

### Data processing and analysis

We coded and entered the data into EpiData V.3.1 and then exported it to SPSS V.26 for analysis. The data were cleaned and checked for completeness with simple frequencies and cross-tabulation. During the data management, we categorised the treatment outcome as either favourable or unfavourable, building on the criteria fulfilment or not. Next, we conducted a bivariable logistic regression analysis to identify potential covariates of unfavourable treatment outcomes. Then, variables with p≤0.25 were retained for multivariable logistic regression analysis. We tested this final model's goodness of fit using the Hosmer-Leme show statistic test. The model fitted well since it was not significant (p=0.265) that met the Hosmer-Leme show statistic requirement of p>0.05. We also undertook a multicollinearity test to see the correlations among independent variables using the variance inflation factor (VIF). All variables had a VIF of <1.5, indicating the absence of multicollinearity among the variables considered for the final model. We calculated crude OR and adjusted OR (AOR) with a 95% CI to measure the strength of association between the outcome and independent variables. Variables with a p<0.05 in the multivariable regression analysis were considered to have a significant association with unfavourable treatment outcomes.

## RESULTS

### Sociodemographic characteristics of patients

We assessed a total of 693 patients for this study. Of these, 384 (55.4%) patients were male, with a male-to-female ratio of 1.24:1, and more than half of them (52.2%) were children aged below 14 years. The median age was 13 years, with an IQR of 0–39 years. The majority, 534 (77.1%), of the patients were residents of Harar town. About half of the patients (50.2%) obtained prescription of drugs from qualified medical and paediatric residents (table 1).

### Clinical characteristics and laboratory findings

Concerning types of pneumonia, CAP was the most common (96.8%) diagnosis, followed by HAP (2.2%) and aspiration pneumonia (1%) (figure 1). Nearly three-fifths of the patients had comorbidities (59.7%), of which severe acute malnutrition (SAM) (10.9%), pulmonary tuberculosis (PTB) (9.2%) and anaemia (8.47%) accounted for around half of this comorbid burden (table 2).

Clinical features of around half of the patients revealed abnormally increased body temperatures (49.2%) and respiratory rates (50.5%). Screening of chest X-ray results for 619 (89.3%) of the patients also suggested pneumonia (83.8%). However, the majority of the patients had normal clinical values for heart rate (69.3%) and oxygen saturation of ≥90% (83.3%) (tables 3 and 4).

### Medication prescribed and treatment outcomes

Ceftriaxone plus azithromycin 322 (46.5%) followed by ceftriaxone alone 159 (22.9%) were the most frequently used antimicrobials. The treatment outcomes were categorised as favourable treatment outcomes for those who improved and were discharged from the hospital, and unfavourable treatment outcomes for those who died in the hospital or were transferred to the intensive care unit after being initiated with antimicrobials. Accordingly, most patients (87.3%) had discharged with improvements, while 10.7% (95% CI: 8.5% to 13%) of them have died in the hospital. Overall, 88 (12.7%; 95% CI: 10.2 to 15.2) patients had an unfavourable treatment outcome including those patients transferred to intensive care units (table 5).

### Factors associated with unfavourable treatment outcome

Bivariable logistic regression analysis identified some factors associated with unfavourable treatment outcomes. In this sense, patient characteristics including age >65

Table 1 Sociodemographic characteristics of patients with pneumonia at medical and paediatric wards of HFSUH and JH, Harar, eastern Ethiopia from 1 May 2021 to 31 May 2021 (n=693)

| Variables | Category | Frequency (%) | Median age (in years) | IQR (in years) | Range (in years) |
|---|---|---|---|---|---|
| Age categories (in years) | 0–14 | 362 (52.2) | 13 | 0–39 | 0.08–88 |
| | 15–24 | 37 (5.3) | | | |
| | 25–64 | 246 (35.5) | | | |
| | ≥65 | 48 (6.9) | | | |
| Sex | Male | 384 (55.4) | | | |
| | Female | 309 (44.6) | | | |
| Place of residence | Harar | 159 (22.9) | | | |
| | Outside of Harar | 534 (77.1) | | | |
| Prescriber qualification | General practitioner | 150 (21.6) | | | |
| | Medical intern | 195 (28.1) | | | |
| | Resident | 384 (50.2) | | | |

HFSUH, Hiwot Fana Specialised University Hospital; JH, Jugal Hospital.

years, comorbidity, TB, chronic obstructive pulmonary disease, abnormal body temperature, tachycardia, bradypnoea or tachypnoea, oxygen saturation <90% and leucocytosis were the factors considered in the model of multivariable regression analysis (table 6).

Finally, the multivariable regression analysis showed that the unfavourable treatment outcome had a significant relationship with the presence of comorbidities (AOR=2.96; 95% CI: 1.47 to 5.97); abnormal body temperatures (AOR=4.03; 95% CI: 2.14 to 7.58); bradypnoea or tachypnoea (AOR=3.92; 95% CI: 1.94 to 7.92); tachycardia (AOR=2.57; 95% CI: 1.45 to 4.55); leucocytosis (AOR=2.78; 95% CI:1.38 to 5.58); oxygen saturation of <90% (AOR=2.52; 95% CI: 1.37 to 4.64) and patients who had received an initial inappropriate antimicrobial regimen (AOR=4.30; 95% CI: 2.33 to 7.94) (table 6).

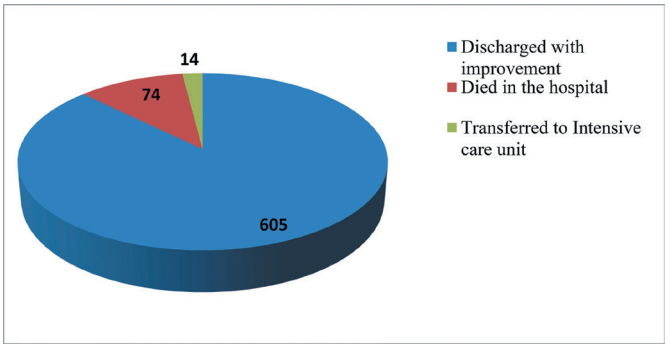


Figure 1 Types of pneumonia among patients admitted with pneumonia at paediatric and medical wards of HFSUH and JH, Harar, eastern Ethiopia, from 1 May 2021 to 31 May 2021 (n=693). HFSUH, Hiwot Fana Specialised University Hospital; JH, Jugal Hospital.

## DISCUSSION

We found that one-in-eight pneumonia patients admitted to hospitals had unfavourable treatment outcomes. This verdict was considerably high among patients with comorbidities and clinical characteristics such as tachycardia, bradypnoea or tachypnoea, abnormal body temperature, oxygen saturation below 90%, leucocytosis and inappropriate initial drug regimens.

The finding showed that 12.7% of patients had unfavourable treatment outcomes, including all-cause mortality and disease progression with transfers to intensive care units. This result was lower than studies done in Thailand (31.97%),[19] Botswana (58.4%),[24] Ethiopia at Nekemte referral hospital (30.6%),[25] Ethiopia at Jimma (22.1%)[21] and Ethiopia at Addis Ababa (35.5%).[18] Yet, higher than another study conducted at Addis Ababa, Ethiopia (7.7%).[26] The attainment of a lower proportion of unfavourable treatment outcome might be related to the existence of a range of specialised healthcare professionals in the selected study area and being a referral or teaching hospital. In addition, the inclusion of all age groups,unlike other studies that primarily consider extreme age groups (ie, paediatric or elderly population).[21 24 25] The status of the immune system may also play a role in prevention and positively impact treatment outcomes of infectious diseases[27–30] since paediatric and geriatric populations are more often at high risk of immune compromisation. Hence, trends in vaccination coverage in the country can attribute to discrepancies among the studies. This finding also aligns with studies that revealed full vaccination coverage in urban areas different from a low uptake among rural residents.[5 9 31] It may account for the relatively lower percentage of unfavourable pneumonia outcome reports of Metropolitan studies from elsewhere.[10 32]

Another finding was an overall mortality rate of 10.7%, which was in line with a study done in India (10.5%).[33]

**Table 2** Specific comorbidity among patients with pneumonia at medical and paediatric wards of HFSUH and JH, Harar, eastern Ethiopia from 1 May 2021 to 31 May 2021 (n=414)

| Specific comorbidity | Frequency (%) |
|---|---|
| SAM | 45 (10.9) |
| Pulmonary TB | 38 (9.2) |
| Anaemia | 36 (8.7) |
| Acute gastroenteritis | 31 (7.5) |
| Congestive heart failure | 27 (6.5) |
| Moderate acute malnutrition | 27 (6.5) |
| Chronic obstructive pulmonary disease | 26 (6.3) |
| Acute decompensated heart failure | 24 (5.8) |
| Hyperactive airway disease | 23 (5.6) |
| Meningitis | 16 (3.9) |
| Disseminated TB | 13 (3.1) |
| Deep vein thrombosis | 11 (2.7) |
| Urinary tract infection | 11 (2.7) |
| Type 2 diabetes mellitus | 10 (2.4) |
| Chronic liver disease | 6 (1.4) |
| SAM+pulmonary TB | 6 (1.4) |
| Hypertension | 5 (1.2) |
| Pertussis | 5 (1.2) |
| Asthma | 4 (1) |
| Lung cancer | 4 (1) |
| Moderate acute malnutrition+amebiasis | 4 (1) |
| Sepsis | 4 (1) |
| Others* | 38 (9.2) |

*Acute coronary syndrome, attention deficit hyperactivity disorder, acute kidney injury, anaemia+ hyperactive airway disease, appendicitis, bronchiectasis, congenital heart disease, congestive heart disease +anaemia, cholelithiasis, croup, chronic rheumatic valvular heart disease, dyspepsia, moderate acute malnutrition + pulmonary TB, moderate acute malnutrition +hyperactive airway disease, myelomeningocele, retroviral infection, SAM + acute gastroenteritis, SAM + anaemia, SAM + congenital heart disease, SAM + congestive heart disease, SAM+ hyperactive airway disease, type 1 diabetes mellitus.
HFSUH, Hiwot Fana Specialised University Hospital; JH, Jugal Hospital; SAM, severe acute malnutrition; TB, tuberculosis.

**Table 3** Clinical characteristics and laboratory findings of patients with pneumonia at medical and paediatric wards of HFSUH and JH, Harar, eastern Ethiopia from 1 May 2021 to 31 May 2021 (n=693)

| Variables | Category | Frequency (%) |
|---|---|---|
| Weight (Kg) | 1–5 | 59 (14) |
| (n=421) | 6–10 | 170 (40.4) |
| | 11–15 | 48 (11.4) |
| | ≥16 | 144 (34.2) |
| Blood pressure | Normal | 320 (94.96) |
| (n=337) | Elevated blood pressure | 4 (1.19) |
| | Hypotension | 13 (3.86) |
| Body temperature | Normal | 349 (50.4) |
| | Febrile | 341 (49.2) |
| | Hypothermia | 3 (0.4) |
| Heart rate | Normal | 480 (69.3) |
| | Tachycardia | 213 (30.7) |
| Respiratory rate | Normal | 310 (44.7) |
| | Tachypnoea | 350 (50.5) |
| | Bradypnoea | 33 (4.8) |
| $SPO_2$ | Normal | 577 (83.3) |
| | Decreased | 116 (16.7) |
| WCC | Normal | 241 (34.8) |
| | Leucocytosis | 452 (65.2) |
| Result of CXR | Normal CXR | 82 (13.2) |
| (n=619) | Pneumonia | 519 (83.8) |
| | Cardiomegaly | 6 (1) |
| | PTB | 3 (0.5) |
| | Not concluded | 3 (0.5) |
| | Other* | 6 (1) |

*Bronchiectasis, disseminated tuberculosis, pneumonia+cardiomegally and pneumonia+ pulmonary tuberculosis.
CXR, chest X-ray; HFSUH, Hiwot Fana Specialised University Hospital; JH, Jugal Hospital; PTB, pulmonary tuberculosis; SPO2, oxygen saturation; WCC, white cell count.

But, the result was lower than studies done in England and Wales,[23 34] Malawi,[9] Ethiopia at Addis Ababa[18] and Ethiopia at Jimma,[21] in which the overall mortality rates were 24.4%, 14.6%, 18.5% and 20.2%, respectively. On the contrary, the finding was higher than studies done in Italy (7.3%),[35] Ethiopia at Addis Ababa (5.3%)[26] and Ethiopia at Nekemte referral hospital (5.85%).[25] This higher mortality rate might be due to the high burden of comorbid illnesses[21] accounting for relative susceptibility to respiratory infections[36] and high all-cause mortality in Harar.

The odds of having unfavourable treatment outcomes were almost three times higher among patients with comorbid conditions compared with those without comorbidities. This finding is consistent with studies conducted in Malawi[37] and Ethiopia.[18] The presence of comorbidity may also increase in-hospital mortality among patients with pneumonia as an independent risk factor.[38] In addition, by prolonging hospital stays, comorbidity may increase the risk of acquiring multidrug-resistant pathogens,[39–41] further contributing to undesirable treatment outcomes.

Among the comorbidities identified, acute malnutrition, tuberculosis, anaemia and heart failure were common. Severe acute malnutrition is prominent and the

Table 4 Distribution of clinical characteristics with each age range among patients with pneumonia at medical and paediatric wards of HFSUH and JH, Harar, eastern Ethiopia from 1 May 2021 to 31 May 2021 (n=693)

| Variables | Category | Age range | | | | |
|---|---|---|---|---|---|---|
| | | 0–14 | 15–24 | 25–64 | ≥65 | Total |
| Presence of comorbidity | Yes | 256 | 16 | 112 | 32 | 414 |
| | No | 108 | 21 | 134 | 16 | 279 |
| Temperature | Normal | 196 | 16 | 118 | 19 | 349 |
| | Hyperthermia | 163 | 21 | 128 | 29 | 341 |
| | Hypothermia | 3 | 0 | 0 | 0 | 3 |
| Heart rate | Normal | 237 | 17 | 189 | 37 | 480 |
| | Tachycardia | 125 | 20 | 57 | 11 | 213 |
| Respiratory rate | Normal | 197 | 11 | 92 | 10 | 310 |
| | Tachypnoea | 164 | 22 | 134 | 30 | 350 |
| | Bradypnoea | 1 | 4 | 20 | 8 | 33 |
| Oxygen saturation | ≥90% | 323 | 31 | 190 | 33 | 577 |
| | <90% | 39 | 6 | 56 | 15 | 116 |
| WCC | Normal | 126 | 9 | 92 | 14 | 241 |
| | Leucocytosis | 236 | 28 | 154 | 34 | 452 |

HFSUH, Hiwot Fana Specialised University Hospital; JH, Jugal Hospital; WCC, white cell count.

leading cause of mortality and morbidity in Ethiopia.[42–46] The overall recovery time from hospitalised children was reported to belong to undesired treatment outcomes such as death.[47 48] Such outcomes have been common in comorbidities such as pneumonia,[49 50] congestive heart failure[51] and oxygen saturations below 90%.[52] Moreover, a history of heart failure,[53–55] anaemia[56–58] and TB[59] impacted the incidence and poor prognosis of pneumonia resulting in death.

In fact, the absence of aetiological diagnosis,[60 61] and sensitive radiologic tools[62] for early respiratory infections may contribute to complications and hospitalisations.[63] A history of PTB is a risk factor for long-term pulmonary impairment,[64] and one-in-five incidence of severe pneumonia was reported in these populations,[65] implicating one of the priorities for screening for better treatment outcomes.[61] Building the capacity of inpatient service providers and regular monitoring for service provision based on the management protocol was also recommended.[66]

Table 5 Unfavourable treatment outcome among patients admitted with pneumonia at paediatric and medical wards of HFSUH and JH, Harar, eastern Ethiopia, 1 May 2021–30 May 2021 (n=693)

| | | Unfavourable treatment outcome | | |
|---|---|---|---|---|
| | | No | Yes | Total |
| General population | | 605 | 88 | 693 |
| Age group | 0–14 | 323 | 39 | 362 |
| | 15–24 | 34 | 3 | 37 |
| | 25–64 | 217 | 29 | 246 |
| | ≥65 | 31 | 17 | 48 |

HFSUH, Hiwot Fana Specialised University Hospital; JH, Jugal Hospital.

In this study, the odds of having unfavourable treatment outcomes among patients who had abnormal body temperature, tachycardia, bradypnoea or tachypnoea, oxygen saturation less than 90% and leucocytosis at baseline/admission were 4.03, 2.57, 3.92, 2.52 and 2.78 times higher when compared with patients without these clinical conditions, respectively. Consistent findings were reported from studies conducted in Canada,[5 67] Japan,[68] India,[22 23] Nigeria,[9 69] Malawi[9] and Ethiopia (Addis Ababa).[18] These factors might indicate the severity of pneumonia and are associated with unfavourable treatment outcomes.[23 70–73] The effects of pneumonia on a person's life expectancy are also significant. According to the Global Burden of Disease study 2019, Ethiopians' life expectancy increased from 46.91 years (45.71–48.11) in 1990 to 68.84 years (67.51–70.18) in 2019. Despite this, lower respiratory infections remain the third-leading cause of premature death for all ages, which mandates appropriate prevention and treatment strategies to prevent and treat them. This study had some limitations. Due to the secondary nature of the data, we were unable to gather some relevant patient-related characteristics and particular laboratory findings that might influence the direction of the treatment outcomes.

**Table 6** Factors associated with unfavourable treatment outcome among patients admitted with pneumonia at paediatric and medical wards of HFSUH and JH, Harar, eastern Ethiopia, 1 May 2021–30 May 2021 (n=693)

| Variable | Category | Unfavourable treatment outcome | | COR | AOR | P value |
|---|---|---|---|---|---|---|
| | | No | Yes | | | |
| Age (years) | 25–64 | 217 | 29 | 1 | 1 | |
| | 0–14 | 323 | 39 | 0.90 (0.542–1.50) | 0.82 (0.42–1.61) | 0.569 |
| | 15–24 | 34 | 3 | 0.66 (0.191–2.28) | 0.48 (0.12–1.96) | 0.307 |
| | ≥ 65 | 31 | 17 | 4.10 (2.02–8.32)** | 2.67 (0.97–7.37) | 0.059 |
| Presence of comorbidity | No | 266 | 13 | 1 | 1 | |
| | Yes | 339 | 75 | 4.53 (2.46–8.33)** | 2.96 (1.47–5.97)* | 0.002 |
| Tuberculosis | No | 578 | 77 | 1 | 1 | |
| | Yes | 27 | 11 | 3.06 (1.44–6.41)* | 1.27 (0.44–3.65) | 0.663 |
| COPD | No | 588 | 79 | 1 | 1 | |
| | Yes | 17 | 9 | 3.94 (1.67–9.14)* | 1.06 (0.32–3.49) | 0.926 |
| Temperature | Normal | 333 | 16 | 1 | 1 | |
| | Abnormal | 272 | 72 | 5.51 (3.13–9.69)** | 4.03 (2.14–7.58)** | <0.001 |
| Pulse rate | Normal | 442 | 38 | 1 | 1 | |
| | Tachycardia | 163 | 50 | 3.57 (2.26–5.64)** | 2.57 (1.45–4.55)* | 0.001 |
| Respiratory rate | Normal | 297 | 13 | 1 | 1 | |
| | Bradypnoea or Tachypnoea | 308 | 75 | 5.56 (3.02–10.24)** | 3.92 (1.94–7.92)** | <0.001 |
| $SPO_2$ | ≥90% | 525 | 52 | 1 | 1 | |
| | < 90% | 80 | 36 | 4.54 (2.79–7.38)** | 2.52 (1.37–4.64)* | 0.003 |
| WCC | Normal | 228 | 13 | 1 | 1 | |
| | Leucocytosis | 377 | 75 | 3.49 (1.89–6.43)** | 2.78 (1.38–5.58)* | 0.004 |
| Inappropriate initial therapy | Noc | 527 | 50 | 1 | 1 | |
| | Yes | 78 | 58 | 5.14 (3.16–8.33) | 4.30 (2.33–7.94) | <0.001 |

Hosmer-Lemeshow goodness of fit test was fitted with a P-value of 0.265.
*P<0.05, **p<0.001.
AOR, adjusted OR; COPD, Chronic obstructive pulmonary disease; COR, crude OR; HFSUH, Hiwot Fana Specialised University Hospital; JH, Jugal Hospital; $SPO_2$, oxygen saturation; WCC, white cell count.

## CONCLUSIONS

This study found that nearly one in eight patients with pneumonia had unfavourable treatment outcomes. It was considerably high among patients with comorbidities and other clinical characteristics involving abnormal body temperature, tachycardia, bradypnoea or tachypnoea, oxygen saturationless than 90% and leucocytosis. Therefore, considering regionally adaptable intervention and giving special attention to pneumonia patients admitted with comorbidity and other superimposed abnormal conditions might help improve the treatment outcomes of these populations.

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**Authors' contribution** All authors made a significant contribution to the work reported. AJ, TG and DE conceived the original idea and drafted the proposal. AJ, TG, ASM and DE were involved in data acquisition, analysis, interpretation and write up of the paper. All authorsdrafted the manuscript and prepared it for publication, have agreed on the journal to which the article has been submitted, and agreed to be accountable for all aspects of the work.

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**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** The information obtained from patient medical record cards was kept confidential, and the name of the patient and other information that specifically identify the patient was not recorded.

**Ethical consideration** Ethical clearance was obtained from the Institutional Health Research Ethics Review Committee of Haramaya University, College of health and medical sciences, with the reference number 055/2021. A letter of permission was handed to the concerned body of HFSUH and JH as well as the purpose of the study was elaborated. Voluntary, informed, written and signed consent was obtained from the administrator of each hospital. During data collection, all necessary measures were considered for the protection of COVID-19.

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