Original Article

Incidence of recovery from severe pneumonia and its predictors among children 2–59 months admitted to pediatric ward of Ayder Comprehensive Specialized Hospital, Tigray, Ethiopia: A retrospective Cohort study

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Abstract

Background: Pneumonia is a major reason for hospital admission among children, particularly in resource-poor areas. A hospital stay (length of stay) alone is found to contribute for 46.8% of a household cost for single episode of severe pneumonia. The aim of this study was to determine the incidence of recovery from severe pneumonia and predictors among children 2–59 months of age admitted to pediatric ward of Ayder Comprehensive Specialized Hospital (ACSH). **Methods:** A retrospective facility-based cohort study was conducted among under-five-year-old children admitted in ACSH. Three years medical records from July 7, 2015 to July 6, 2018 were reviewed. A total of 285 children with severe pneumonia admitted to pediatric ward of ACSH were included. Kaplan-Meier Survival Curve was used to estimate recovery time. The independent effects of covariates on recovery time are analyzed using multivariate Cox-proportional adjusted model. **Result:** The median survival time was four days (95% CI = 3.732 – 4.268). The incidence of recovery was 92.3%. Co-morbidity (AOR: 3.47, 95%CI, 2.21, 5.4), malnutrition (AOR = 1.9, 95%CI, 1.2, 3.1), duration of chief complaint (AOR = 0.72, 95%CI: 0.54, 0.94), and vaccination (AOR = 0.32, 95% CI, 0.13, 0.81) were significant predictors of time to recovery from severe pneumonia. **Conclusion:** High recovery rate and short length of hospital stay was observed in this study. Increased duration of chief complaint, presence of co-morbidity, being malnourished, and vaccination were factors that associated with time to recovery. Therefore focuses have to be given in increasing the community's health seeking behavior to visit health facility early and especial attention should be given for children with co-morbidity, malnutrition, and unvaccinated children.

Keywords: Children 2–59 months, Ethiopia, incidence of recovery, predictors, severe pneumonia

Introduction

Pneumonia is a form of acute respiratory infection that affects the lungs. The World Health Organization (WHO) recommends diagnosis of pneumonia when children under five have acute onset of cough with fast breathing. Streptococcus pneumonia

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and Haemophilus influenza type b (Hib) are the most common cause of bacterial pneumonia in children.[1]

Pneumonia is the most common infectious cause of death in children around the world. In 2015, it killed 920,136 children under the age of five years, accounting for 16% of all children under the age of five deaths.[1] It is also a common reason for children to be admitted to hospitals, especially in resource-poor communities.[2] The majority of children who contract pneumonia live in low-income nations, many of which have inadequate immunization programs.[3] Pneumonia is the single largest infectious cause of death in children worldwide. It killed 920,136 children under the age of 5 years in 2015, accounting for 16% of all deaths of children under five years.[4] It is also a major reason for hospital admission among children, particularly in resource-poor areas.[5]

While case fatality is a well-known metric for determining the severity of an illness, prolonged hospitalization can also be used to determine the severity of pneumonia.[6] The average length of stay (LOS) in hospitals is considered a measure of efficiency. According to the US Centers for Disease Control and Prevention, the average length of hospital stay for children aged 15 years (excluding neonates) for severe pneumonia treatment is five days. Any hospital stay exceeding five days is considered to be prolonged.[7]

Illness and hospitalization cause a considerable level of psychological discomfort, and it is one of the most distressing situations that people can go through in their lives. Young children are more vulnerable, and they are more prone to link their distress from illness and hospitalization to concepts like being away from home and being separated from their parents. Illness and hospitalization are painful and anxiety-provoking experiences for children, and they can result in short-term or long-term behavioral and psychological problems.[8]

Families faced a substantial financial burden as a result of severe pneumonia treatment in the hospital. A hospital stay (duration of stay) accounts for 46.8% of a household's total expense for a single episode of severe pneumonia.[9] In a hospital inpatient setting, direct medical costs for severe pneumonia range from 26.6% to 115.8% of monthly household income.[10]

For an episode, a hospital stay involves a 5.5% chance of an adverse drug reaction, a 17.6% risk of infection, and a 3.1% risk of an ulcer. Each additional night spent in the hospital raises the chance of bad drug reactions by 0.5%, infections by 1.6%, and ulcers by 0.5%.[11] Increased LOS in the hospital, on the other hand, is linked to hospital-acquired malnutrition.[12]

Primary care physicians are the frontline professionals to care and follow children with severe pneumonia.

Identifying the predictors of time to recovery from severe pneumonia may assist the primary care physicians to counsel parents on the likely duration of hospitalization. This will enable them to mobilize resources for the hospital care of the child and re-adjust to any disruption that the admission may cause. This may reduce the incidence of DAMA, thereby ensuring adequate management and reducing risk of death. It also helps the physicians to allocate scarce resource and pay special attention for high risk group children on admission and during hospital stay, and may eventually add an input in the struggle to reduce under five deaths and to achieve the national targets. Understanding the predictors of time to recovery from will help the primary care physicians in planning for resources like bed and drug. It would also fill the existing information gap related to poor treatment outcomes of pediatrics patients.

In November 2011, the Ethiopian government included pneumococcal conjugate vaccines (PCV) and Haemophilus influenza type b (Hib) vaccines in the national baby immunization program.[13]

The aspirational targets for 2025 and 2035, according to the health sector transformation plan (HSTP) launched in 2015, are to reduce the under-five mortality rate to 31 and 14 per 1000 live births, respectively.[14]

Despite the programs and techniques indicated above, few research on the recovery duration from severe pneumonia and its associated factors have been undertaken in the study area. As a result, the goal of this study is to investigate the time to recovery from severe pneumonia and its determinants in children aged 2 to 59 months who are admitted to the ACSH pediatric unit with severe pneumonia.

Methods and Materials

Study area and period

The study was conducted at Ayder Comprehensive Specialized Hospital (ACSH) which is found in Mekelle city from August to September 2018. Mekelle is a capital city of Tigray regional state located in Northern Ethiopia 783 KM away from Addis Ababa. The city has one referral and three general hospitals.

Study design

Retrospective cohort study design was conducted.

Study population

The study population was selected children with severe pneumonia aged from 2 to 59 months who were managed in ACSH pediatric ward from July 7, 2015 to July 6, 2018.

Sample size determination

The sample size was determined using STATA statistical package, Version 12. A regression coefficient of covariates was predetermined to obtain the maximum sample size. A regression coefficient 0.39 (effect size) for level of consciousness when other covariates are held constant found to be a covariate of interest that maximizes the sample size.[15]

The variability of 0.33 standard deviation (SD) used, probability of success (recovery) observed was 0.879, 0.5% marginal of error, and 95% confidence interval. The number of subjects needed to achieve a power of 80% and assuming no subjects anticipated to withdraw from the follow up. The total sample size required is 285.

Sampling technique

All children charts with severe pneumonia admitted to pediatric ward of ACSH from July 7, 2015 to July 6, 2018, were reviewed. At a first step those children aged less than two months were excluded. From the remaining records, charts with missing value for the major variables especially age and medical record number were discarded. At last, data were retrieved (extracted) from 285 eligible and available charts consecutively.

Data collection tool and procedure

A data abstraction tool was developed using the selected variables from components of chart of federal ministry of health. The data abstraction tool had child age in months, sex, and place of residence as sociodemographic variables. A variable LOS was derived by subtracting the date of admission from the date of discharge.

On the clinical parameters section, the variables outcome status was obtained which is later used to determine the occurrence of event. Chief complaint, duration of chief complaint, body temperature at admission, level of consciousness, exclusive breast feeding, immunization status, HIV status, co-morbidity, type of co-morbidity, malnutrition, and antibiotic administered were included.

Data quality assurance

The pattern of history taking and physical examination was observed first to semi standardize the data abstraction tool. Clinical nurses collected the data after getting a training of one day. Completed questionnaires were collected on daily basis and checked for completeness and consistency. Data entry and cleaning was done on daily basis and timely feedback was being communicated to the data collectors.

Study variables

Dependent variable: Time to recovery from severe pneumonia.

Independent variables

- Sex
- Age
- Place of residence
- Type of chief complaint
- Duration of chief complaint
- Body temperature at admission
- Respiratory rate
- Chest indrawing
- Need of oxygen support at admission.

Level of consciousness

- Weight
- Height
- MUAC
- Exclusive breast feeding
- Immunization status
- HIV sero-status
- Presence of co-morbidity
- Type of co-morbidity.

Type of antibiotic prescribed.

Data analysis

Data was entered to Epi-data for windows and analyzed using SPSS version 20. Summarization of the data was done using either mean (SD) or median (interquartile range) after checking for the normality of the continuous variables. Normality was checked using kurtosis, skewness, and Q-Q plots. Kaplan-Meier Survival Curve was used to estimate recovery time after initiation of inpatient treatment and to compare groups. The log rank and generalized Wilcoxon (Breslow) tests were used to test the null hypothesis that states a no difference in the distribution of survival times.

Multivariable Cox proportional hazards regression

The independent effects of covariates on recovery time were analyzed using multivariable Cox proportional adjusted model. Hazard ratios with their 95% confidence interval (CI) are estimated and *P* value less than 0.05 was used to declare presence of significant association.

Assessing model assumption

The proportional hazard assumption was checked statistically by testing an interaction of the covariates with time.

Operational definition (Variable definition)

Event: Recovery from severe pneumonia.

Discharged (Recovered): Those who left the hospital with clinical improvement confirmed by a physician.

Recovery time: The time from admission to when the child is discharged from the hospital due to improvement in symptoms calculated by number of days (hospital stay).

Time zero: The time when a child is being admitted to the inpatient pediatric ward.

Censored: A child with severe pneumonia who has been admitted to the ward and happens to be dead, self-discharged, or with unknown outcome status.

Absconded: Those who left the hospital by themselves (without being discharged by a physician).

Ethical consideration

Ethical approval was obtained from the Review Board (RB) of Mekelle University, college of health sciences. Letter of permission was obtained from school of public health and medical director to use patient cards and was submitted to the concerned body in the pediatric ward. As the study used a review of records, no consent was needed from the mothers or caregivers of the study subjects.

Results

Sociodemographic and clinical characteristics of study participants

From 285 cases, 49.8% of the children were in the age group 2–11 months and 41.8% were in the age group of 12–35 months. The median age of the patients was 12 months (IQR = 6, 18). Males account for 150 (52.6%) of the patients and 171 (60%) of the children were from Mekelle city and the rest were from different zones of Tigray region and Afar. Most of the children's chief complaint was cough (66.7%) followed by fast breathing (17.5%). Sixty-four percent (64%) of the children came to the hospital in the third day of start of chief complaint, 6% of the patients had a duration of chief complaint above seven days while the rest 86 (30%) being within four to seven days [Table 1].

Most (89.8%) of the children had history of exclusive breast feeding. More than half (54.7%) of the children were fully immunized, 103 (36.1%) were up-to-date (vaccinated according to their age), and 8 (2.8%) were not fully immunized according to the National Expanded Program of Immunization (EPI) [Table 1].

The median length of hospital stay was four days (IQR = 2.5, 7). The median duration of chief complaint was three days [Table 2].

Medical outcome after admitting with severe pneumonia

Out of 285 children, 263 (92.3%) of them were discharged with improvement, only one patient was found to be dead [Figure 1].

Antibiotic prescribing pattern

Less than half of the patients, 126 (44.2%) had taken Ceftriaxone alone followed by crystalline penicillin for 112 (39.3%) of them [Figure 2].

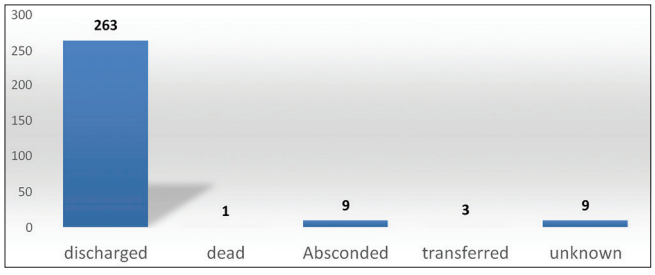

Figure 1: Outcome of children aged 2–59 months with severe pneumonia admitted from july 2015 to july 2018 at ACSH

Kaplan-Meier survival estimation

According to the Kaplan-Meier survival estimation, the median survival time without using any stratification factor was four days (95% CI = 3.732 – 4.268) [Figure 3].

Table 1: Frequency and Percentage for some of the categorical variables of children aged 2-59 months with severe pneumonia admitted from July 2015 to July 2018 at ASCH

Variables	Frequency	%
Age category		
2-11 months	142	49.8
12-35 months	119	41.8
36-59 months	24	8.4
Sex of child		
Male	150	52.6
Female	135	47.4
Residence		
Mekelle	172	60.4
Out of Mekelle	113	39.6
Type of chief complaint		
Cough	190	66.7
Fever	18	6.3
SOB	23	8.1
Fast breathing	50	17.5
Other	4	1.4
Duration of chief complaint		
Below 3 days	182	63.8
4-7 days	86	30.2
Above 7 days	17	6.0
Vaccination status		
Fully immunized	156	54.7
Up-to-date	103	36.1
Not fully immunized	8	2.8
Unknown	18	6.3
Presence of co-morbidity		
Yes	83	29.1
No	202	70.9
HIV sero status		
non-reactive	36	12.6
reactive	1	0.4
unknown	248	87
Level of consciousness		
conscious	283	99.3
unconscious	2	0.7
Exclusive breast feeding		
Unknown	19	6.7
No	10	3.5
Yes	256	89.8
Chest indrawing		
Yes	74	26
No	211	74
Malnutrition		
MAM	13	30.95
SAM	29	69.05
Oxygen support needed?		
Yes	177	62.1
No	108	37.9

Table 2: Summary measures for Continuous Variables for children aged 2–59 months with severe pneumonia admitted from July 2015 to July 2018 at ASCH

Variables	Median	Interquartile Range	Variables	Mean	Standard Deviation
Length of hospital stay	4	2.5, 7.0	Temperature at admission	37.7	0.9
Age of child	12	6.0, 18.0	Respiratory rate at admission	63.1	14.7
Duration of chief complaint	3	1.0, 5.0	Weight in grams	8179.4	2664.6
Mid upper arm circumference	14	12, 15.0	Height in centimeters	72.9	12.0

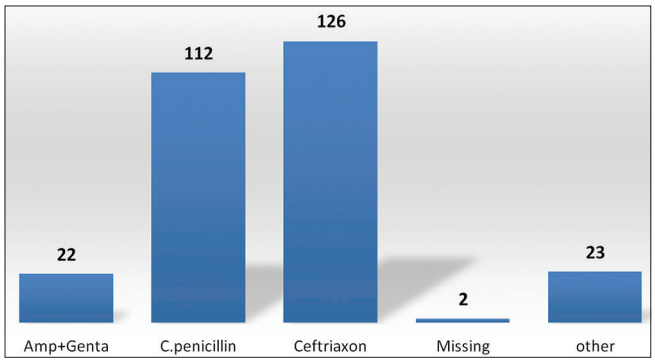

Figure 2: Type of antibiotic administered to children aged 2–59 months with severe pneumonia admitted from July 2015 to July 2018 at ASCH

Survival distribution among strata of categorical variables

The survival distribution among groups of the independent variables antibiotic type, categorized duration of chief complaint, breastfeeding, need of oxygen support at admission, presence of co-morbidity, type of co-morbidity, vaccination status, place of residence, and malnutrition status were significantly different [Figures 4 and 5].

Predictors of time to recovery from severe pneumonia among children

The multivariate Cox regression was done by entering the variables found with a *P* value less than or equal to 0.25 in the univariate Cox regression analysis. Presence of co-morbidity, presence of malnutrition at time of admission, and vaccination status were found to be significant predictors of time to recovery from severe pneumonia in children aged from 2 to 59 months.

Children with no co-morbidity were 3.47 times more likely to recover from severe pneumonia as compared to children with co-morbidity (AOR: 3.47, 95%CI, 2.21, 5.4). Children who were not malnourished were 1.9 times more likely to recovery as compared to children with malnutrition (AOR = 1.9, 95%CI, 1.2, 3.1). Children who presented to hospital within 4–7 days duration of chief complaint had 28% lesser hazards of recovery from severe pneumonia as compared to those children presented within three days (AOR = 0.72, 95%CI: 0.54, 0.94). Children who were not fully immunized had 68% lesser hazards of recovery compared to children who were fully vaccinated (AOR = 0.32, 95% CI, 0.12, 0.80).

While checking the proportional hazard assumption, the variable co-morbidity was found to be dependent on time and the solution

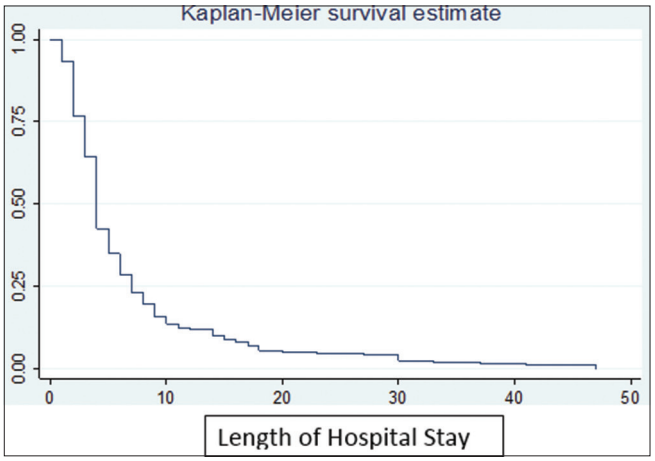

Figure 3: Kaplan-Meier survival estimation of children aged 2–59 months with severe pneumonia admitted from July 2015 to July 2018 at ASCH

taken was to divide the time axis in to two (at the median survival time which is four) and two hazard ratios are generated [Table 3].

Discussion

The aim of this study was to estimate time to recovery from severe pneumonia and its predictors among children aged 2–59 months who were admitted to pediatric ward of ACSH from July 2015 to July 2018. The median time until recovery from severe pneumonia was four days (95% CI: 3.732–4.268). The variables duration of chief complaint, vaccination, and malnutrition status of child and presence of co-morbidity were significant predictors of time to recovery from severe pneumonia.

The median time to recover from severe pneumonia in children 2–59 months old estimated by this study is four days. Being a tertiary hospital settled in a developing African country, this could be termed as shorter duration of hospitalization (fast progress). The United States Centers for Diseases Control and Prevention estimated that the average length of hospital stay for treatment of pneumonia in children is five days.[7] This is in agreement with findings reported in studies done in University of Gondar Comprehensive Specialized Hospital[16] and Debre Markose Hospital,[17] Northern Ethiopia. This short duration of the hospital stay could reflect the good quality of the care and adherence of the service providers to the standard treatment. However, this duration is lower than the duration at Mulago hospital Uganda (7 days),[18] and higher than the duration in Nepal (2 days).[19] The difference in quality of care

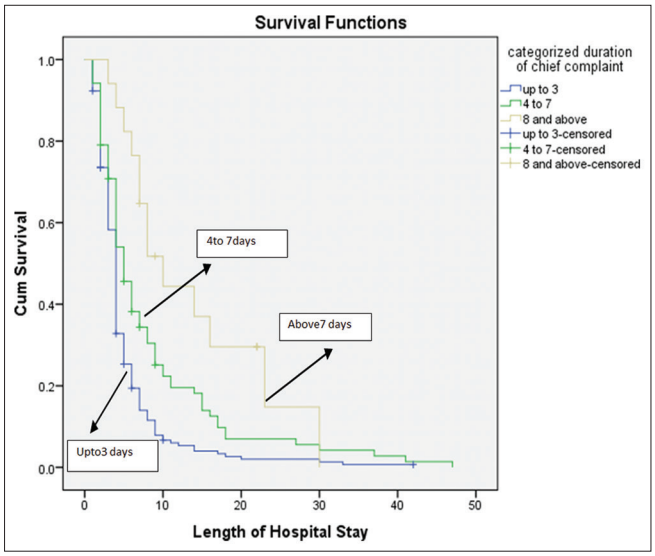

Figure 4: Cumulative survival distribution by duration of chief complaint among children aged 2–59 months with severe pneumonia admitted from July 2015 to July 2018 at ASCH

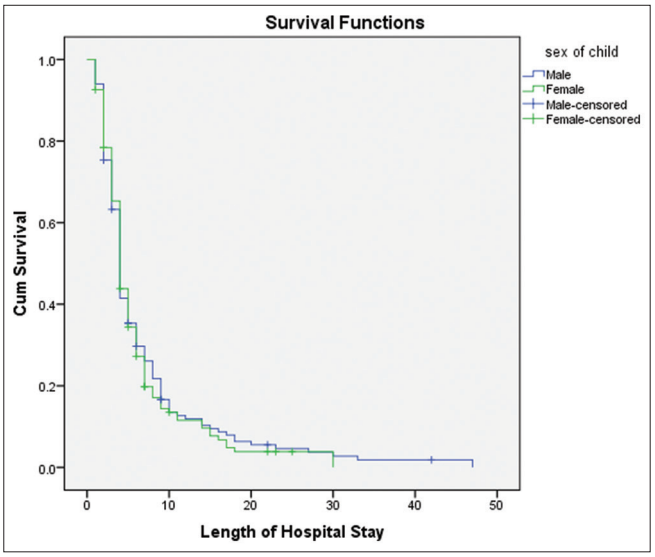

Figure 5: Cumulative survival distribution of sex of children aged 2–59 months with severe pneumonia admitted from July 2015 to July 2018 at ASCH

Table 3: Predictors of time to recovery among children aged 2-59 months with severe pneumonia admitted from July 2015 to July 2018 at ASCH

Variables	Hazard Ratio (HR)	95% CI	*P*
Duration of chief complaint			
Within 3 days	1	1	
4 to 7 days	0.71	0.43-0.94	0.03
Above 7 days	0.45	0.25-0.83	0.02
Vaccination status			
Fully immunized	1	1	
Up-to-date	0.67	0.50-0.87	0.002
Not fully immunized	0.32	0.12-0.80	0.01
Unknown	0.64	0.36-1.15	0.001
Presence of co- morbidity			
No	1	1	
Before four days of admission	3.47	2.21-5.44	0.0001
After four days of admission	2.36	1.57-3.54	0.003
Presence of malnutrition			
Yes	1	1	
No	1.92	1.19-3.11	0.002
Residence			
Rural	1	1	
Urban	0.42	0.21-3.21	0.50
Exclusively breastfeeding			
Exclusively breastfed	1	1	
Not exclusively breastfed	0.53	0.13-2.5	0.56
Unknown	0.81	0.25-4.52	0.20
Height	0.63	0.35-2.53	0.12
Respiratory rate	0.45	0.25-5.23	0.58
Need of oxygen support			
Yes	1	1	
No	0.65	0.13-3.52	0.86
Type of Antibiotic			
Crystalline penicillin	1	1	
Ceftriaxone	3.21	0.43-4.26	0.78
Other medications	2.53	0.21-5.36	0.67

and severity level of the disease could explain the inconsistency among the studies.

Higher duration of chief complaint (late presentation to a hospital) was found to contribute for prolonged duration of hospital stay. The tendency to recover in children who presented with a duration of chief complaint between four and seven days was 0.71 times that of those presented before three days and in those with above seven days of duration of chief complaint was 0.459 times that of the reference group (below three days). This is consistent to the finding in Debre Markos referral hospital[17] and Gambia[7] where a greater proportion of late presenters to a hospital tend to have prolonged length of hospital stay than early presenters which supports the finding of this study. The lower hazard of recovery among late presenters could be due to complications that they might develop before presenting to the hospital. But, this is inconsistent to the finding in study one in University of Gondar Comprehensive Specialized Hospital.[16]

Those who are not fully immunized and were up-to-date with the national EPI guideline had less tendency to recover earlier than the children who are fully immunized. This is due to the fact that the immune system of the fully immunized children is able to respond rapidly and at a high activity level, thereby destroying the pathogen before it causes complications and reduces the risk of spread to other people.[20] However, in studies conducted in University of Gondar Comprehensive Specialized Hospital,[16] Debre Markos referral hospital[17] and Gambia[7] reported immunization status is not a significant predictor of time to recovery from severe pneumonia. Since the Gambian study was conducted in a rural health center, the discrepancy could be due to the setup or type of the health facilities these two research studies are conducted. On the other hand, the Gambian study used a logistic regression method which differs

from the method used in this work which is Cox proportional hazards regression.

Those children with any type of co-morbidity were found to stay longer in hospital than their counterparts who were free of co-morbidities. Specifically presence of malnutrition was the most influential one related to the other co-morbidities like cardiac disease and diarrheal diseases. This is in line with a studies done in University of Gondar Comprehensive Specialized Hospital,[16] Debre Markos referral hospital,[17] Gambia by B.P. Kuti *et al.*[7], and Nepal by Sudha Basnet *et al.*[19] In addition to this, children who were not malnourished recovered faster. This could be due to the reason that co-morbidities need different treatment protocol and extra time to treat.

Key points:

- The median time to recover was short (4 days, 95% CI: 3.732–4.268).
- The incidence of recovery was 92.3%.
- Late presenters, those with co-morbidity and not fully immunized had lower hazards of recovery.

Conclusion

Childhood pneumonia is a treatable respiratory illness with high recovery rate. Short length of hospital stay was observed in this study. Presenting late to a hospital, presence of co-morbidity especially being malnourished, and not being immunized were factors that can increase the length of hospital stay. To our knowledge, this is the only study to identify immunization status as a predictor of recovery from severe pneumonia. Malnourished children were reported to stay about two times longer than those who were not malnourished. Therefore, focuses have to be given in increasing the community's health seeking behavior to visit health facility early and especial attention should be given for children with co-morbidity, malnutrition, and unvaccinated children. Working on preventive measures like feeding children nutritious meals will reduce costs due to prolonged admission. Researchers need to further study on clinical aspects especially laboratory results that were not included in this study. Using prospective study methods to minimize missing data of measurements like height, mid upper circumference, and weight will be minimized.

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Conflicts of interest

There are no conflicts of interest.

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