

Time to recovery and its predictors among children age of 2 up to 59 months admitted with severe community acquired pneumonia in Public Hospitals of Central and North Gondar Zones, Ethiopia 2021.

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Abstract

Background: Community acquired pneumonia is a leading cause of morbidity and mortality in children worldwide. In Ethiopia considerable interventions have been taken to reduce morbidity and mortality of pneumonia in under five children, however little is known about the time to recovery and predictors among children admitted with Severe community acquired pneumonia

Therefore this study aimed to identify the time to recovery and its predictors among children admitted with severe community-acquired pneumonia in public hospitals in central and north Gondar zone, Ethiopia, 2021.

Method: An institutional based retrospective follow up study was conducted from January 01, 2018 to December 31, 2020. The collected data were entered in to EPI info version 7.2.1.0 then exported to STATA version 14 for analysis. Cox-ph assumption test and model fitness was checked. Variables had “p” value < 0.25 in the Bivariable analysis were entered in to multivariable Cox-regression analysis. Variables had p-value of < 0.05 were declared as statistically significant.

Results: Out of the total 701 study participants about 98.15% were recovered during the follow up period and the median recovery time was 3 days with inter quartile range (IQR) of (2–5 days). Recovery rate from severe community acquired pneumonia was 26.71 ((95% CI: 24.79-28.78)) per 100 person days observation. Being rural residency (AHR=0.8; 95% CI (0.68-0.94)), admitted at primary hospital (AHR=1.43; 95% CI (1.16-1.76)), being stunted (AHR: 0.63, 95% CI (0.44–0.89)), mixed breast feeding (AHR=0.53; 95% CI (0.32-0.87)), late presenters for seeking care (AHR= 0.71: 95% CI (0.54-0.93)), presence of danger sign at admission (AHR: 0.81, 95% CI (0.68-0.97)), co-morbidity (AHR= 0.66; 95%CI (0.56-0.79)) and treatment by ampicillin and gentamicin (AHR, 0.61, (95% CI (0.40–0. 92)) were found to be significant predictors of time to recovery.

Conclusions: The median recovery time was similar with other studies done in most developing countries and relatively shorter than other countries abroad. However, the recovery time varies based on the predictor variables like; co- morbidity, danger sign at admission, time of seeking care, stunting, and breast-feeding status.

Introduction

Pneumonia is defined as inflammation of parenchymal structures of the lung, such as the alveoli and the bronchioles (1). The World health organization has defined pneumonia in children clinically based on either a cough/difficulty breathing and rapid respiratory rate, chest indrawing, or a decreased level of consciousness (2).

Community-acquired pneumonia may be either bacterial or viral and the most common cause of infection in all age categories is Streptococcus pneumonia and it is the known leading bacterial cause of severe pneumonia among children in developing countries. Common viral causes of community-acquired

pneumonia also include the influenza virus, respiratory syncytial virus, adenovirus, and Para influenza virus (3, 4).

Pneumonia is a leading cause of under five children mortality in the world (5). In 2019 about 5.2 million under 5 years children died, of which Pneumonia is one of the leading causes of death next to preterm birth complications and birth asphyxia (6). According to the world health organization community acquired pneumonia (CAP) is the main cause of pediatric death, accounting for 20 % of deaths in children younger than 5 years old (7). In 2016, pneumonia killing around 900,000 children which accounted approximately 16% of the total 5.6 million under-five deaths, worldwide (8).

In under-five children the incidence of pneumonia is estimated to be 0.29 and 0.05 episodes per child-year in developing and developed countries, respectively (9). In Europe and North America CAP is one of the most common serious infections in children, with an incidence of 34 to 40 cases per 1,000 children (10). In low- and middle-income countries (LMIC) more than 95% under five children deaths occur due to pneumonia (11-13).

In African and Asia regions about two million pneumonia deaths occur in under five children annually (9). In sub-Saharan Africa, the estimated proportion of death in children aged below 5 years attributed to pneumonia is 17–26% (5, 14). According to UNICEF report in 2015 more than 490,000 of under five children pneumonia deaths occurred in sub Saharan Africa (15).

Ethiopia is the fifth among 15 countries having the highest under five years of age mortality rate due to pneumonia in the world (16). In Ethiopia approximately 3,370,000 under five children experiencing pneumonia and 40,000 deaths occurred every year (17). Even though CAP is common among children all over the world the outcome is more worsen in developing countries (18). Poor outcomes are usually related to CAP severity, efficiency and patient characteristics and much higher risk factors among children in developing countries (19).

Although it is highly treatable diseases the medical condition can be worsen and life threatening in developing and low-income countries particularly in under five years children (24). In severe cases, hospitalization is necessary to provide parenteral antibiotics and supportive measures and to consider invasive procedures to diagnose and treat complications (20). delayed recovery time and long duration of hospital stay slows the patient's normal growth and child development (21). Additionally, parents and caregivers waste their time for caring their children and it is also become high burden for other nosocomial infection, unmanageable patient load due to high bed occupancy, and high trouble for families, communities and governments in financial costs (21, 22).

Globally considerable interventions have been taken to reduce morbidity and mortality of pneumonia (23). There were clear actions (“a global call to action on childhood pneumonia”) that the government and the world society build strong commitments to speed up improvement on combating pneumonia; these includes build up pneumonia control strategies, Strengthen quality primary health care, enhance government investment in health and nutrition, advance health governance, hasten vaccination coverage

and champion multi-sectoral partnerships (24). In Ethiopia important areas for tackling (reducing) morbidity and mortality from pneumonia were implemented. These were prevention (increase vaccination coverage, improve access to safe water and reduce air pollution), protection (improve breast feeding practice, ensure adequate nutrition) and diagnose and treat children with pneumonia (increase care seeking, scale up integrated service delivery, universal health coverage invest in health workers) (25). However, the main challenge is slow recovery time and increased length of hospitalization. Identifying risk factors that may cause for slow recovery time of children with SCAP is very important to solve the problem accordingly and for optimal utilization of scarce resources as well.

Although few studies were conducted on time to recovery and predictors of recovery time from SCAP they were mainly limited at one specialized hospital. Therefore, this study was conducted to determine the recovery time and predictors among children age 2-59 months admitted with severe community acquired pneumonia (SCAP).

Methods

Study design

An Institutional-based retrospective follow up study was employed

Study area and period

The study was conducted in central and north Gondar zones which found in Amhara regional state, Ethiopia. Gondar and debark towns are the capital towns of the Central and North Gondar zone located at 727 km and 830 km from the capital city, Addis Ababa respectively. Currently there are total populations of 2279138 and 909386 in the central and north Gondar zone respectively (26, 27). Totally in both zones 12 public hospitals and 88 health centers are found. Of which, ten public hospitals including UGCSH and 75 health centers are found in the Central Gondar zone while 2 public hospitals and 13 health centers are found in the North Gondar zone (26, 27).

The study was conducted from January 01, 2018 to December 31, 2020.

Source Population

All Children 2 up to 59 months of age who were admitted in Central and North Gondar zone public hospitals for the management and treatment of severe community acquired pneumonia.

Study population

All Children 2 up to 59 months of age who were admitted in Central and North Gondar zone public hospitals and received treatment for severe community acquired pneumonia (SCAP) from January 1st,

2018 to December 31,2020.

Inclusion and Exclusion criteria

Inclusion criteria

All children 2 up to 59 months of age who were admitted in Central and North Gondar zone public hospitals and received treatment for severe community acquired pneumonia (SCAP) from January 1st, 2018 to December 31, 2020 were included.

Exclusion Criteria

Children with incomplete records concerning variables of interest, those children their date of admission and date of discharge was not recorded, those have missing charts and patient who were admitted and started treatment at other health facilities and has been referred in.

Sample size determination and sampling procedure

Sample Size determination

The sample size was determined by using schoenfeld formula for survival analysis (28).And by considering the proportion of recovered patients from(SCAP), which was 0.889, taken from a previous study conducted (29). The sample size was calculated by using the above formula considering key factors: stunting, danger sign at admission, duration of seeking care and co-morbidity variables from the previous study (29). The maximum sample size was obtained for a variable "danger sign at admission which was 467. Considering design effect (1.5), the final sample size for this study was 701.

Sampling Procedure

A total of 12 public Hospitals found in the Central and North Gondar zones. By using simple random sampling technique University of Gondar comprehensive specialized Hospital (UGCSH), Debark Hospital and Koladiba Hospital were selected.

There were 1740 recorded number of children 2 up to 59 months of age admitted at selected hospitals with severe community acquired pneumonia (SCAP) for a period of 3 years from Jan1st 2018 to December 31/2020: University of Gondar hospital =735, Debark hospital=585, Kolladiba hospital= 420.

The sample size in each selected hospital was allocated proportionally by using the formula $nh=Nh/N*n$. Then to select sample size from each selected hospital we used systematic random sampling technique.

Thus, interval “K” value is calculated as $K = N/n$, where n = final sample size= 701, which gave a sampling interval (K) of 2 then by using patients’ record order which was listed in the log book, study participants (charts) were selected in every 2 number intervals until to reach the total sample size. The first participant (chart) was selected by lottery method and if there was missing or incomplete charts the next chart was taken and replaced from the log book registration list.

Study Variables

Dependent variable.

- Time to recovery from severe community-acquired pneumonia

Independent variables

- Socio- demographic factors :
- Clinical and concomitant (co-morbidity) related factors:
- Nutritional status and of children: Stunting,wasting and underweight.
- Vaccination and Breastfeeding status of the child and
- Time to seeking care

Operational Definitions

Event (Recovery): - Children improved from SCAP as discharged by the clinician during the study period.

Survival time: - Is the time starting from the date of admission to recovery from SCAP.

Censored: - Children referred out, died and self-discharged (against treatment) without recovery during the study period.

Co-morbidity:- Any disease condition (acute or chronic) present during admission in addition to SCAP(29).

Danger sign:- The child having loss of consciousness, vomiting everything, wheezing, grunting convulsions and inability to feed (30).

Time to seeking care: - Children getting care with in < 5 days after getting sick are considered as early presenters while those children getting care after ≥ 5 days are considered as late presenters (29).

Fully vaccinated: - Children who had completed all forms of vaccinations.

Partially vaccinated: - Children who had taken at least one dose of PCV.

Not vaccinated: - Children who had never vaccinated PCV and other vaccines (29).

Exclusive breast feeding: - Children who were introducing only breast milk except for ORS, drops, syrups (vitamins, medicine, and minerals) with his/her age during the age of less than 6 months.

Mixed feeding: - Children who were introducing other liquid, semi-solid and solid foods in addition to breast milk with his/her age during the age of less than 6 months (61).

Data collection tools

Data were collected by using a structured checklist adapted from previous similar studies (21, 29, 31, 32), and developed in the English language to extract relevant information. The tools includes socio-demographic characteristics section, Clinical related variables and Co morbid illness section, nutritional status section and vaccination, breast feeding status section and time to seeking care .

Data collection procedures

Medical record number of patients with SCAP was retrieved from the log book of pediatrics ward. And the data was collected by using standardized English version data extraction form/ check list in each patient chart review at chart room.

Data Quality Control

A high emphasis was given for developing the data collection instrument, and providing training for data collectors and supervisor on data collection technique for one full day. During the data collection process, regular monitoring and supervision of the overall activity was done by the supervisor and principal investigator to check for completeness and to ensure the quality of data.

Data processing and analysis

Data were entered using Epi-info version 7.2.1.0 and analysis was done using STATA Version 14 statistical software. Data were cleaned and edited before analysis. The data was described in terms of central tendency and dispersion, in a frequency distribution and presented in graph, tables, and text. Days were used as a time scale to calculate time to recovery. The outcome variable was dichotomized into censored or event (recovered).

Kaplan Meier's survival curve was used to estimate the recovery time of children along categories of covariates and log rank test was used to test the significant between deferent groups of predictor

variables. Cox proportional hazard assumption was checked graphically and using schoenfeld residuals test. Multicollinearity and model assumptions for each covariate were tested before running the Cox proportional hazard regression model. Bivariable regression with a level of significance less than or equal to 0.25 were entered into multivariable Cox-regression analysis and finally; significant factors was identified based on Adjusted HRs (AHRs) included in 95% confidence level and p-value less than 0.05.

Results

Socio-demographic characteristics of the study participants

A total of 701 children charts were reviewed and analyzed in this study. Among these more than half of participants (56.49%) were males and 375 (53.5%) of patients were rural resident. The median age of the study participants was 10 months with IQR of 5-24 months and 52.2 % were under the age group of 2-11 months (table 1).

Table 1:- Socio-Demographic Characteristics among children age of 2 up to 59 months admitted with severe community acquired Pneumonia in Public hospitals of Central and North Gondar Zone, Ethiopia January, 2018-December, 2020.

Variables	Catagories	Frequency (701)	Percent (%)
Age	2-11months	366	52.21
	12-59 months	335	47.79
Sex	Male	396	56.49
	Female	305	43.51
Recedence	Urban	326	46.50
	Rural	375	53.50

5.2. Nutritional, breast feeding and vaccination status

Of the total 701 study participants, the overall under nutrition was 59(8.42%). Forty-nine (6.99%), 46(6.56%), and 34(4.85%) of them were underweight, stunting, and wasting respectively. About 656(93.58%) children were on vaccination and from these, 317(45.22%) were fully vaccinated. Regarding to breast feeding status from the total study participants 680 (97%), 18 (2.57%) and 3(0.43%) were exclusively breast feeding, had mixed feeding and not breast feed during the first six month of their age respectively (Table 2).

Table 2:- Nutritional, breast feeding and vaccination status among children age of 2 up to 59 months admitted with severe community acquired pneumonia in Public Hospitals of Central and North Gondar Zone, Ethiopia January,2018- December 2020.

Variables	Frequency (701)	Percent (%)
Weight for age		
Normal	652	93.01
Underweight	49	6.99
Height for age		
Normal	655	93.44
Stunting	46	6.56
Weight for height		
Normal	667	95.15
Wasting	34	4.85
Breast feeding status		
Exclusive feeding	680	97.00
Mixed feeding	18	2.57
Not breast feeding	3	0.43
Vaccination status		
Fully vaccinated	317	45.22
Partially vaccinated	339	48.36

Not vaccinated	45	6.42
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5.3. Clinical characteristics, co-morbidities and time to seeking care

Of the 701 study participants 455 (64.9%) were febrile and about 213 (30.39) were hypoxic. The median temperature and oxygen saturation was 37.8 with IQR (37.1-38.6) and 86% IQR (80%-90%) respectively. About 198(28.25%) developed danger signs, and the most frequent danger sign was vomiting 123 (17.55%) followed by grunting 84(11.98%). From the total analyzed children 240(34.24%) had co-morbid and the most common co morbidity, was hyperactive airway disease (childhood asthma) followed by acute gastroenteritis. As regards to the treatment options for the SCAP, 62.91%, 33.38% and 3.71% were treated with ceftriaxone, crystalline penicillin and ampicillin & gentamicin respectively (Table 3).

Table 3:- Clinical Characteristics and co-morbidities among Children age of 2 up to 59 Months admitted with SCAP in Public Hospitals of Central and North Gondar Zone, Ethiopia January,2018- December2020.

Variables	Categories	Frequency (701)	Percent (%)
Temperature in °c	<37.5 ⁰ c	246	35.09
	≥37.5 ⁰ c	455	64.91
Oxygen saturation (Spo2)	< 90	213	30.39
	≥90	488	69.61
Time to seeking care	≤ 5 days (early presenters)	633	90.30
	>5 days (late presenters)	68	9.70
previous Hx of ARTI	Yes	133	18.97
	No	568	81.03

Presence danger sign	Yes	198	28.25	
	No	503	71.75	
Types of danger signs	Vomit every thing	123	17.55	
	Wheezing	56	7.99	
	Grunting	84	11.98	
	Unable to feeding	20	2.85	
	Lethargic	12	1.71	
	Loss of consciousness	3	0.43	
	Types of antibiotics			
	ceftriaxone	441	62.91	
	Crystalline penicillin	234	33.38	
	ampicillin and gentamicin	26	3.71	

Presence of Co-morbidity	Yes	240	34.24
	No	461	65.76
Types of co-morbidity	HAAD/bronchial asthma	144	20.54
	Acute gastroenteritis	66	9.42
	Heart failure /CVD	13	1.85
	Anemia	5	0.71
	under nutrition	21	3
	Pertussis	6	0.86
	Measles	3	0.43
	Meningitis	2	0.29
	HIV/ADIS	1	0.14
	Rickets	5	0.71
	Others*	16	2.28

5.4 The median recovery time and comparisons of survival status between categories of predictors using Kaplan Meier curve and log-rank test.

Of 701 study participants admitted with SCAP, about 688 (98.15%) were recovered. The patients were followed for a minimum of 1 and a maximum of 17 days. The overall median recovery time of children 2-59 age months admitted with severe community acquired pneumonia in public hospitals of central and north Gondar zones was 3 days IQR of 2-5 days. The total person-time risk was 2567 with the overall recovery rate of 26.71 per 100 person days (95% CI: 24.79-28.78) observation.

The overall survival status of children with SCAP was estimated by the Kaplan-Meier survival curve (fig 1)

The Kaplan Meier curve showed that there was understandable difference between groups of predictors. Based on the estimation, patients who had co morbidity, dangerous signs at admission, previous history of ARTI, those children present lately to hospital, those children have rural resident, children had mixed breast-feeding status, and stunted children required long time to recovery from severe community acquired pneumonia compared to their counter parts respectively. For instances, the median time to recovery among children admitted with SCAP who had co-morbidity was 4 days (IQR: 3-5 days) and those children admitted without co-morbidity had the median recovery of 3 days (IQR: 2-4 days). Similarly the median time to recovery of children who had danger sign at admission was 4 days (IQR: 3-5 days), while patients without danger sign was 3 days IQR (2-4 days). Regarding to nutritional status of the child, stunted children had the median to recovery of 5 days IQR (4-7days) while normal children had time to recovery of 3 days IQR (2-4 days) (table 4).

Table 4: Table shows Comparison of survival time to recovery of children with SCAP patients regarding to different categories of predictors by using log-rank test

Variables	median recovery time in day with IQR	Chi-square	Degree of freedom	P-Value
Residency				
Urban	3(2-4)			
Rural	3(2-5)	12.77	1	<0.001
Hospital type				
Tertiary hospital	3 (2-5)			
General hospital	3(2-5)			
Primary hospital	3(2-4)	15.66	2	<0.001
Breast feeding status				
EBF	3 (2-4)			
Mixed feeding	5 (3-5)			
NBF*	6 (4-7)	15.15	2	<0.001
Duration of seeking care				
Early presenters	3(2-4)			
Late presenters	4(3-6)	23.74	1	<0.001

Previous hx* of ARTI					
No	3 (2-4)				
yes	4(3-5)	34.07	1	<0.001	
Presence of danger sign at admission					
No	3(2-4)				
Yes	4(3-5)	34.07	1	<0.001	
Presence of co- morbidity					
No	3(2-4)				
Yes	4(3-5)	52.19	1	<0.001	
Types of antibiotics					
Ceftriaxone	3 (2-4)				
Crystalline penicillin	3(2-4)				
Ampicillin &gentamicin	5(4-6)	8.91	2	0.012	
WFA*					
Normal	3 (2-4)				

Under weight	5(4-7)	37.21	1	<0.001
HFA*				
Normal	3(2-4)			
Stunting	5 (4-7)	38.56	1	<0.001
WFH*				
Normal	3(2-4)			
Wasting	5 (4-7)	17.64	1	<0.001

* hx=history * NBF= not breast feeding *WFA=weight for age *HFA=height for age *WFH=weight for height

There was a significant recovery time difference among categories of residence, Co morbidity, presence of danger sign at admission, antibiotics (drug) type, Hospital type, breast feeding status, duration of seeking care and nutritional status of the child (Weight/Age, Height/Age and Height/Weight) (Fig 2) .

5.5 model selection and PH-assumption test

Cox regression model fitness and proportional hazard assumptions test were checked graphically and by using Shenfield residual global test. PH assumption was fitted showed global test of ($\chi^2= 21.11, p= 0.0989$)

5.6 Predictors of recovery time from Sever community acquired pneumonia

Predictors that have p-value of less than 0.25 in the bi-variable Cox regression analysis were selected and entered in to multivariable Cox regression analysis to identify independent association with time to recovery. Eight predictors (residence, hospital type, duration of seeking care, types of antibiotics given, danger sign at admission, co-morbidity, breast feeding status and height for age (HFA) were statistically significant predictors of recovery time.

According to the multivariable Cox regression analysis, the recovery time was delayed by 20% (AHR=0.8; 95% CI (0.68-0.94)) among patients of rural residency as compared with its counterpart. Similarly, the

duration of recovery time of patients with co-morbidity was increased by 34% (AHR 0.66; 95%CI (0.56-0.79)) as compared with their counter parts. The hazard of children who had danger sign at admission for delay recovery time was 19% (AHR; 0.81, 95% CI (0.678-f 0.66; 95%CI (0.56-0.79)) times as compared with those admitted without danger sign. Regarding the duration of seeking care children with SCAP who came lately (≥ 5 days) to the health facility were 29% (AHR= 0.71:95% CI (0.541-0.928)) delayed recovery time as compared to those who came early (< 5 days).

Those children who were on mixed feeding and not breast feeding was 47% (AHR=0.53; 95% CI (0.32-0.87)) slow their recovery time as compared to exclusive breast feed children. Likewise, the recovery time of stunted children from SCAP decreased by 37% as compared to children with normal height for age (AHR; 0.63, 95% CI (0.44–0.89)).

Regarding of the treatment regimen, the recovery time of children treated with ampicillin and gentamicin for SCAP was decreased by 39% as compared to children treated with ceftriaxone (AHR, 0.61, (95% CI (0.40–0. 92)). The recovery time of children admitted with SCAP at primary hospital was 1.43 times shorter (AHR=1.43; 95% CI (1.16-1.76)) than that of children admitted at specialized hospital (Table 5).

Table 5:- Multivariable Cox Proportional Regression Analysis For Independent Predictors Of Recovery Among Children Age 2-59 Months With SCAP Admitted In Public Hospitals Of Central And North Gondar Zone, Ethiopia From January,2018 to December,2020

Variables	Categories	CHR(95% CI)	AHR(95% CI)
Residency	Urban	1	1
	Rural	0.80(0.69-0.93)*	0.80(0.68-0.94)*
Hospital type	Tertiary	1	1
	General	1.03(0.87-1.23)	0.96(0.80-1.15)
	Primary	1.36(1.11-1.64)*	1.43(1.16-1.76)**
Duration of care	< 5 days	1	1
	≥5 days	0.599(0.46-0.78) **	0.709(0.541-0.928)*
Breast feeding status	EBF	1	1
	Mixed	0.52(0.32-0.85)	0.53(0.32-0.87)*
	NBF	0.41(0.13-1.27)	0.37(0.11-1.16)
Previous hx of ARTI	No	1	1
	Yes	0.87(0.71-1.05)	0.91(0.74-1.11)
Danger sign	No	1	1
	Yes	0.667(0.56-0.79)**	0.81(0.68-0.97)*
Co morbidity	No	1	1
	Yes	0.61(0.52-0.72)**	0.66(0.56-0.79)**
Types of antibiotics given	Ceftriaxone	1	1
	Crystalline penicillin	0.99(0.85-1.17)	0.98(0.83-1.15)
	Ampicillin & gentamicin	0.61(0.41-0.92)*	0.61(0.40-0.92)*
	Normal	1	1

Weight/age (WFA)	Underweight	0.48(0.35-0.65)**	0.69(0.47-1.00)
	Normal	1	1
Height/age (HFA)	Stunted	0.46(0.34-0.63)**	0.63(0.44-0.89)*
	Normal	1	1
Weight/height (WFH)	Wasted	0.55(0.39-0.78)**	0.75(0.49-1.11)

NBF=not breast feeding, EBF =Exclusive breast feeding, hx =history

*** p- Value < 0.05 ** p –value ≤ 0.001**

Discussion

This study tried to assess recovery time and its predictors among children age 2–59 months with SCAP admitted in public hospitals in Central and North Gondar zone, Northeast Ethiopia. The median recovery time was 3 days IQR (2–5 days). Different predictors were contributing to the recovery time of children admitted with SCAP. Residence, hospital type, breast feeding status, nutritional factors (stunting), co morbidity, and presence of danger at admission and duration of seeking care were found to be predictors of this study.

The result of this study finding showed that the median recovery time was in line with studies conducted in Vanderbilt university hospital, USA (2.3days) and Nepal (2days) (32, 34). Similarly this study finding was almost consistent with the recovery time of similar studies done in Bahridar specialized Hospital, Ethiopia (3 days) (35), Debremarkos referral Hospital, Ethiopia (4 days) (29), Gambia (4.5 days) (36).

But this study finding revealed that shorter recovery time than study findings done in Netherland (6.7 days) (37) and Boston, USA (6 days). This discrepancy may be due to the reason that, these countries are high income countries compared to our country Ethiopia, and their health care system might be well organized and developed. Due to that the bed occupancy rate is probably low and people have the capacity to pay any charge at hospital this may create opportunity for patients stay longer at hospital until complete stability from all sign and symptoms of the disease.

This study showed that residency is a significant predictor of recovery time of children admitted with SCAP; children who were rural resident had recovery dalliance as compared to its counterpart. This finding contradicts to a study done in Bahirdar felegehiot Hospital, Ethiopia, that being urban residency reduce the length of recovery (35) and study conducted in Egypt was revealed that being urban residency was the risk of long recovery time from pneumonia (33). This result suggested by that, most of the time peoples living in rural Ethiopia are economically poor and they may not afford the cost of the treatment. Due to that they do not take their sick children early to health facility and this dalliance worsens the

severity disease, which consequences slow the recovery time (38). In addition to that the burden of under nutrition is higher in rural Ethiopia as compared to the urban and obviously that under nutrition is the cause for immune suppression and which delay the recovery time(39).

Hospital type was one of the significant factors which contribute for the time to recovery of children in this study. Based on the finding, children who were admitted at primary hospital were recovered earlier than children admitted at tertiary hospital. This could be due to the reason that more complicated (children with danger signs) and children who had co-morbidity were referred to tertiary hospitals for further management. In addition to this, since the case flow of primary hospitals is relative lower than tertiary hospital which could make it easy to diagnose and manage early children with severe community acquired pneumonia (SCAP).

Stunting was the significant predictor for the recovery time of children admitted with SCAP. Stunted children had slow recovery time as compared to children with normal height for age. This finding was supported by the study conducted in Debreworkos referral hospital, Ethiopia (29). This is due to the fact that under-nutrition is often linked to immune function; consequently delay the prognosis of the disease and prolong the recovery time (40, 41).

Breastfeeding status of the child was one of significant factors that associate e with recovery time of patients admitted with severe community acquired pneumonia. Children who had exclusive breast feeding for the first six months were recovered early from SCAP than those mixed feeding. This result was supported by the study done in Bahirdar Felegegion Hospital Ethiopia (35) and; Vanderbilt university, Nashville hospital ,USA (34). This is due to the fact that breast milk positively affect the child's immune system via multiple mechanisms including immune modulatory, anti-inflammatory, and antimicrobial actions, which enables children to be have short recovery time from SCAP (42).

Time to seeking care was a significant determinant for the recovery time of children with SCAP. Those children who presented to the hospital lately (after five days of illness) had longer recovery time as compared with those children presented early (before five days of illness). This finding is supported by similar studies done in Debreworkos hospital, Ethiopia (29) and Gambia (36). The reason could be related to time to seek treatment that the progression of disease increases as children being late to seek treatment. Therefore, the required recovery time also increases.

This study suggested that those children admitted with SCAP and had danger sign at admission were reduced the recovery rate by 19% than those admitted without danger sign (AHR; 0.81, 95% CI (0.678–0.97)). This indicates that those children without danger had short recovery time and hospital stay than those admitted with danger sign. This finding was in line with other similar studies conducted in different countries (29, 32, 36). This is due to the fact that presences of danger sign in pneumonia patient create an opportunity for bacteria enter in to the bloodstream from the lungs and can spread to other organs, potentially causing organ failure and may have trouble breathing in enough oxygen and delay recovery time (11).

The current study revealed that co morbidity was significantly associated with recovery time from SCAP. Children who were admitted in the hospital with co-morbidity were delayed their recovery time by 47% as compared to children who were admitted without co-morbidity. This finding is in line with other different studies done in Ethiopia (29, 35). This is because of Co-morbidities significantly increased the severity of pneumonia, including the need for oxygen and significantly associated with more complications, thus reduce the recovery time of children with pneumonia (43).

The type of antibiotics/drug type was one of the significant predictor of time to recovery for children with pneumonia in this study. Children who were treated by ceftriaxone had fast recovery time as compared with those children who were treated with ampicillin and gentamicin. This result was supported by the study conducted in Italy and Uganda (20, 21). This is due to the fact that since, streptococcus pneumonia is the commonest cause of community acquired pneumonia. And which is resistant to penicillin as compared to ceftriaxone, thus treating with ceftriaxone will reduce the length of recovery time (44).

Since the study was done retrospectively, possibly important variables like paternal socio-demographic, socio-economic and environmental factors were not included.

Conclusion

The median time to recovery from SCAP was relatively lower than other similar studies done in Ethiopia and most other countries abroad. Being urban residency, mixed breast feeding, stunting, presence of danger sign at admission and co morbidity were risk factors for slow recovery time. Whereas admitted at primary hospital and treatment with ceftriaxone was protective factors.

Declarations

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Availability of data and materials

All data supporting the findings and conclusion are presented in the manuscript. The datasets is available from the corresponding author on reasonable request.

Authors' contributions

Designing the study: **ZGT**

Data entry: **ZGT**

Analyzed and interpreted the data: **ZGT**

Critically edited and revised the manuscript: **AAG & MMB**

All authors read and approved the final manuscript.

Ethics approval and consent to participate

Ethical clearance was obtained from the Institutional Review Board of the University of Gondar (**Ref no.1502/2013**). Permission was obtained from the clinical director and pediatrics department. Confidentiality agreement was signed by data collectors to keep the privacy of information. As the study was conducted through a review of patient charts retrospectively, no consent was obtained from the mother or caretakers. The data were analyzed anonymously according to the Declaration of Helsinki for human studies

Consent for publication: Not applicable.

Competing interests: The authors declare that they have no competing interests

Abbreviations

AHR	Adjusted Hazard Ratio
ARTI	Acute Respiratory Tract Infections
CAP	Community Acquired Pneumonia
CI	Confidence Interval
HIV	Human Immunodeficiency Virus
HR	Hazard Ratio
LMIC	Low and Middle Income Countries
SCAP	Sever Community Acquired Pneumonia

URTI Upper Respiratory Tract Infection

WHO World Health Organization

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Figures

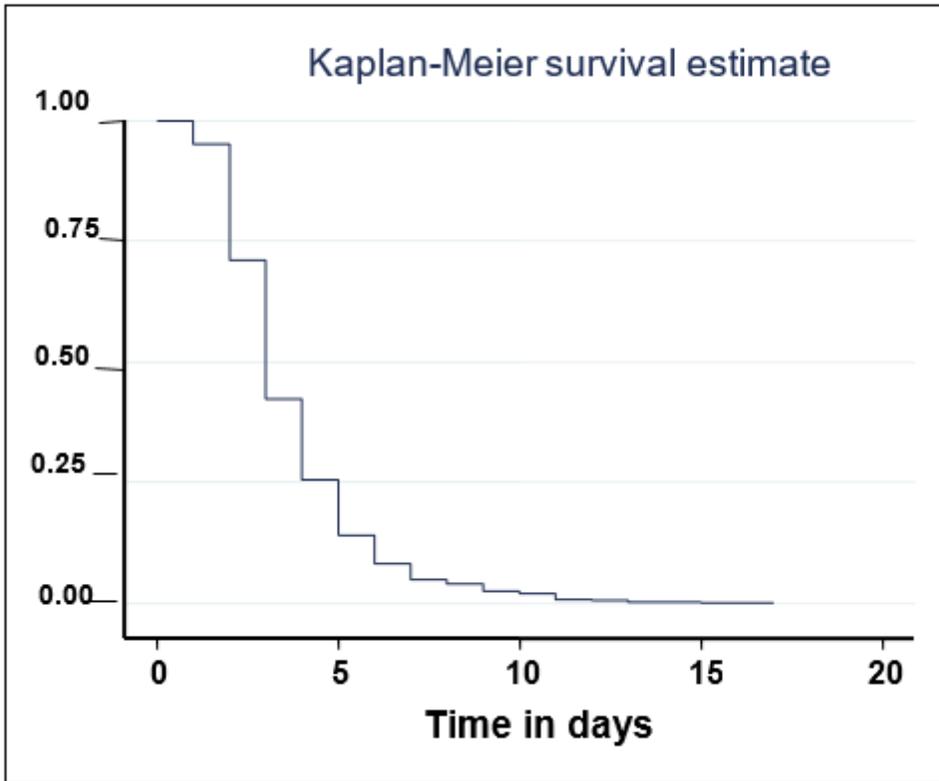


Figure 1

The overall Kaplan–Meier estimation of survival function from admission to recovery among children age 2-59 months admitted in public hospitals of Central and North Gondar zone From January, 2018-december, 2020.

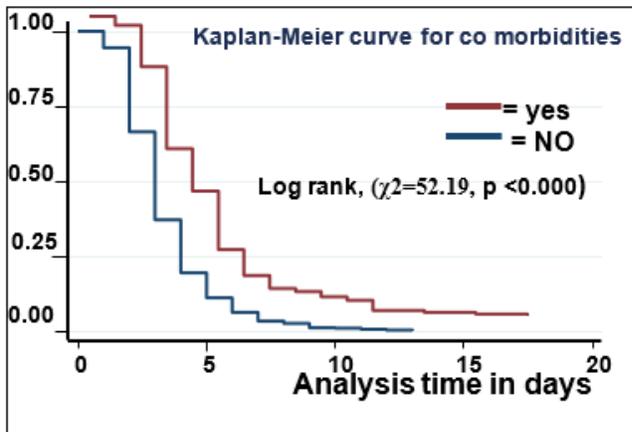


Fig 2(a)

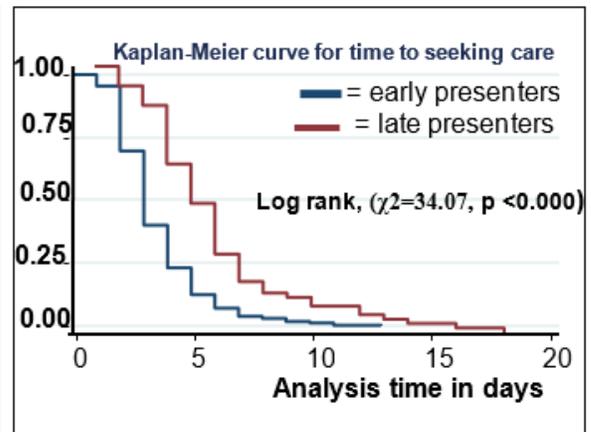


Fig 2(b)

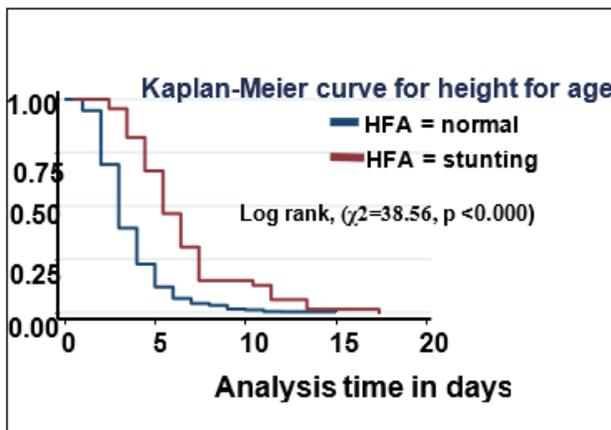


Fig 2 (c)

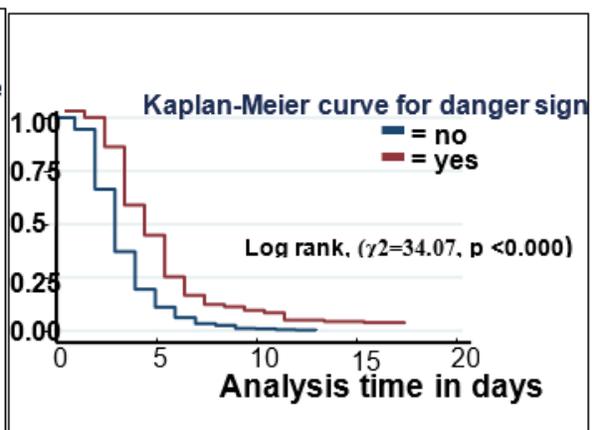


Fig 2(d)

Figure 2

Kaplan-Meier survival estimate and log rank test for time to recovery among SCAP children by categorical variables: co morbidity (Fig 2a), time to seeking care (Fig 2b), and height for age (Fig 2c) and presence of danger sign (Fig 2d).