Patterns and Trends in the Attributable Fractions of under-5 Years Hospitalization and Inpatient Death for Neonates, Infectious Diseases, and Severe Acute Malnutrition in Yemen: A Retrospective Data Analysis

Salem M. Banajeh*

Department of Pediatrics & Child Health, Sana'a University, Sana'a, Yemen

Abstract: *Objectives*: To examine trends in hospitalization and inpatient deaths of neonates, and infectious diseases (IDs) between 2005-2014; and severe acute malnutrition (SAM) between 2010 and 2014 in Yemen.

Method: It was a retrospective descriptive study. Data were extracted from the clinical records of the patients admitted from 2005 to 2014 for neonates and cases aged 1-59 months with IDs. For cases with SAM data were available from 2010 to 2014. Data were analyzed using SPSS version 20.

Results: Between 2005 and 2014, 39282 under-5 hospitalized and 33.6% were neonates. Of 26069 aged 1-59 months, 15224(58.4%) hospitalized with IDs. Pneumonia (44.6%), diarrhea (29.9%), and meningitis (10.6%) were the main subgroups. During the study period, there were 4183 under-5 deaths. Neonatal deaths accounting for 3671 (87.8%). Deaths aged 1-59 month were 512(12.2%) and IDs contributing 440(85.9%). Compared to 2005/06, neonatal hospitalization and death declined by 9.2% and 18.1% in 2013/14, and IDs by 56.8% and 79.2%, respectively. Pneumonia reductions were 65.4% and 83.7%, diarrhea 42% and 95.5%, and meningitis 73% and 83%, respectively. Between 2010-2014, SAM cases were 1781 of 13689 total hospitalization [13% (95%CI 12.5-13.6)] and 53 SAM deaths of 224 total deaths [23.7 % (18.6-29.6)]. SAM hospitalization rate increased from 8.5% in 2010, to 18.4% in 2014 and death rate increased from 27% (17.6-39.0) to 57.5% (42.2-71.5), respectively.

Conclusion: Despite significant decline in IDs and vaccine preventable diseases, this study showed 87.8% of under-5 mortality were neonates. The increasing trends in SAM hospitalization and death are alarming. Interventions to improve neonatal survival and to reduce SAM morbidity and mortality are urgently needed.

Keywords: Infectious diseases, SAM, neonates, under-5, Yemen.

INTRODUCTION

Worldwide, an estimated 5.9 million child deaths under 5 years were reported to have occurred in 2015, and the under-5 mortality rate has fallen to 42.5 deaths per 1000 live births compared to 12.7 million and 90.6 deaths/1000 live births in 1999, respectively [1]. Of those who died in 2013, an estimated 51.8% died of infectious causes and 44% died in the neonatal period [2]. Many of these deaths may be averted through primary and community care interventions [1, 2]. Mortality rates among children admitted to government hospitals in low-income countries, particularly in sub Sahara Africa, are high. Most of the deaths are caused by preventable diseases including pneumonia, malaria, diarrhea, and malnutrition. High inpatient child death in some health facilities may be partly attributed to poor quality of care [3-6]. Improving health services, monitoring health facility performance, and increasing coverage of interventions at the community level are important strategies to increase child survival. Counting the causes of under-5 inpatient deaths is an important step to monitor health facility performance and to guide implementing interventions at both hospital and community levels [7]. Reports suggest that up to 50% of child deaths occur in health facilities [3, 8].

Yemen is a least developing. It has a population of 25.2 millions, with 14% under-5 years. Health information published in 2014 by the WHO estimates that 47% of children in Yemen are stunted and 16% are wasted, and estimates infant and under- 5 mortality rates 40.4 and 51.3 per 1000 live births, respectively [9]. The Millennium Development Goal(MDG) 4 that called for two-thirds reduction of the under-5 mortality rate(U5MR) by 2015 has been achieved in Yemen with U5MR declined from 126/1000 live births in 1990 to 41.9/1000 live births in 2015 [1, 10].

The objectives of this study were: 1) To describe levels and trends of attributable fractions of hospitalization and inpatient death of neonates and children aged 1-59 months with infectious diseases (IDs) and the major sub-groups: very severe pneumonia, severe dehydrating diarrhea, and bacterial meningitis between 2005 and 2014; and 2): To examine trends in hospitalization and inpatient death rates of children admitted with severe acute malnutrition (SAM) between 2010 and 2014.

*Address correspondence to this author at the Department of Pediatrics & Child Health, Sana'a University, Sana'a, Yemen;
E-mail: salembanaj@gmail.com

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PATIENTS AND METHODS

Study Setting and Background

The study was conducted in Al-Sabeen Hospital for Women and Children, the main pediatric hospital in Sana'a city, the capital of Yemen. This government-run hospital provides both primary and secondary care to the urban and rural population of Sana'a city and the surrounding rural Sana'a province (approximately 3 million inhabitants). The services include walk-in outpatient clinics during working days. It has a 15-bed emergency unit that provides pediatric and neonatal services 24 hours a day supported by laboratory and radiology services. The hospital has 2 pediatric medical wards (49 beds), an infectious isolation ward (27 beds), pediatric surgical ward (24 beds), and 2 special baby care units (SBCU) that provide neonatal care services: one for in-born and the other for out-born neonates. In 2010, malnutrition unit (22 beds) that provides nutritional therapy for children hospitalized with SAM was included in the hospital services with technical and financial support from the WHO-EMRO including training of health staff on clinical assessment, anthropometric measurements, use of WHO-Growth standard, and supply of therapeutic diets(F75 and F100).

Yemen, supported by Global Alliance for Vaccines Initiative (GAVI) Alliance, introduced pneumococcal conjugate vaccine (PCV-13) in early 2011, and monovalent live attenuated human rotavirus vaccine (Rotarix™) in October 2012 in the national immunization programmme. Three doses of PCV-13 are given free of charge at age of 6,10, and 14 weeks, and 2 doses of Rotarix™ given at age 6 and 10 weeks. The estimated national coverage rate in 2011-2014 was: 56%, 82%, 90%, and 88% for PCV (dose 3). For Rotarix™ vaccine, the national coverage rate for 2012-2014 (dose 2) was 23%, 79%, and 72%, respectively [11]. The coverage rates for Sana'a city where this study was conducted were 60%, 81%, 91%, and 87% for PCV-13, and 27%, 86%, and 83% for Rotarix™, respectively [11].

Definitions and Case Management

The clinical definition of very severe pneumonia used at this hospital is cough, rapid breathing and lower chest in-drawing and at least one of the following danger signs: clinical cyanosis, unable to breastfeed or drink, lethargy or not alert. The clinical definition of meningitis is fever of sudden onset with one or more one of the following relevant signs: convulsions, neck stiffness, bulging anterior fontanel in children aged < 12 months, poor sucking, altered consciousness, irritability, toxic appearance and/or purpuric rash. The clinical diagnosis of acute gastroenteritis(AGE) with severe dehydration is defined as at least three watery or looser than normal stools in a 24-hour period and of less than 7 days duration, and severe dehydration required two or more of the following signs: lethargy or unconsciousness, sunken eyes, inability to drink, and skin pinch recovers very slowly [12]. Un-complicated SAM is defined as either weight-for-height Z-score less than -3, using WHO Growth Standard and/or mid-upper arm circumference(MUAC) less than 11.5 cm for 6-59 months age group, and <11 cm for the 2-6 months group, or bilateral nutritional pitting edema diagnosing Kwashiorkor. Children who attend the emergency unit with clinically very severe pneumonia, clinical features of meningitis, and those attend with severe dehydrating diarrhea are usually assessed by the on-duty pediatrician. An intravenous line is usually established and blood is collected for full blood count, C-reactive protein and blood smears for malaria. Chest X-ray for pneumonia is also done routinely. The management of these clinical syndromes is usually conducted according to the WHO guidelines [12]. Cases of SAM without complications are usually admitted and managed in the malnutrition unit (MU) and those with complications (usually severe AGE and/or pneumonia) are first admitted in the pediatric emergency/ medical ward where initial stabilization phase started with the support of the MU team. Within 3-7 days as the child regains his appetite, he is usually sent to continue the initial therapy followed by the rehabilitation phase in the MU according to the current WHO guidelines [12, 13].

Study Design

This study was a retrospective analysis of data of neonates, and children aged 1-59 months collected between 2005 and 2014; and data of children hospitalized with SAM between 2010 and 2014.

Data Collection

Information recorded for each patient admitted at Al-Sabeen Hospital includes the date of admission, age and sex of the child and inpatient diagnosis recorded in the admission logbook. The death logbook records the name, age, and sex of the child and cause and date of death, and are signed by both the attending pediatrician and nurse. At the end of every calendar year, summary data on all children hospitalized and total deaths for each pediatric ward are obtained from

the unit of records and statistics. Information on the causes of admission and death by age group (<12 months, 12-59 months, >59 months) and male: female proportions are obtained from the admission, discharge, and death logbooks of each pediatric ward. Data are collected using designed datasheets and then entered in Microsoft Excel spreadsheets. For this study, data for children older than one month and less than 5 years and data for neonates admitted between 1 January 2005 and 31 December 2014 were analyzed. The frequency distribution of admissions and deaths were examined, stratified by age group and ward of admission (Medical ward, Isolation infectious ward, and Neonatal care units). The data distribution were also stratified by 2-year five periods (2005/06, 2007/08, 2009/10, 2011/12, and 2013/14). Data of the total children who were hospitalized and died with very severe pneumonia, bacterial meningitis, and severe dehydrating diarrhea [12] were included in the analysis. The cause-specific hospitalization and death was stratified according to the 2-year five periods. Data on the causes of hospitalization and death for neonates were not available for analysis. Data for children hospitalized with SAM were available from 2010. We stratified the annual SAM hospitalization, and death rates (per 100 admissions and inpatient deaths) of cases collected between 2010 and 2014. We excluded children with surgical diagnoses from this analysis

Ethical Considerations

Because the data were obtained retrospectively, no names were recorded, none of the parents were interviewed and none of the children were followed up, we were therefore advised that ethical approval was not needed for this study. However, approval to conduct this study was obtained from the Director General of Al-Sabeen Hospital. The author does not have access to identifying information prior to data entry and does not interact with patients or legal guardian. Consequently, public health service report based on these data has been deemed non-research by the Center for Global Health at the Center for Disease Control and Prevention (CDC), since the primary intent of data collection is public health practice, specifically routine activities to improve health services. Also the activities in this report are not experimental, and therefore ethical approval was not deemed necessary for this study [14].

Data Management and Statistical Analysis

Summary data for each calendar year (2005-2014) were imported into SPSS software version 20(IBM, Armonk, NY, USA). A time period variable was created consisted of 2-year five periods and variables that include counts of total number of hospitalizations and deaths for each period in each ward were analyzed. Variables of the proportions by age group including under 12 months sub-group for both hospitalizations and deaths in each ward were also analyzed. Variables that include the number of cases and rates of all IDs and very severe pneumonia, bacterial meningitis, and severe dehydrating diarrhea subgroups and the proportions of deaths were also analyzed. To compare proportions of hospitalization for each ward across 2-year five periods, we used non-parametric Kruskal-Wallis test for k independent samples. The test null hypothesis assumes that the frequency distributions of hospitalization in each ward is the same across categories of 2-year periods group. We also measured and compared inpatient mortality for each age-related subgroup hospitalized in each ward. Also, we compared the counts of patients hospitalized and counts of deaths for neonates and all IDs and subgroups. We calculated the reductions in the counts in 2013/14 period compared to 2005/06. We used Poisson probability distribution generalized linear models with log-link function. The counts of hospitalization and death were introduced separately in the model as the dependant variable. In the model we included the 2-year five periods variable which was also included as a predictor factor. The procedure computed the main effect of the 5-period variable with the first period as the reference and expressed as unadjusted exponential l (Beta) with its 95% Wald confidence interval (95% Wald CI) as well as the P value. For SAM cases (2010-2014), we compared the annual hospitalization and death rates in 2014 with those in 2010 to calculate % change in rates including 95% confidence interval. For all the analysis, the statistical significance level was set at <0.05.

RESULTS

Study Population Characteristics

Between January 2005 and December 2014, 39282 under-5 year children were hospitalized and 13213(33.6%) were neonates. Among 26069 (66.4%) inpatients aged 1-59 months, 15622(59.9%) were under 12 months. The proportion hospitalized with infectious diseases (IDs) were 15224 (58.4%). Pneumonia, dehydrating diarrhea, and meningitis sub-groups combined accounted for 12956(85.1%) of all IDs hospitalization, and each accounting for

6785(44.6%), 4557(29.9%), and 1614(10.6%), respectively. During the study period there were 4183 under-5 inpatient deaths and 3671(87.8%) were neonates. Inpatient deaths older than one month were 512 and 440 (85.9%) were IDs with the sub-groups contributing 320 (72.7%).

2-Year Period Hospitalization and Inpatient Mortality (2005-2014)

In each of the three wards, the proportions of under-5 hospitalized across the 2-year five periods were comparable and showed no statistically significant difference (Table **1**). Compared to 2005/06, inpatient mortality trends showed statistically significant reduction of 75.5% (95% CI 66-83) in the medical ward, and 66% (54-76) in the Isolation ward in 2013/14, respectively. However, inpatient neonatal deaths, improved more slowly with a reduction of 18.1% (15.6-21.0) over 10-year period (Table **2**).

Trend in all Infectious Diseases (IDs) Hospitalizations and Deaths

We observed a significant reduction in IDs hospitalization in 2013/14 compared to 2005/6 period with a reduction of 56.8% (55.4-58.3). Reduction in IDs deaths was also significantly higher with a decline of 79.2% (72.1-84.9) (Table **3**). Despite significant decline, both pneumonia and diarrhea remain the most important causes of IDs hospitalization in our study. In 2005/06 period, both accounting for 2298 and 1193, respectively of 4474 IDs hospitalizations contributing 78.0%, compared to794 and 691, respectively of 1932 IDs hospitalizations in 2013/14 and contributing 76.9% (Tables **3** & **4**).

Trends in IDs Sub-Groups Hospitalizations and Deaths (Table 4)

Pneumonia is the most frequently listed (44.6%) IDs sub-group. The hospitalization decreased with a significant reduction of 65.4% in 2013/14 (Table **4**). Inpatient pneumonia mortality declined from 36.4% in 2005/06 to 5.9% in 2013/14 and an impressive reduction of 83.7% (70-92). Dehydrated diarrhea hospitalization, accounting for 29.9% of all IDs, also significantly decreased by 42% in 2013/14, and the decline of diarrhea-related mortality of 95.5% (85-99) is most impressive. Meningitis hospitalization accounting for 10.6% of all IDs also declined with a 73% (68-77) reduction, and inpatient meningitis mortality reduced by 83% (64-93), respectively.

Table 1: Baseline Characteristics of Hospitalized Children Aged Under 5 Years (2005-2014): Distribution Across 2-Year Period Categories

Period	Medical Ward		Isolation Ward		Neonatal Units
	Total	<12 months	Total	<12 months	
Sum	**20914**	**12447**	**5155**	**3175**	**13213**
2005/06					
Sum	4901	2822	903	561	2566
% of sum	23.4	22.7	17.5	17.7	19.4
2007/08					
Sum	4890	2691	871	524	2797
% of sum	23.4	21.6	16.9	16.5	21.2
2009/10					
Sum	4535	2563	951	518	3150
% of sum	21.7	20.6	18.4	16.3	23.8
2011/12					
Sum	2985	1968	1196	741	2369
% of sum	14.3	15.8	23.2	23.3	17.9
2013/14					
Sum	3603	2403	1234	831	2331
% of sum	17.2	19.3	23.9	26.2	17.6
P* value	**0.115**	**0.078**	**0.225**	**0.297**	**0.120**

*Non-parametric Kruskal-Wallis tests for K independent samples.

Table 2: Proportions of Inpatient Deaths of under Five Children by Hospital Wards & 2-Year Periods (2005-2014): Sum (% of Sum)

Period	Neonatal units deaths	Medical ward deaths	Isolation ward deaths
Total Sum	3671	328	184
2005/06	778(21.2)	94(28.7)	67(36.4)
2007/08	801(21.8)	87(26.5)	37(20.1)
2009/10	838(22.8)	68(20.7)	34(18.5)
2011/12	617(16.8)	56(17.1)	23(12.5)
2013/14	637(17.4)	23(7.0)	23(12.5)
GLM-Poisson probability distribution with log link function: 2013/14 compared to 2005/06 for inpatient death proportions.			
2013/14	637(17.4)	23(7.0)	23(12.5)
(Response)			
2005/6	778(21.2)	94(28.7)	67(36.4)
(Reference)	1	1	1
Expon(Beta)*	0.819	0.819	0.343
(95%Wald CI**)	(0.74-0.91)	(0.155-0.386)	(0.214-0.551)
P value	<0.0001	<0.0001	<0.0001
%reduction	18%	75.5%	66%
(95% CI**)	(15.6-21.0)	(66-83)	(54-76)

*Unadjusted Exponential (Beta coefficient). **Confidence interval.

Table 3: Infectious Diseases (IDs) Hospitalizations and Deaths: 2-Year Period Trend Analysis

Period	ID hospitalization: Sum(% of sum)	Total Sum=15224 % Reduction (95% CI*) Compared to 2005/6 period	ID deaths: Sum(% of sum)	Total Sum=440 % Reduction (95% CI*) compared to 2005/6 period
2005/6	4474(29.4)	----	154(35.0)	-------
2007/8	3729(24.5)	16.7 (15.6; 17.8)	123(27.9)	20.1(14.6; 27.2)
2009/10	2956(19.4)	33.9 (32.6; 35.3)	88 (20.0)	42.9(35.3; 50.8)
2011/12	2133(14.0)	52.3 (50.9; 53.8)	43 (9.8)	72.1(64.5; 78.6)
2013/14	1932(12.7)	56.8 (55.4; 58.3)	32 (7.3)	79.2(72.1; 84.9)
GLM-Poisson probability distribution with log link function: 2013/14 compared to 2005/06 for IDs hospitalizations & deaths.				
2013/14 (Response)	1932(12.7%)		32(7.3%)	
2005/06	4474(29.4%)		154(35%)	
(Reference)	1		1	
Exponen(B)**				
for response	0.432		0.208	
(95% Wald CI*)	(0.409-0.455)		(0.142-0.304)	
P value	< 0.0001		<0.0001	

Severe Acute Malnutrition (Table 5)

Between 2010-2014, a total of 13689 aged 1-59 months were hospitalized and 1781 [13% (95%CI 12.5-13.6)] were admitted in the MU with SAM and 1165(65.4%) were under 12 months. In 2010, SAM hospitalization rate per100 admissions was 8.54% (270/3160) and increased to 18.35% (548/2986) in 2014, with an increase of 9.81% (95% CI 8.11-11.51), P=0.0002(Odds Ratio 2.41(95%CI 2.06-2.81). Of 224 total deaths for the same period, uncomplicated SAM

Table 4: 2-Year Proportions of Pneumonia, Diarrhea, and Meningitis-Related Hospitalization & Death: Comparing Proportions of 2013/14 and 2005/06 Period

Period	Total	2005/06	2007/8	2009/10	2011/12	2013/14
Pneumonia	6785	2298	1692	1304	697	794
admissions	(%)	(33.9)	(24.9)	(19.2)	(10.3)	(11.7)
Expon (B)		1				0.346
(95% Wald CI)						(0.319-0.375)
P value						<0.0001
% Reduction						65.4%
(95% CI)						(63.5-67.4)
Pneumonia	118	43	33	24	11	7
Deaths	(%)	(36.4)	(28.0)	(20.3)	(9.3)	(5.9)
Expon (B)		1				0.163
(95% Wald CI)						(0.073-0.362)
P value						<0.0001
% Reduction						83.7%
(95% CI)						(70-92)
Dehydrating	4557	1193	1181	924	568	691
Diarrhea	(%)	(26.2)	(25.9)	(20.2)	(12.5)	(15.2)
Expon (B)		1				0.579
(95% Wald CI)						(0.527-0.636)
P value						<0.0001
% Reduction						42%
(95% CI)						(39-45)
Diarrhea	138	44	53	30	9	2
Deaths	(%)	(31.9)	(38.4)	(21.7)	(6.5)	(1.5)
Expon (B)		1				0.045
(95% Wald CI)						(0.011-0.187)
P value						<0.0001
% Reduction						95.5%
(95% CI)						(85-99)
Meningitis	1614	406	365	419	313	111
admissions	(%)	(25.1)	(22.6)	(26.0)	(19.4)	(6.9)
Expon (B)		1				0.273
(95% Wald CI)						(0.222-0.337)
P value						<0.0001
% Reduction						73%
(95% CI)						(68-77)
Meningitis	64	24	14	15	7	4
deaths	(%)	(37.5)	(21.9)	(23.4)	(10.9)	(6.3)
Expon (B)		1				0.167
(95% Wald CI)						(0.058-0.480)
P value						<0.0001
% Reduction						83%
(95% CI)						(64-93)

Table 5: Trends in Severe Acute Malnutrition (SAM) Hospitalization & Death Rates Per 100 Admissions & Deaths: Comparing 2014 and 2010

Year	SAM /Total admissions	SAM admission rate % (95%CI)	SAM deaths /Total	deaths SAM death rate % (95%CI)
2010-2014	1781/13689	13.0(12.5-13.6)	53/224	23.7(18.6-29.6)
2010	270/3160	8.5(7.6-9.6)	17/63	27.0(17.6-39.0)
2011	247/2476	9.98(9.06-11.47)	6/51	11.8(5.5-23.4)
2012	264/2216	11.9(10.6-13.3)	4/38	10.5(4.2-24.1)
2013	452/2851	15.9(14.6-17.2)	3/32	9.4(3.2-24.2)
2014	548/2986	18.4(17.0-19.8)	23/40	57.5(42.2-71.5)
2014 compared to 2010:		Difference: 9.8(8.1-11.5)		30.5(11.04-47.4)
		OR 2.4 (95%CI 2.1-2.8)		3.7 (95% 1.6-8.5)
		P= <0.0001		0.002

deaths were 53 cases [23.7% (18.6-29.6)]. SAM death rate was 26.98% (17/ 63 deaths) in 2010 and 57.50% (23/ 40 total deaths) in 2014, increasing by 30.52% (11.04-47.37) [OR 3.66(95% CI 1.58-8.46); P=0.002].

DISCUSSION

Significant effort has been made in improving child survival worldwide and the global under-5 mortality has declined by almost half. However, during the first 28 days of life, neonatal proportion of under-5 deaths has been estimated at 44% in 2013 [2]. Yemen has achieved MDG4 by reducing under-5 mortality by two-thirds in 2015 [10]. With 18000 neonatal deaths of total 34000 under-5 deaths, neonates in Yemen contributed 52.9% in 2015 [10]. In this study, in the 10-year period (2005-2014) neonatal proportion (n=13213) of total under- 5 admissions (n=39282) who needed special care was 33.6%, and the proportion of neonatal deaths (n=3671) of under-5 deaths (n=4183) was 87.8%. The increasing proportion of death in the neonatal period in our study indicates that both preventive and treatment interventions to improve newborn survival should be scaled up. Interventions for every newborn (cord cleaning with antiseptic, prevention of hypothermia, early breastfeeding within the first hour of life, and vitamin K_1 administration), immediate resuscitation of sick newborn with available equipment and oxygen supply, and early recognition and management of neonatal infection that needs high quality neonatal nursing care. These interventions can reduce the three most common causes of neonatal deaths: preterm, intrapartum, and infection-related deaths by 58%, 79%, and 84%, respectively [15].

The present study showed significant decline in IDs hospitalization and death rates of under 5 children in 2013/14 period compared to 2005/6. The decline is also impressive in IDs sub-groups (Tables **3** & **4**). Worldwide, both pneumonia and diarrhea remain the major infectious causes of morbidity and mortality in children younger than 5 years. They accounted for 15% and 9%, respectively of the 6.3 million under-5 deaths that occurred in 2013 [2, 16, 17].

The introduction of PCV 13 and Rotarix™ in the national immunization programme in Yemen may have contributed in the significant reductions in IDs hospitalization and inpatient death in 2013/14. However, both pneumonia and diarrhea still contributing 76.9% of IDs burden (Tables **3** & **4**) compared to 78.0% in 2005/06 which may reflects the burden in the community the hospital serves. The persistent high burden may be explained by the multiple etiologies of both pneumonia and diarrhea. Introduction of Rotarix™ in Yemen resulted in the decline of the average annual prevalence of rotavirus gastroenteritis (RVGE) from 42.9% before the vaccine introduced to 18.5% in 2014, severe RVGE hospitalization decreased by 67%, and severe RVGE dehydration declined by 58%; however non-RVGE significantly increased three times in 2013-2014 [18]. With decreasing prevalence of RVGE following rotavirus vaccine introduction, norovirus has been reported as the leading viral cause of GE in both hospital and community settings [19, 20]. Similarly, childhood pneumonia after PCV 13 introduction showed more multiple pathogens. A recent study of highly vaccinated (including PCV 13) children to investigate the incidence and causes of childhood

pneumonia in South Africa, reported Bordetella pertussis, respiratory syncytial virus(RSV), and influenza virus were strongly associated with childhood pneumonia [21].

To improve child survival, the WHO/UNICEF created framework to reduce child morbidity and mortality from pneumonia and diarrhea in developing countries [22]. In 2013, the WHO and UNICEF launched the integrated Global Action Plan for the Prevention and Control of Pneumonia and Diarrhea(GAPPD) with commitment to eliminate child deaths from pneumonia and diarrhea by 2025 [23]. Successful implementation of the integrated GAPPD will need strong commitments from national governments, the private sectors, and the international donor agencies. Well funded programs to expand immunization coverage, to prevent and treat childhood pneumonia and diarrhea, and to prevent and treat malaria are the important components of technical progress in a developing country [24, 25]. An estimated 80% decline in under-5 mortality has been attributed to technical progress [25]. Greater vaccination coverage has significantly faster declines in under-5 mortalities, independent of income, and doctors per capita [25].

SAM is the direct cause of 0.5 million child deaths every year as well as a major risk to many other causes of child deaths particularly those due to pneumonia and diarrhea [26]. In a recent study to assess the efficacy of daily co-trimoxazole prophylaxis on survival in non-HIV children hospitalized with complicated SAM showed diarrhea (30%), severe pneumonia (27%), or both conditions (27%) were the most common causes of hospitalizations before enrollment [27]. Children with SAM have high inpatient mortality and the risk of death remains high for several months after hospital discharge [28, 29]. In this study, over a 5-year period (2010-2014), we observed SAM attributable fractions contributing 13% of all hospitalizations; and 23.7% of inpatient deaths. The attributable fraction of hospitalizations and inpatient deaths in 2014 increased more than twice compared to 2010 (Table **5**). The on-going military conflict since early 2015 in Yemen could further increase SAM-related hospitalization and death. This study has several limitations. The study was a retrospective analysis of data from records in a single health facility. The results of the study cannot be generalized to the whole country; however they may reflect the child health status in the community this hospital serves. Also the available recorded data could not identify children with repeated admissions. Lack of data on the neonatal causes of hospitalization and death is a major limitation. However, the recording of neonatal attributable fractions may have contributed to describe the pattern and trends of neonatal morbidity and mortality. For low-income countries, including Yemen, the introduction of Pediatric Hospital Reporting (PHR) programme could be a useful tool to produce a reliable annual hospital report which enable data to be used to plan interventions at local and national levels to improve the quality of care [30].

CONCLUSIONS

Between 2005 and 2014, significant decline trend in IDs hospitalization and inpatient death among under-5 was observed in AL-Sabeen Hospital. The observed decline in IDs and the vaccine-preventable diseases supports optimism that IDs-related morbidity and mortality can be further reduced by increasing vaccination coverage. The increase in neonatal inpatient mortality proportion of under-5 inpatient deaths presents important public health challenges indicating that neonatal interventions and neonatal training on life saving equipment needs scaling-up. SAM attributable fractions of hospitalization and mortality showed increasing trends in 2014. With the on-going military conflict since early 2015 in Yemen, SAM situation may be worse, and children need urgent help from international agencies.

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