The Predictors of Hospital-Death Among Children in Western Iran

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Abstract- Analyzing child mortality, an important indicator of health and development of countries, can help policymakers to develop health programs that resulted in improving Childs's health. Recognizing the causes of in-hospital deaths also assists health caregivers to revise their medical services. The aim of this study was to explore the causes of death in the largest hospital in western Iran. This retrospective descriptive-analytical study was conducted in Imam Reza Hospital (IRH) in Kermanshah, data including demographic characteristics (e.g., age), medical information, and causes of death of patients aged ≤18 years, from April 2012 to March 2017 were collected using a checklist. The causes of mortalities were categorized based on the International Coding of Diseases (ICD, Version 10). Using logistic regression, Chi-square, and Cramer's V test in SPSS, the relationships between the outcome and predicting variables were assessed. The results showed 1113 deaths among 21,247 people≤, 18 years people admitted to IRH for five years. About 55% were female and 74% neonate, with a dropping trend from 2011 (4.62%) to 2016 (4.00%). Medical records, mostly, used a variety of usual medical terms for the causes of death, rather than using ICD10 categories. Data were analyzed after alternating medical terms and re-coding data using ICD10. Respiratory system diseases by 34% (dominancy of hyaline membrane diseases), infectious diseases by 28% (leading by sepsis), and diseases of the blood by 13% (mostly disseminated intravascular coagulation (DIC)), respectively, were the most common causes of death. Age was the most important associated factor for all-cause mortality associated with infectious diseases and respiratory system diseases (P=0.01). Having a significant number of neonatal mortality, paying more attention to the neonatal, prenatal, and antenatal care is recommended. In addition, the fatality of infectious diseases is concerning and needs paying serious attention to the health care system.

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Introduction

According to the World Health Organization (WHO) definition, the chronological age group people ≤18 years is considered as a child (1). Accordingly, around 23% of the population in Iran is the child. Children are inherently vulnerable, and diseases may profoundly affect their lives. Therefore, they need special health care services (2). Although Millennium Development Goal 4 (MDG4) calls for an end to preventable child deaths, child mortality remains a problem in many nations, and millions of children are still dying due to preventable causes (3-5).

Care of children is a basic moral responsibility of societies. Further, the development of countries depends on how healthy the children are, according to evidence (2). Although the under-5 mortality rate has been dropping during the last decades (90.6 deaths per 1000 live births in 1990 to 42.5 deaths in 2015) (6), still, approximately 11 million children <5year, mostly newborn, die each year across the world. The majority of these deaths happened in low and middle-income countries (7,8), though it varies among different countries. The highest rates of child mortality are still in

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Sub-Saharan Africa and South Asia, respectively (9).

The causes of child-death detailed information are crucial for health policymakers, health caregivers, and researchers in order to prioritize funding. Interventional activities resulted in improving child survival. Further, clarifying the pattern and causes of in-hospital death not only may help to estimate the burden of diseases, but it also can plain the medical errors and the failure of caregivers in the hospital, which are preventable. WHO describes in-hospital deaths as the potential reference to provide great improvements in clinical practice and increasing survival (10).

Many risk factors, In Iran, including cultural factors, environmental factors, socio-demographic status, and economic factors, which have a critical role in premature deaths, can be fully avoided. Also, many others, such as inherited diseases including congenital anomalies as one of the most important predisposing factors of child mortality can be reduced (11).

On the other hand, the aging population and reducing the fertility rate in Iran highlights the importance of child care and pediatric medical services. However, little known about the age-specific pattern and causes of in-hospital death, including those ≤18 years, in western Iran. Therefore, the current study was conducted to explore the death rate and causes of in-hospital mortality, as well as predicting factors among patients ≤18 years admitted to IAH during five from 2012 to 2017.

Materials and Methods

Setting

The setting of this study was Imam Reza Hospital (IRH), which had 750 beds, including various pediatrics wards plus outpatients medical offices, where patients with any illness, regardless of the severity of diseases, age, socioeconomic status, and sex, are visited daily. The hospital locates in the north of Kermanshah city (along with countryside villages has about 800,000 population) in western Iran. The patients who are visited by doctors in IAH come across the city and countryside, without preference for each area.

Study design and participants

In this retrospective descriptive-analytical study, all medical records of deaths ≤18 years registered to IRH, during five years from April 2012 to March 2017, were explored for data related to the study purposes. Using convenience sampling, all death that met the inclusion criteria (age ≤18 years and recorded adequate information) were selected to be included in the study. Those with incomplete personal or medical information were excluded because they had died before getting medical services in IRH; hence they are not accounted for in-hospital death.

Instrument and data collection

Data were collected by two trained nurses and using an open-ended questionnaire developed based on the study objectives. The questionnaire was evaluated and approved by expert opinions compromising a statistician, an internal specialist medical doctor, and a Ph.D. in public health.

The questionnaire included three parts:

i. Socio-demographic characteristics included age (neonate, infant, toddler& pre-school, school age, and teenager) , gender (female, male).
ii. Medical histories including; comorbidity (preterm, Hyaline Membrane Disease (HMD), congenital heart disease, sepsis or septicemia, metabolic disorders, others and none), admitted ward (Neonatal ICU, pediatrics ICU, pediatrics ward, operating ward, ICU, post ICU, internal ward and neurosurgery), and insurance (public, private and none) (Table1).
iii. The cause-of-death was classified as adopting the International Classification of Diseases, Tenth Revision (ICD–10) (Table 2).

Data analysis

Data analysis was performed using statistical package for social sciences (SPSS) statistical software (Version 23.0; IBM Corporation, Chicago, USA). Qualitative/categorical variables are expressed as frequencies and percentages. The Chi-square and Cramer's V test was used to assess any association between causes of death and possibly explanatory factors such as age, gender, and comorbidity. A probability value (*P*) of less than 0.05 was considered statistically significant.

Ethics approval

The Research Ethics Committee at Kermanshah University of Medical Sciences (KUMS) has approved the study protocol (Ethics registration no=95194). In addition, the information has been reported in general, and individual personal information has been kept confidentially

Results

Data analysis showed that 1113 deaths among 21,247 people ≤18 years admitted to IRH for five years. About 74.0% of deaths were neonates, mostly (55.0%) female (Table 1).

About 98.8% of cases had been suffering from at least one comorbidity (e.g., preterm, Hyaline Membrane Disease (HMD), congenital heart disease, sepsis, metabolic disorders). The most frequently occupied hospital wards by participants, respectively, were; neonatal ICU (78.2%) and pediatrics ICU. About 85.3% of cases had been supported by public health insurance (Table 1).

The trend of the in-hospital mortality rate for children has been decreasing slightly, from 4.62% in 2012 to 4.0 % by 2017 (Table 2).

Table 1. General characteristics of children died from 2012 to 2017 in western Iran (hospital-based data, n=1113)

Characteristic	Subgroup	N (%)
Age (year)	**Neonate (1 month≥)**	824 (74.1)
	Infant(12 month≥)	89 (7.9)
	Toddler & Pre-school (1-5y)	81 (7.3)
	School-age (6-12y)	53(4.7)
	Teenager (13-18y)	63(5.7)
	Missing	3(0.3)
Gender	**Male**	501 (45.0)
Comorbidity	**Pre-term**	517 (46.5)
	Hyaline membrane disease	131 (10.2)
	Congenital heart disease	74 (6.7)
	Sepsis or Septicemia	46(4.1)
	Metabolic disorders	31 (2.8)
	Others	301 (28.5)
Admitted ward	**Neonatal ICU**	821 (73.8)
	Pediatrics ICU	178 (16.0)
	Pediatrics ward	29(2.6)
	Operating ward	20 (1.8)
	ICU	22 (1.9)
	Post ICU	26 (2.3)
	Internal ward	13(1.3)
	Neurosurgery	4(0.3)
Health insurance	**Public**	949 (85.3)
	Private	103 (9.2)
	Unknown	38 (3.4)
	Missing	23(2.1)
Total		1113 (100.0)

Table 2. The trend of in-hospital child mortality rate in western Iran 2012-2017 (n=1113)

Children ≤18 years	2012	2013	2014	2015	2016	Total
Admitted(N)	5,975	3,415	3,813	3,929	4,115	21,247
Died (N)	276	267	213	189	165	1,113
Rate (%)	4.62	7.82	5.59	4.81	4.00	5.24

The three most frequent causes of in-hospital child deaths, respectively, were respiratory system diseases, infectious diseases, and diseases of the blood by 34.0%, 28.0%, and 13.0%. The least rank cause of death was related to external causes of mortality (caused by the intentional and unintentional accident, *e.g.,* drowning) (0. 1%) (Table 3).

Sepsis and Hyaline membrane disease were the most common diagnosis, accounting for 24.1% and 20.2% of deaths, respectively. Disseminated intravascular coagulation was the cause of 11.7 % of deaths. Other causes of death were pneumothorax by 5.2%, septic

shock by 3.7%, and asphyxia by 2.4 %. Less frequent causes of deaths were categorized as others.

The causes of death were not significantly associated with gender (*P*=0.33) and comorbidity (*P*=0.15). Age was associated significantly with the causes of death (*P*=0.01). In fact, infection diseases and respiratory system diseases (leading by neonatal sepsis and Hyaline membrane disease) were more common in neonates.

Table 3. All causes of hospital death among children, according to the ICD10 classification in western Iran 2012-2017 (n=1113)

Causes	N (%)
Diseases of the respiratory system	376 (33.7)
Infectious & parasitic diseases	308 (27.6)
Diseases of the blood & blood-forming organs & certain disorders involving the immune system	141 (12.6)
Diseases of the circulatory system	63 (5.6)
Congenital malformations, deformations, and chromosomal abnormalities	47(4.2)
Certain condition in the prenatal period	41(4.1)
Diseases of the nervous system	31 (2.8)
Trauma (Injury, poisoning, burning, violence, etch)	32 (2.9)
Diseases of the genitourinary system	16 (1.4)
Endocrine, nutritional & metabolic diseases	13 (1.2)
Neoplasms	14(1.3)
Diseases of the digestive system	12(1.1)
Diseases of the musculoskeletal system & connective tissue	3(0.2)
External causes of morbidity and mortality	2(0.1)
Missing data	13 (1.2)
Total	1113 (100.0)

Discussion

This retrospective study has been conducted to analyze the major causes of death among child patients (≤18 y) and likely associated factors with death during the years 2012 to 2017, in a mega-hospital in western Iran. We used an open-ended questionnaire developed based on the study's objectives to collect data on socio-demographic, medical characteristics, and causes of death which has been recorded in hospital data sets.

The results indicated that the in-hospital mortality rate for children has been dropping, though slightly, from 2012 to 2017. This may be due to the developing health care system resulted in increasing child survival and/or growing standard of living and socio-economic facilities; all these help to achieve MDG4 targets.

The current study showed a significant number of neonatal mortality (74%). This result is in accordance with the results of some studies conducted in Iran and other countries. For example, Sadeghieh Ahari and colleagues from Ardabil have shown that 75% of child mortality was in the neonatal period in 2012 (12). Ardabil is a state in North West of Iran, but people living there have a different culture, socioeconomic status, and lifestyle from those living in Kermanshah. Likewise, the results of Rabbani's survey conducted in 2015 showed that the neonatal mortality rate is high in Pakistan (13). A global study by E Black *et al*., in 2012 showed two-fifths of child mortality occurred in the neonatal period (14). Similarly, E Black *et al*., in another global study in 2015, reported about 44% of neonatal mortality (15). Child mortality is shifting closer and closer to the time of birth worldwide; thus, paying attention to the neonatal, prenatal, and antenatal care is recommended.

Another key finding in the current study was that female deaths constituted 55% of mortality. This finding is consistent with the findings of previous studies conducted by Namakin *et al*., (16), Sawyer *et al*., (17), Dongying Zhao *et al*., (18), Jitendra *et al*., (19), and Pandey *et al*., (20), which reported in-hospital child mortality in females are more comparing peer males. This might be explained by the role of genetic, socio-behavioral causes (e.g. sex discrimination) and environmental factors in the development of mortality rates in female child. For instance, sex discrimination lead to their negligence during her childhood and consequently a higher number of deaths among female child.

The study demonstrated that diseases of the respiratory system, infectious diseases, and diseases of the blood were the most common causes of deaths, respectively. These results are consistent with the findings of Bakhtiari *et al*., (21), Yang *et al*., (22), and

Alberts *et al*., (23), who showed that the respiratory system diseases were the second leading cause of child mortality. Likewise, a study conducted in Canada by Chien illustrated infectious diseases were the leading cause of child mortality (24). Similarly, E Lawn and colleagues reported the major causes of neonatal death globally were infection diseases (25). Reporting respiratory system diseases on the top of child mortality causes is predictable; however, the fatality of infectious diseases is concerning and needs serious attention.

However, many other researchers reported converse results. For instance, Dehkordi *et al*., from Tehran in 2012, reported congenital abnormalities, neoplasms, and external causes of mortality (e.g., drowning), respectively, were the most common causes of child deaths (7). Similarly, Alberts *et al*., (23) and Bakhtiari *et al*., (21) reported that the leading causes of child mortality were injuries. Hamilton's study conducted in Columbia, United State showed external causes of mortality (e.g., accidents and homicide) was the top of mortality causes (26). This discrepancy between studies may be due to regional, cultural, and genetical factors and needs further investigation.

The findings of this study showed that sepsis, Hyaline Membrane Disease (HMD), and disseminated intravascular coagulation were the leading killers of children, respectively. Previous studies conducted by E Black *et al*., (14) and Gheini *et al*., (27) showed that HMD and sepsis were the most common causes of neonatal death. Also, in another study conducted by Nayeri in Tehran, the capital of Iran, HMD was the major cause of death among neonates in 2007 (28). Likewise, Tour *et al*., showed sepsis, HMD, and disseminated intravascular coagulation were the main causes of child death in Ahvaz, Iran, in 2014 (29).

Regarding the comorbidity diseases at hospital admission, our findings show that about half of the cases had a history of prematurity. Furthermore, preterm birth is a major cause of neonatal mortality and also a significant contributor to long-term adverse health outcomes. Thus, clarifying the risk factors for preterm birth (e.g., infections and complications during pregnancy) is strongly recommended if prevention is to be addressed appropriately.

The results of this research also demonstrated that age was the most important associated factor for all-cause mortality associated with infectious diseases and respiratory system diseases. These results concur with the findings from previous studies. We observed that the risk of infectious diseases and respiratory system diseases was higher in neonates. Interestingly, the neoplasms, external causes (e.g., accidents, drowning and etc.), and injuries were significantly related to older children. Previous studies conducted by Patel *et al*., (30) and Mokdad *et al*., (31) have reported similar findings. In fact, neonates are very vulnerable to infection. Managing pregnancy, improving antenatal care, and educating women about the benefits of breastfeeding would be useful.

The results indicated that the in-hospital mortality rate for children has been dropping slightly from 2012 to 2017. This may be due to the developing health care system resulted in child survival, and increasing standard of living and socio-economic facilities. Yet, the neonatal mortality is notable; hence, it needs improving neonatal care, increasing prenatal and antenatal care. According to the results, respiratory system diseases, infectious diseases, and diseases of the blood (based on ICD10) were the three leading causes of in-hospital death among patients ≤18. Considering the fatality of infectious diseases plus the fact that they can be prevented, interventional campaigns by health care system authorities and policymakers, as well as a further investigation by researchers, are recommended.

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