

Iatrogenic illness in the paediatric intensive care unit at Gharian teaching hospital, Libya

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الأمراض العلاجية المنشأ في وحدة الرعاية المركزة للأطفال في المستشفى التعليمي في غريان، ليبيا أحمد إسماعيل، سعاد شدييد

الخلاصة: كان الهدف من دراسة المتابعة التشفوية هذه هو التعرف على معدل الحدوث وعوامل الاختطار للأمراض العلاجية المنشأ وحاصل الحالات التي قبلت في وحدة الرعاية المركزة للأطفال في مستشفى تعليمي في ليبيا. وقد تبين أن معدل حدوث المضاعفات العلاجية المنشأ قد وصل إلى 22.9% بين 423 حالة أدخلت على مدى عام كامل. وكان أكثر الأسباب شيوعاً لهذه المضاعفات: الأخطاء البشرية (18.4%)، تتلوها الأعطال التي تصيب الماكينات (4.5%)، وبلغ المعدل الإجمالي للوفيات 7.6%، وهو أعلى بمقدار يُعتدُّ به إحصائياً في الحالات العلاجية المنشأ (13.4%) مقابل الحالات الأخرى (5.8%). وقد كان حَزَز score اختطار الوفيات بين الأطفال (PRISM) مؤشراً جيداً لتوقع اختطار الأمراض العلاجية المنشأ. وقد ترابط كلٌّ من معدل الوفيات من الأمراض العلاجية المنشأ ومعدل حدوثها ترابطاً يُعتدُّ به إحصائياً مع حَزَز مرتفع لاختطار الوفيات بين الأطفال، ومع استخدام التهوية التنفسية الآلية، مع معدّل مرتفع لإشغال الأسرة في وحدة الرعاية المركزة، ومع وجود مرض تنفسي وعصبي، ومع مدة طويلة من المكث في وحدة الرعاية المركزة، ومع صغر عمر الطفل.

ABSTRACT The aim of this prospective follow-up study was to determine the incidence and risk factors of iatrogenic illness and the outcome among cases admitted to the paediatric intensive care unit in a teaching hospital in Libya. The incidence of iatrogenic complications was 22.9% among 423 cases admitted over a 1-year period. Human error (18.4%) followed by machine defects (4.5%) were the most common causes of complications. The overall mortality rate was 7.6% and was significantly higher in iatrogenic cases than others (13.4% versus 5.8%). Paediatric risk of mortality (PRISM) score was a good predictor of risk of iatrogenic illness. Both mortality and occurrence of iatrogenic illness were significantly associated with: higher PRISM score, use of mechanical ventilation, higher bed occupancy rate in the unit, presence of respiratory and neurological diseases, prolonged duration of stay in the intensive care unit and younger age of the child.

Maladies iatrogènes en unité de soins intensifs pédiatriques à l'hôpital universitaire de Gharian en Libye

RÉSUMÉ La présente étude prospective de suivi visait à déterminer l'incidence et les facteurs de risque des maladies iatrogènes ainsi que leur évolution chez des patients admis en unité de soins intensifs pédiatriques d'un hôpital universitaire en Libye. L'incidence des complications iatrogènes était de 22,9 % sur 423 patients admis au cours d'une période d'un an. La cause de complications la plus fréquente était l'erreur humaine (18,4 %) suivie par les dysfonctionnements techniques (4,5 %). Le taux de mortalité globale était de 7,6 %, mais s'avérait nettement supérieur pour les cas iatrogènes (13,4 % par rapport à 5,8 %). Le score PRISM (*Paediatric risk of mortality score*) était un bon indicateur prédictif de maladie iatrogène. La mortalité tout comme la survenue d'une maladie iatrogène étaient fortement associées aux éléments suivants : un score PRISM élevé, le recours à la respiration artificielle, un taux d'occupation des lits important dans l'unité, la présence de maladies respiratoires et neurologiques, un séjour prolongé dans l'unité de soins intensifs et l'âge particulièrement jeune de l'enfant.

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Introduction:

The paediatric intensive care unit (PICU) has evolved as a unique setting for the care of children with unstable or life-threatening illness. The primary goal of intensive care is to prevent mortality in patients with reversible critical illness [1]. Despite efforts to provide the best care, complications may continue to occur in the critically ill patient, either because of the natural course of the disease or after a procedure or institution of a new therapy [2].

Iatrogenic illness is defined as an unexpected adverse condition that occurs as a result of medical care and is independent of the patient's underlying disease. It is an important determinant of the need for paediatric intensive care [3]. Iatrogenic illness has been classified as either due to complications of drugs or complications of a medical or surgical act [4]. The occurrence of nosocomial infection as an iatrogenic complication has been demonstrated to increase the risk of death in critically ill patients and the incidence of nosocomial infection remains high especially in patients receiving critical care. Poor staff hygiene is considered to be leading source of infections acquired during hospitalization [5]. Monitoring of critically ill patients to assess their current status and anticipate problems is essential to paediatric critical care and the assessment of PICU outcome has been done to evaluate the effectiveness and efficiency of such care [1]. The aims of the current study were to determine the incidence and risk factors for iatrogenic illness, together with the outcome among cases admitted to the PICU of a teaching hospital in Libya in an attempt to prevent or minimize such illness.

Methods

Sample and setting

This was a prospective follow-up study of all cases admitted to the PICU of

Gharian teaching hospital during the period December 2007 to December 2008. The total number of beds in the PICU was 5. The staffing of the unit over 24 hours was divided into 2 shifts; each shift routinely included 2 doctors, 2 nurses and 1 ancillary worker. In this study we excluded cases with low Glasgow coma scale (below 3) and patients who died within the first hour of admission.

Data collection

Data were collected from all patients regarding age, sex and primary diagnosis, after which patients were classified into medical emergency, surgical emergency or elective admission status. Severity of the illness was assessed at the end of admission day using the paediatric risk of mortality score (PRISM score) according to Gale [6]. Laboratory investigations were carried out for diagnostic purposes (serum calcium, sodium, potassium, creatinine, blood urea, prothrombin time, partial thromboplastin time, serum bilirubin and aspartate and alanine aminotransferases) and are not reported here. The bed occupancy rate in the unit at the time each case was admitted was determined by dividing the number of cases including this case by the total number of beds in the PICU (i.e. 5 beds) according to Thierry et al. [7].

Iatrogenic illness was assessed as present or absent according to the criteria of Joseph et al. [3]. If present, we determined whether it happened in the PICU and the type, i.e. whether it could be attributed to human error (adverse drug events, vascular catheter complication, nosocomial infection, cutaneous injury, bedsore, accidental extubation, laryngeal dyspnoea) or to a machine/equipment error (ventilator or other equipment, monitor malfunction) according to Joseph et al. [3]. The severity of each iatrogenic complication was classified as: minor (resolved spontaneously), moderate (required only routine therapy) or major (fatal or life-threatening if a specific intensive

care therapy was required to treat the iatrogenic complication e.g. artificial ventilation) [8]. The duration of stay inside the PICU and outcome of the patients (alive or dead) were also determined.

Statistical analysis

The collected data in this study were statistically presented and analysed using descriptive statistics, chi-squared test, relative risk, confidence interval and correlation. We used Spearman correlation test for ordinal variables and numerical skewed variables and Pearson correlation test for interdependent numerical variables. Significance was accepted at a level of $P < 0.05$. Analyses were performed using the statistical software package SPSS, version 7.0 for Windows.

Results

Background characteristics

This prospective follow-up study was carried out over a period of 1 year and included 423 cases. The mean number of cases per month was 35.3 and per day was 1.2. The total number of beds in the PICU of Gharian teaching hospital was 5, the mean number of cases for each bed per month was 7 and the mean duration of stay was 4.1 days. The characteristics of the studied cases are summarized in Table 1. The proportions of females and males in the sample were similar (48.7% versus 51.3%). The age range was 1 month to 6 years and the majority were aged < 2 years (69.5%). The underlying cause of admission to the PICU revealed that 28.1% of cases presented with respiratory diseases, 20.6% with neurological diseases, 20.1% with gastrointestinal diseases, 13.9% with cardiac diseases and 17.3% with other conditions (diabetic ketoacidosis, renal conditions, organophosphorus poisoning, septicemia, preoperative preparation, postoperative care, and drug poisoning). The PRISM scores ranged from 1 to 34 with a mean of 14.7.

Table 1 Characteristics of the study sample of children admitted to the paediatric intensive care unit (PICU) ($n = 423$)

Variable	No.	%
Age (years)		
< 2	294	69.5
≥ 2 –6	129	30.5
Sex		
Male	217	51.3
Female	206	48.7
Duration of stay (weeks)		
< 1	95	22.5
≥ 1	328	77.5
PICU bed occupancy rate		
2/5 (40%)	142	33.6
3/5 (60%)	95	22.5
4/5 (80%)	137	32.4
5/5 (100%)	49	11.6
Cause of admission (underlying diseases)		
Respiratory	119	28.1
Neurological	87	20.6
Gastrointestinal tract	85	20.1
Cardiac	59	13.9
Other ^a	73	17.3
PRISM score		
1–9	77	18.2
10–19	168	39.7
20–29	100	23.6
≥ 30	78	18.4
Presence of iatrogenic illness		
Yes	97	22.9
No	326	77.1
Type of iatrogenic complication^b		
Human error		
Yes	78	18.4
No	345	81.6
Mechanical error		
Yes	19	4.5
No	404	95.5
Outcome		
Dead	32	7.6
Alive	391	92.4

^aDiabetic ketoacidosis, renal conditions, organophosphorus poisoning, septicaemia, preoperative preparation, postoperative care and drug poisoning.

^bAccording to Joseph et al. [3].

PRISM = paediatric risk of mortality [6].

Iatrogenic illness rate

The rate of iatrogenic illness among the studied cases is presented in Table 2. The occurrence of iatrogenic illness

significantly increased with: lower patient age (< 2 years), prolonged duration of stay in the PICU (≥ 1 week), presence of respiratory and neurological diseases,

high PRISM score (≥ 30) and higher bed occupancy rate in the unit ($> 3/5$). The incidence of iatrogenic illness was significantly higher among ventilated cases (54.5%) compared with non-ventilated ones (21.2%) (RR = 2.57, 95% CI: 1.68–3.94, $P < 0.001$). Out of 12 mechanically ventilated cases with iatrogenic illness, 9 developed ventilator-associated pneumonia and 3 developed septicaemia. The rates of developing iatrogenic illness were 34.5% for cases admitted to the PICU with respiratory disease, 32.9% for gastrointestinal disease, 16.1% for neurological disease, 11.7% for cardiac diseases and 9.6% for other disorders. Of the 7 cases with other disorders, 5 had drug-induced complications and 2 had septicaemia. Iatrogenic drug-induced complications were detected in 5 cases (1.2% of admitted cases); 2 cases were due to metoclopramide toxicity, 2 to carbamazepin toxicity and 1 to haloperidol toxicity.

Table 3 displays the distribution of cases with iatrogenic illness according to severity of iatrogenic complications and age, bed occupancy rate and duration of stay. Most cases with moderate and major complications were infants < 2 years of age (92.1% and 88.9% respectively, $P < 0.01$), patients admitted when the PICU bed occupancy rate was $> 3/5$ (68.4% and 81.5% respectively, $P < 0.01$) and patients staying in the PICU ≥ 1 week (81.9% and 74.1% respectively, $P < 0.05$).

Mortality rate

Out of 423 cases admitted to this PICU over the 1-year period of this study 32 died, an overall mortality rate of 7.6%. The mortality rate significantly increased with lower age, presence of respiratory disease, prolonged stay in the PICU, higher PICU bed occupancy rate and higher PRISM score (Table 4). The mortality rate was higher among cases with iatrogenic complications (13.4%) than those without (5.8%) (RR = 2.29, 95% CI: 1.17–4.48, $P < 0.05$). More deleterious outcome was observed with

Table 2 Occurrence of iatrogenic illness among children admitted to the paediatric intensive care unit (PICU) according to demographic and clinical data

Variable	Total (<i>n</i> = 423)	Iatrogenic illness				RR (95% CI)	χ^2 -value	<i>P</i> -value
		Yes (<i>n</i> = 97)		No (<i>n</i> = 326)				
		No.	No.	%	No.			
Age (years)							11.64	< 0.001
< 2	294	81	27.6	213	72.5	2.22 (1.35–3.64)		
≥ 2–6	129	16	12.4	113	87.6			
Sex							0.08	> 0.05
Male	217	51	23.5	166	76.5	1.05 (0.70–1.49)		
Female	206	46	22.3	160	77.7			
Underlying diseases							27.5	< 0.001
Respiratory	119	41	34.5	78	65.6	1.87 (1.32–2.63)		
Neurological	87	28	32.9	57	67.1	1.60 (1.11–2.33)		
Gastrointestinal tract	85	14	16.1	73	83.9	0.65 (0.39–1.09)		
Cardiac	59	7	11.9	52	88.1	0.47 (0.23–0.95)		
Other	73	7	9.6	66	90.4	0.37 (0.18–0.77)		
Duration of stay (weeks)							12.56	< 0.001
< 1	95	9	9.5	86	90.5	2.83 (1.48–5.41)		
≥ 1	328	88	26.8	240	73.2			
PICU bed occupancy rate							20.32	< 0.001
≤ 60%	237	35	14.8	202	85.2	2.26 (1.56–3.25)		
> 60%	186	62	33.3	124	66.7			
PRISM score							47.48	< 0.001
1–9	77	8	10.4	69	89.6	0.40 (0.20–0.79)		
10–19	168	22	13.1	146	86.9	0.45 (0.28–0.69)		
20–29	100	29	29.0	71	71.0	1.37 (0.95–1.98)		
≥ 30	78	38	48.7	40	51.3	2.85 (2.05–3.94)		
Mechanical ventilation							13.12	< 0.001
Yes	22	12	54.5	10	45.5	2.57 (1.68–3.94)		
No	401	85	21.2	316	78.8			

RR = relative risk; CI = confidence interval; PRISM = paediatric risk of mortality [6].

the use of mechanical ventilation, where the mortality rate was 81.8% among ventilated cases compared with 3.5% among non-ventilated ones (RR = 23.4, 95% CI: 13.5–40.7, $P < 0.001$).

Correlations

Variables that were significantly correlated among studied cases are presented in Table 5. There was a significant correlation between the presence of iatrogenic illness and each of the following variables: PRISM score ($r = 0.68$), use of mechanical ventilation ($r = 0.53$), PICU bed occupancy rate ($r = 0.52$), presence of respiratory disease ($r = 0.46$), duration of stay in the PICU ($r = 0.44$) and age (r

= -0.38). Also mortality outcome was significantly correlated to the following variables: PRISM score ($r = 0.87$), use of mechanical ventilation ($r = 0.76$), presence of iatrogenic complications ($r = 0.40$), severity of iatrogenic complications ($r = 0.55$), presence of respiratory disease ($r = 0.37$), duration of stay in the PICU ($r = 0.52$), bed occupancy rate ($r = 0.48$) and age of the child ($r = -0.41$).

Discussion

Iatrogenic illness

This study revealed that the incidence of iatrogenic complications among

children admitted to the PICU of Gharbian teaching hospital was 22.9%. Human errors as a cause of iatrogenic illness was found in 18.4% of studied cases and machine or equipment defects were the cause in 4.5%. This was in agreement with the results of other studies [3,4,7]. Payen et al. reported iatrogenic disease (due to human errors or machine/equipment defects) in 21.6% of cases in a PICU [4]. Thierry et al. reported that human errors were responsible for 18.6% of the cases of iatrogenesis in his study [7]. Joseph et al. reported that human errors were responsible for 4.0% of the total number of cases admitted to the PICU and machine or equipment

Table 3 Severity of iatrogenic illness among children admitted to the paediatric intensive care unit (PICU) according to demographic and clinical data

Variable	Severity of iatrogenic complications								χ^2 -value	<i>P</i> -value
	Minor (<i>n</i> = 32)		Moderate (<i>n</i> = 38)		Major (<i>n</i> = 27)		Total (<i>n</i> = 97)			
	No.	%	No.	%	No.	%	No.	%		
<i>Age (years)</i>										
< 2	22	68.8	35	92.1	24	88.9	81	83.5	7.67	< 0.01
≥ 2–6	10	31.3	3	7.9	3	11.1	16	16.5		
<i>PICU bed occupancy rate</i>										
≤ 60%	18	56.3	12	31.6	5	18.5	35	36.1	9.58	< 0.01
> 60%	14	43.8	26	68.4	22	81.5	62	63.9		
<i>Duration of stay (weeks)</i>										
< 1	16	50.0	7	18.4	7	25.9	30	30.9	8.54	< 0.05
≥ 1	16	50.0	31	81.6	20	74.1	67	69.1		

RR = relative risk; CI = confidence interval.

defects were the reason for 4.3% of admitted cases [3] and Marcin et al. reported that machine or equipment defects were responsible for 7.6% of admitted cases [9].

This study also revealed that the frequency of iatrogenic illness was higher in infants < 2 years of age (27.6%) than those aged ≥ 2 years (12.4%) and this association was significant. This has been reported by other studies [10,11]. Libby et al. reported that the rate of iatrogenic illness in young children ranged from 25%–29% and that the rate increased at lower ages [10].

In the present study, the proportions of females and males in the sample were similar (48.7% versus 51.3%) and there were no sex differences in the occurrence of iatrogenic illness: 22.3% of females and 23.5% of males. This was in accordance with other studies [12,13].

The mean duration of stay in the PICU in this study was nearly 4 days and the frequency of iatrogenic illness increased as the duration of stay increased: 26.8% among patients staying in the PICU ≥ 1 week compared with 9.5% among those staying < 1 week. This agrees with other evidence that the risk of iatrogenic illness increased when the duration of stay was longer than 1 week [9,14].

The distribution of cases according to the cause of admission to the PICU revealed that the most common reason was respiratory disease, followed by neurological, gastrointestinal tract, cardiac and other diseases. The risk of developing iatrogenic illness was also highest for cases admitted with respiratory disease: 34.5% of cases of iatrogenic illness had respiratory disease compared with 28.1% of all cases admitted to the unit. These findings were in agreement with reports from numerous studies [15–18]. However, in 4 PICUs in Moscow, the most common cause of admission in was neurological disorders [17] and Marcin et al. also reported that most of the complications developed in cardiac cases and only 3.5% of cases with GIT disorders had iatrogenic complications [9]. Iatrogenic drug-induced complications were recorded in 5 (1.2%) admitted cases. This agrees with Ross et al [1] who reported that drug-induced complications accounted for 2.1% of cases admitted to a PICU, whereas Payen et al. reported that iatrogenic medication errors represented as much as 14.7% of admitted cases [4].

A significant positive correlation was found between the occurrence of iatrogenic illness and the use of mechanical ventilation: the incidence of

iatrogenic illness was 54.5% among ventilated cases compared with only 21.2% of non-ventilated cases. Out of 12 mechanically-ventilated cases with iatrogenic illness, 9 (75.0%) developed ventilator-associated pneumonia and 3 cases developed septicaemia. Others have reported that pneumonia is a frequent iatrogenic complication of mechanical ventilation, with an incidence ranging from 9% to 80%, depending on the duration of mechanical ventilation and the diagnostic methods employed [9].

The PRISM score measures illness severity, based on abnormalities observed in the bedside examination and laboratory assessments [6]. In the present study, the PRISM score ranged from 1 to 34 with mean of 14.7, which is higher than the study of Wang et al. in which the PRISM score ranged from 0–35 with mean of 6.48 [19], this could be explained by the fact that Gharian teaching hospital is a referral centre for the whole province and there is no PICU in the general hospitals in the local area. Among our cases, the highest rate of iatrogenic illness (48.7%) was observed among cases with PRISM score ≥ 30. Other reports showed that cases with higher PRISM score were more liable to develop complications during their ICU stay [9].

Table 4 Outcome among children admitted to the paediatric intensive care unit (PICU) according to demographic and clinical data

Variable	Total (<i>n</i> = 423)	Outcome				RR (95% CI)	χ^2 -value	<i>P</i> -value
		Dead (<i>n</i> = 32)		Alive (<i>n</i> = 391)				
		No.	%	No.	%			
<i>Age (years)</i>							7.29	< 0.01
< 2	294	29	9.9	265	90.1	4.20 (1.30–13.7)		
≥ 2–6	129	3	2.3	126	97.7			
<i>Sex</i>							0.046	> 0.05
Male	217	17	7.8	200	92.2	1.08 (0.55–2.09)		
Female	206	15	7.3	191	92.7			
<i>Underlying disease</i>							11.59	< 0.05
Respiratory	119	17	14.3	102	85.7	2.89 (1.49–5.60)		
Neurological	87	4	4.6	83	95.4	0.55 (0.19–1.53)		
Gastrointestinal tract	85	6	7.1	79	92.9	0.92 (0.39–2.15)		
Cardiac	59	2	3.4	57	96.6	0.41 (0.10–1.67)		
Other	73	3	4.1	70	95.9	0.50 (0.16–1.58)		
<i>Duration of stay (weeks)</i>							5.22	
< 1	95	2	2.1	93	97.9			
≥ 1	328	30	9.2	298	90.2	4.34 (1.06–17.9)		
<i>PICU bed occupancy rate</i>							8.62	< 0.01
≤ 60%	237	10	4.2	227	95.9			
> 60%	186	22	11.8	164	8.2	2.80 (1.36–5.77)		
<i>PRISM score</i>							45.16	< 0.001
1–9	77	2	2.6	75	97.4	0.29 (0.07–1.23)		
10–19	168	5	3.0	163	97.0	0.33 (0.13–0.85)		
20–29	100	5	5.0	95	95.0	0.59 (0.24–1.51)		
≥ 30	78	20	25.6	58	74.4	7.37 (3.76–14.4)		
<i>Iatrogenic illness</i>							6.13	< 0.05
Yes	97	13	13.4	84	86.6	2.29 (1.17–4.48)		
No	326	19	5.8	307	94.2			
<i>Mechanical ventilation</i>							182.9	< 0.001
Ventilated	22	18	81.8	4	18.2			
Non-ventilated	401	14	3.5	387	96.5	23.4 (13.5–40.7)		

RR = relative risk; CI = confidence interval; PRISM = paediatric risk of mortality [6].

Our study also revealed that most of the moderate complications (requiring only routine therapy) and major complications (requiring specific intensive care therapy to treat the complication, e.g. artificial ventilation) were observed among infants < 2 years old (92.1% and 88.9% respectively), those admitted when the PICU bed occupancy rate was > 3/5 (68.4% and 88.9% respectively) and patients staying in the PICU ≥ 1 week (81.9% and 69.1% respectively). These findings agree with many authors [4,11,12,20].

Mortality

The overall mortality rate of cases admitted to the PICU over the 1-year period of this study was 7.6%. In another study of 9 PICUs the mortality rate ranged from 82.4% to 97.0% [21]. The low mortality rate in our study could be because we did not include patients with low Glasgow coma scores at admission. The rate of mortality among cases developing iatrogenic illness was significantly higher than among non-iatrogenic cases

(13.4% versus 5.8%). This agrees with the findings of Joseph et al. in which the mortality rate among iatrogenic cases was 15.7% and among the non-iatrogenic cases was 2.7% [3]. But in another study by the same author the mortality rate among iatrogenic cases was only 4.0% and among the non-iatrogenic cases was 8.9% [21]. El Nawawy reported that the mortality rate among iatrogenic cases was 50.0% and among non-iatrogenic cases was 38.6% [11]. Meanwhile, Payen et al. reported

Table 5 Variables significantly correlated with iatrogenic illness and mortality among children admitted to the paediatric intensive care unit (PICU)

Variable	Correlation coefficient <i>r</i>	<i>P</i> -value
Presence of iatrogenic illness		
PRISM score	0.68	< 0.001
Use of mechanical ventilation	0.53	< 0.001
PICU bed occupancy rate	0.52	< 0.001
Presence of respiratory disease	0.46	< 0.001
Duration of stay in PICU	0.44	< 0.01
Age	-0.38	< 0.01
Mortality outcome		
PRISM score	0.87	< 0.001
Use of mechanical ventilation	0.76	< 0.001
Presence of iatrogenic complications	0.40	< 0.01
Severity of iatrogenic complications	0.55	< 0.001
Presence of respiratory disease	0.37	< 0.01
Duration of stay in PICU	0.52	< 0.001
PICU bed occupancy rate	0.48	< 0.001
Age	-0.41	< 0.01

PRISM = paediatric risk of mortality [6].

no mortality in relation to any iatrogenic illness in a PICU [4]. This variation in mortality rates may be due to the difference in number of cases, ages of patients and the severity of iatrogenic illness in these various studies.

It was also observed in our study that the mortality rate was higher among infants < 2 years of age (9.9%), and there was a negative correlation between age and mortality outcome. This was in agreement with Libby et al. who reported that the mortality rate in young children ranged from 9%–90% [10]. Moreover, El Nawawy reported that the mortality rate increased as age decreased.

In our study there was no significant statistical difference between males and females as regards mortality rate [11]. This was in agreement with Magid et al. [13].

It was observed in this study that mortality rate increased as the duration of stay increased: 9.2% among cases staying ≥ 1 week compared with 2.1% among those staying < 1 week. A significant positive correlation was present

between mortality outcome and duration of stay in the PICU. This was in agreement with Hewitt-Taylor who reported that most patients who stayed for 7 days or more died [22].

This study also revealed that the mortality rate significantly increased with increased bed occupancy rate in the PICU. The mortality rate was 4.2% when the bed occupancy rate was ≤ 60% and 11.8% when it was > 60%. This was in agreement with Tilford et al. [20] and Sanchez [23]. We believe that when the occupancy rate in the unit is high, the workload on doctors and nurses is higher, which can lead to a greater risk of iatrogenic illness and therefore greater morbidity and mortality.

In this study the mortality rate among children with respiratory disorders was 14.3% (the highest rate among the diseases) and a significant positive correlation was found between mortality outcome and the presence of respiratory diseases. This agrees with Thomas et al. who reported that respiratory problems were the commonest

cause of death in infants admitted to the PICU [18].

The incidence of iatrogenic illness in this study was significantly higher among ventilated cases (54.5%) compared with non-ventilated ones (21.2%). A significant positive correlation was present between the occurrence of iatrogenic illness and the use of mechanical ventilation ($r = 0.53$). This is in agreement with a study by Magid et al. who reported that the mortality rate among ventilated patients was 87.5% [13]. Mechanical ventilation, while frequently life-saving is also associated with numerous iatrogenic complications, some of which are themselves life-threatening, such as ventilator-associated pneumonia of patients ventilated for longer than 48 hours, pneumothorax, tension pneumothorax, lung collapse, decreased cardiac output and hypotension [24].

This study also revealed that the frequency of mortality increased as the PRISM score increased, from 2.6% for cases with PRISM score 1–9, 3.0% for score 10–19 and 25.6% for score ≥ 30. Singhal et al. reported that the mortality rate was 8.2% for cases with PRISM score 1–9 [25], 24.4% for score 10–19 and 66.7% for score ≥ 30. These results suggest that PRISM score may be used as a predictor for mortality in the PICU [25].

Conclusion and Recommendations

Iatrogenic complications represent a real problem in this PICU with an incidence rate of 22.9% among admitted cases. Human error (18.4%) followed by machine defects (4.5%) were the most common causes of iatrogenic complications. The mortality rate was 7.6% and PRISM score was a good predictor of high-risk cases in the PICU. Mortality outcome was significantly correlated with the occurrence and the severity of iatrogenic

illness. Moreover both mortality and the occurrence of iatrogenic illness were significantly associated with higher PRISM score, the use of mechanical ventilation, increased bed occupancy rate in the unit, the presence

of respiratory disease, prolonged duration of stay in PICU and younger age of the child. Increasing the number of beds in PICU, improving the quantity and quality of manpower with continuous supervision and proper training

together with the frequent examination and assessment of patients using PRISM score to detect high-risk cases is recommended to minimize iatrogenic complications and to improve outcomes in the PICU.

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