Measuring a Selected Set of Key Performance Indicators of Neonatal Intensive Care Units in Two Tertiary Care Hospitals

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Abstract

Background: Key performance indicators (KPIs) indicate, define and measure performance progress, and focus on a range of areas. A healthcare KPI is a well-defined performance measurement that is used to monitor, analyze and optimize all relevant healthcare processes for best patient care. **Aim of the Work:** The study aimed to measure selected key performance indicators (KPIs) for neonatal intensive care units (NICUs) in two tertiary care hospitals and assess the feasibility and acceptability among experts in NICU care. **Patients and Methods**: A retrospective medical record review for 6-months of 400 neonate patients' regarding 10 essential KPIs in NICU care at Ain Shams University and Al Mataria Teaching Hospitals, as well as surveys with expert staff of both hospitals. Comparing the statistics for both hospitals, demographic study revealed that both hospitals had a slightly higher percentage of male patients, however, gestational age distribution reveals a mean gestational age of 36.2 weeks and 2.6 kg for weight, indicating a near-term population. In contrast, Ain Shams showed a higher incidence of chronic lung illness (47.6%) and late-onset sepsis (34%), while Al Mataria had a larger percentage of neonates discharged breast-fed (79.5%). Staff attitudes on KPIs varied across the two institutions, with a strong emphasis on KPI implementation in the areas of chronic lung illness, necrotizing entero-colitis (NEC), discharge breast fed, and hypoxic ischemic encephalopathy. Retinopathies of prematurity and prolonged hospitalization are evaluated as neutral to low. Management levels had the greatest impact on late-onset sepsis (LOS) and NEC. Professional practices had the greatest influence on chronic lung illness and IVH. The outcome indicates a 40.8% acceptance rate, indicating that hospital staffs in the NICU are satisfied for KPI tracking. **Conclusion:** The study reveals significant differences in KPIs prevalence, perceived barriers, responses, and impact on patient outcomes. Key indicators like late-onset sepsis and chronic lung disease have significant impacts, while others like retinopathy of prematurity have divergent perceptions. Regular tracking of KPIs in NICUs can improve clinical practices, reduce morbidity and complications, and enhance communication and collaboration. This comprehensive analysis enables NICUs to provide high-quality care to vulnerable patients, improving outcomes and reducing morbidity.

Keywords: Performance Indicators, Neonatal Intensive Care Units, Tertiary Care.

Introduction

Key performance indicators (KPIs) indicate, define and measure performance progress, and KPIs should focus on a range of areas. A healthcare KPI is a well-defined performance measurement that is used to monitor, analyze and optimize all relevant healthcare processes to increase patient satisfaction.

Quality of care delivered by providers is increasingly inspected in an attempt to increase

efficiency and improve the quality of patient care **(Institute of Medicine and Profit, 2006).** In other areas of medicine, performance measurement and financial incentives are common **(Epstein, Rosenthal, and Petersen 2006).**

Maternal and child health (MCH) has been a priority public health problem for decades. Since the 1990s, the international community has implemented important initiatives to reduce the morbidity and mortality of mothers and newborn infants. We highlight

the Millennium Development Goals (MDG), as well as the current Sustainable Development Goals (SDG) that reinforce good health and well-being for women and children (Goal 3), coupled with the target of universal health coverage and reflected in the renewed Global Strategy for Women's, Children's and Adolescents' Health (2016–2030) **(WHO, 2017)**

The consensus is that measurement of performance is essential to support improvement and accountability. However, this has unleashed a multitude of uncoordinated and often duplicative measurement and reporting initiatives **(Institute of medicine, 2015).** There is a broad panorama of indicators available internationally for the evaluation of the quality of maternal and newborn care; however, a critical analysis shows that most indicators are not readily suitable for adaptation and implementation. Only minorities of published indicators comply with the requirements of scientific validity, usefulness and feasibility empirically tested **(Saturno, 2019).**

Measuring of a Selected Set Key
However, a study of hospital quality assessments, based on hospital-wide mortality rates alone, found substantial discrepancies in performance based on the methods used to calculate mortality rates. This calls into question whether it is valid to conclude the quality of care based on hospital-wide mortality rates (**Shahian, 2010**). In the NICU setting, good performance on one measure of quality (e.g., the proportion of infants with chronic lung disease) is assumed to indicate good performance on related measures of quality (e.g., duration of mechanical ventilation), and on unrelated measures (e.g., rates of health-care-associated infection).

The use of a limited quality measure set for comparative performance measurement would be supported if NICU performance was strongly correlated across multiple measures of quality of care. However, in other areas of health care, studies have found weak or no correlation across measures of quality of care (**Rosenthal, 1997, Wilson, 2007, Granhi, 2002, Palmer, 1996, and Glance, 2008**).

If intra-institutional correlations among quality measures are weak and performance is inconsistent, then inferences about quality from 1 or a few measures of quality are likely uninformative and potentially misleading (**ASH, 2008**). Instead, quality should be assessed by combining multiple measures of quality into 1 or more composite indicators of quality **(Profit, 2010).**

Second, should quality improvement efforts be directed toward individual measures of quality or toward building more tightly connected systems of care, so that performance can be based on several measures of quality simultaneously? **(Gould, 2010)** Traditional approaches to quality improvement have typically addressed individual measures sequentially **(Horbar, 2010).** In many instances, this has promoted better, safer care, but often gains have been temporary. A growing body of literature suggests that sustained and widespread improvements in quality require changes to the system in which care occurs. For example, improvements in unit safety culture, which varies widely across NICUs **(Profit, 2012),** have been linked to lasting improvements **(Sexton and Pronovost, 2010**). The system supporting care delivery is interconnected with the quality of care provided. Therefore, correlations between measures of quality might be interpreted to reflect the degree of care-system integration. Weak correlations might suggest a low degree of systems integration, in which care processes are largely functionally independent **(Wilson, 2007).** Such a finding might signal the need for interventions such as improvements in safety culture−or composite measurement of quality that could more broadly affect performance **(Profit, 2010).**

The comparative performance measurement endeavor, given the modest correlations among measures of quality of care and inconsistency among relative performances, one should not infer overall NICU quality based on a single or a few measures of quality. Our findings call into question the assumption that this measurement approach will lead to widespread improvements in quality, a method that underlies current benchmarking efforts in

health care. Quality improvement efforts may need to focus on multidimensional improvement and build more tightly connected systems of care so that performance can be raised on several measures of quality simultaneously **(Profit, 2013).**

Significance of the study:

To enhance the neonatal care quality through monitoring and tracking selected KPIs and help to identify areas of improvement to ensure the best available outcomes. Improving hospital performance by assessing the feasibility and acceptability of applying KPIs among NICU experts for performance evaluation and Informing decision- making , guiding resource allocation and contributing to evidence based practice to optimize the quality of care .

Research question /hypothesis:

1- what are the selected KPIs for NICU and how do they contribute to assess the quality of care?

2- how feasible is the application of selected KPIs and what are factors affecting feasibility, how acceptable are the selected KPIs among NICU experts and what is the potential impact of using them to measure and improve the neonatal care quality in teriary care hospitals?

Hypothesis of the study:

The primary hypothesis tests for differences in measured KPIs between the hospitals NICUs. Secondary hypothesis examine the feasibility and acceptability of applying KPIs in NICU. Statistical analysis will determine whether the data support or reject these hypotheses.

Aim of the work

1- To measure selected key performance indicators for neonatal intensive care units in two tertiary care hospitals.

2- To test feasibility of these indicators.

3- To explore acceptability of these indicators by experts in neonatal intensive care units in the studied hospitals

Patients and methods

The selected indicators will be measured by a retrospective medical record review for 6-months of 400 neonate patients' regarding 10 essential KPIs in NICU care at Ain Shams University and Al Mataria Teaching Hospitals, 200 patients each; Comparing the statistics for both hospitals,

For the third objective a panel of clinical experts will be approached by a self-administered questionnaire for applicability 27 staff in Ain Shams university versus 21 staff in Al Mataria hospital.

Study Setting: NICU of Ain Shams University Hospital and Mataria Teaching Hospital

Study Population: Patients admitted to NICU and fulfill inclusion criteria

Inclusion Criteria: Gestational age< 28weeks, weight more than 1200 grams, transfer in before age 3 days and readmission within 48 hrs.

Exclusion Criteria: transfer out for reasons other than convalescent or chronic care, gestational age < 28 weeks, weight less than 1200grams, major congenital anomalies, death within 12 hours of birth and readmission after 48h

Sampling Method consecutive sample fulfilling the inclusion criteria

Sample Size: Sample size was estimated to be 200 records for each hospital based on positive rate of indicator 50% ± 7% with 95%CI

Study Tools AND/ OR Study Procedures: A 6-month data collection of 10 critical KPIs of in total 400 infants cared for at NICU of Ain Shams University & Al Mataria Teaching Hospitals comparing the analyzed

results for each hospital and both Hospitals along the 6 months.

An extraction sheet will be developed to extract the parameters of the selected indicators from the medical records

Incomplete medical records will be omitted from the study

KPIs included in the study: 1- Readmission in NICU within 48hrs. 2- Reintubation within 48 hrs. of extubation. 3- Chronic lung disease in preterm <1500gram (CLD).
4- Intraventricular hemorrhage (IVH). 5- Retinopathy of prematurity (ROP). 6- Hypoxic-ischemic encephalopathy (HIE). 7- Late-Onset Sepsis (LOS). 8- Hospitals Stay more than28 days. 9- Discharge on breastfeeding. 10- Necrotizing Enterocolitis (NEC).

Methods of KPI identification and measurements are included in attached table.

Feasibility for data was available within the unit registry and details obtained from medical record recalls after permission of each unit head and hospital manager.although the needed data were almost available , but some details was lacking in the medical record documentation due to lack of tracking these KPIs in both hospitals.

Measuring applicability: through a self-administered questionnaire distributed to 27 experts in Ain Shams and 21experts in Al Mataria hospitals; Ain Shams had a higher proportion of professors while Al Mataria had more specialists and both groups shows predominance of middle age group between 34 to 44yrs old. **Asking about:** Value of the indicator, barriers of the indicator application, impact on the management of the NICU, impact on professional practice, evalution of quality of care, acceptability of KPIs and recommendation / suggestion

Study Interventions: NA

Statistical analysis: recorded data were analyzed using the statistical package for social sciences, version 23.0 (SPSS Inc., Chicago, Illinois, USA). Qualitative variables were presented as number and percentages. Data were explored for normality using Kolmogorov-Smirnov and Shapiro-Wilk Test.

The following tests were done: The Comparison between groups with qualitative data was done by using Chi-square test.

The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following: Probability (P-value): P-value <0.05 was considered significant. P-value <0.01 was considered as highly significant. P-value >0.05 was considered insignificant.

Results

The aim of the study is to measure selected key performance indicators for neonatal intensive care units in two tertiary care hospitals, to test Feasibility for application of these indicators, and to explore acceptability of these indicators by experts in neonatal intensive care units in the studied hospitals

Ain Shams Group: 200 infants cared for at NICU of Ain Shams University.

Al Mataria Group: 200 infants cared for at NICU of Al Mataria Teaching Hospitals.

Table 1 provides a comparative analysis of demographic data between Ain Shams and Al Mataria Hospitals, focusing on gender, age, and birth weight of neonates. The Chi-Square test was employed to evaluate the significance of differences between the two hospitals in these variables. The study data revealed that both hospitals had a slightly higher percentage of male patients, however, gestational age distribution reveals a mean gestational age of 36.2 weeks and 2.6 kg for weight, indicating a near-term population.

Table 2 compares the diagnosis between Ain Shams and Al Mataria Hospitals, focusing on various neonatal conditions. While there are slight variations in the prevalence of these

diagnoses, notably, both hospitals show a high frequency of Respiratory Distress and NNJ especially in Al Mataria hospital.

Table 3 compares key clinical outcomes between Ain Shams and Al Mataria Hospitals for neonatal patients. Significant differences are observed in re-intubation within 48 hours of extubation, HIE rate for in-born babies, IVH rate for in-born babies, rate of late onset sepsis, hospital stays more than 28 days, necrotizing enterocolitis, and babies discharged on human breast milk between Ain Shams and Al Mataria. The significance levels vary, with some having p-values less than 0.05 and some even less than 0.01. These findings indicate differences in these outcomes between the two groups. **The rate of chronic lung disease, and late onset sepsis is notably higher in Ain Shams Hospital**. **Conversely, the rate of neonates discharged on breast feeding is substantially higher in Al Mataria Hospital.**

Table 4 provides the characteristics of both hospital staff suggests that there is no significant difference in staff category or age group distributions between Ain Shams staff and Al Mataria Hospital staff. Though Ain Shams had a higher proportion of professors while Al Mataria had more specialists and both groups shows predominance of middle age group between 34 to 44 yrs old.

Table 5 provides data suggest that there are certain areas where the perceptions of importance differ between the two groups, providing that mean score of more than 4 suggest that the staff group confirm that these indicators are important to apply. While mean score around 3 suggest that these indicators of doubt value to be applied. Though mean score of below 3 suggest that these indicators were of no value to be applied.

Data suggest high perception in the importance of KPIs application in the areas of Chronic Lung Disease, necrotizing enterocolitis, discharge on breast feeding and Hypoxic ischemic encephalopathy. While neutral to low perception for retinopathy of prematurity and prolonged hospitalization

Based on the provided data in table 6, it appears to be a breakdown of responses to various Key Performance Indicators (KPIs) along with identified barriers and corresponding responses.

Total responses to each barrier reveal that the most common barrier is **training** followed by staff engagement and data collection, while resources constrain does not represent a significant barrier.

These results indicate areas where specific barriers are identified, and corresponding responses are suggested to address those barriers for each KPI. Identifying these barriers and responses can help in developing strategies to improve performance and outcomes in these areas.

Based on the provided data (table 7) on the impact of various key performance indicators (KPIs) at both the management level and the professional practice level showed that Management levels indicated the greatest impact on LOS and NEC, followed by reintubation after 48 hours of extubation and release with breast feeding. Professional practices had the greatest influence on chronic lung illness and IVH, followed by longer hospital stays. Interestingly, there is no reported significant impact at either level for Retinopathy of Prematurity.

In table 8: The average quality of care score at Ain Shams is 2.9 (58%), while at Al Mataria, it's 2.5 (50%). This suggests that the perceived quality of care is slightly higher at Ain Shams compared to Al Mataria.

The data provide valuable insights into perceptions of quality of care and areas for improvement in both hospitals, highlighting the importance of training and awareness lectures to enhance healthcare delivery and patient outcomes.

The Acceptability rate of 40.8% in the data signifies the collective satisfaction and approval of hospital staff within the Neonatal Intensive Care Unit (NICU) regarding KPIs tracking. This result signifies the need for further evaluation after regular application of KPIs tracking and education about improvement tools

Table 1: Comparison of Demographic Data between Ain Shams and Al Mataria Hospitals

		Ain Shams (N=200)		mean	Al Mataria (N=200)		mean	Test value	P-value
		N	%		N	%			
Gender	**Male**	115	57.5		123	61.5		0.664	0.415
	Female	85	42.5		77	38.5			
Age (week)	**Less than 30**	9	4.5	36.16	8	4.0	36.26	5.720	0.057
	30 to 34	45	22.5		27	13.5			
	More than 34	146	73.0		165	82.5			
Weight (gram)	**Less than 1500**	9	4.5	2.58	8	4.0	2.65	1.373	0.503
	1500 – 2500	45	22.5		27	13.5			
	More than 2500	146	73.0		165	82.5			

Using: X2= Chi- Square test, p-value >0.05 is insignificant; *p-value <0.05 is significant; **p-value <0.01 is highly significant

Table 2: Comparative Analysis of Neonatal Diagnosis between Ain Shams and Al Mataria Hospitals

		Ain Shams (N=200)		Al Mataria (N=200)	
		N	%	N	%
Diagnosis	**Intraventricular Hemorrhage (IVH)**	9	4.5	6	3
	Neonatal Jaundice (NNJ)	25	12.5	35	17.5
	Respiratory Distress (RD)	75	**37.5**	77	**39.5**
	Late onset Sepsis	56	**28.0**	40	20.0
	Tachypnea of Prematurity (TTN)	26	13.0	36	18.0
	Respiratory Distress Syndrome (RDS)	50	**25.0**	51	**25.2**
	Retinopathy of Prematurity (ROP)	9	4.5	10	5
	Pneumonia	3	1.5	3	1.5
	TOF	2	1.0	0	0
	HIE	14	7.0	12	6.0
	CHD	10	5.0	8	4.0

Table 3: Comparison between Ain Shams and Al Mataria Hospitals According to key performance indicators.

	Ain Shams		Al Mataria		Test value	P-value
	N/ Total	%	N/ Total	%		
Total Number of patients readmitted to ICU within 48 hours	15/200	7.5	12/200	6.0	0.357	0.550
Re-Intubation within 48 hours of extubation	27/95	28.4	10/42	23.8	8.607	**0.003****
Chronic Lung Disease (CLD) rate for In-born babies less than 1500 gm	10 /21	**47.6**	6 /16	37.5	1.297	0.055
Hypoxic ischemic encephalopathy (HIE) rate for in-born babies	21 /176	11.9	9 /185	4.8	5.189	**0.023***
Intraventricular Hemorrhage (IVH) rate for in-born babies	22/200	11.0	11/200	5.5	3.996	**0.046***
Retinopathy of Prematurity (ROP) rate for in-born babies less than 1500 gm	6 /21	28.5	4 /16	25	1.256	0.262
Rate of late onset sepsis	68/200	**34.0**	41/200	**20.5**	9.193	**0.002****
Hospital stays more than 28days	31/200	15.5	15/200	7.5	6.288	**0.012***
Necrotizing enterocolitis	10/200	5.0	3/200	1.5	3.896	**0.048***
Babies discharge on human breast milk	120/200	60.0	159/200	**79.5**	18.022	**<0.001****

Using: X2= Chi- Square test, p-value >0.05 is insignificant; *p-value <0.05 is significant; **p-value <0.01 is highly significant

Table 4: Characteristics of The Expert Sample of Both Hospitals Staff

Demographic of the expert sample	Ain Shams staff (N=27)		Al Mataria Hospital Staff (N=21)	
Staff Category	**Professor**	9 (19%)	**Consultant**	6 (12.5%)
	Lecturer	8 (16.6)	**Fellow**	6 (12.5)
	Assistant lecturer	10 (21%)	**Specialist**	9 (19%)
Age Group	**25-34**	**2 (4.2%)**	1	2%
	35-44	**10 (21%)**	7	14.5%
	45-54	**8 (16.6%)**	6	12.5%
	55-65	**4 (8.3%)**	5	10.4%
	Above 65	**1 (2%)**	4	8.3%

Chi-square Test for Staff Category: 0.665 while P-value: 0.717. For the staff category, the p-value is 0.717. Chi-square Test for Age Group equal 5.167 and P-value: 0.271. For the age group, the p-value is 0.271

Table 5: Perception of Different Hospital Staff Types to Determine Applicability of Quality Indicators in Neonatal Intensive Care Units (NICUs)

Mean of responses	Ain shams			Al Mataria		
	Professor N=9	Lecturer N=8	Assistant N=10	Consultant N=6	Fellows N=6	Specialist N=9
Rate of Late onset sepsis	4.2	3.25	3.2	3.5	2.5	3.7
Rate of Chronic Lung Disease	4.5	4.4	4.5	4.3	4.5	4.9
Rate of Reintubation within 48 hrs of extubation	4.2	4	4	4	3.7	3.5
Rate of Necrotizing Enterocolitis	4.6	4.13	4.6	4.5	4.5	4.2
Rate of discharge on breast feeding	4.3	4.12	4.1	4.3	4.17	3.6
Rate of Hypoxic ischemic encephalopathy	4.3	4.1	3.8	4.7	4.5	4
Rate of Retinopathy of Prematurity	3.1	3.7	2.9	3.5	3.3	3.2
Rate of Intraventricular Hemorhage	3.5	3.25	3.6	3.7	2.8	3.2
Rate of readmission within 48hrs of discharge	3	3	3.4	3	4.17	3.6
Rate of prolonged hospitalization more than 28 days	2.5	3.13	3.3	3	4	3.1

Table 6: The Most Common Barrier for NICU KPIs Application in Relation to Each KPI

KPI	Barrier	Response (48)	%
Late Onset Sepsis	**Data collection**	3	6
	Staff engagement	6	12.5
	Resource constraints	15	31.3
	Training	24	50
Chronic Lung Disease	**Data collection**	3	6
	Staff engagement	15	31.3
	Resource constraints	10	21
	Training	20	41.4
Hypoxic ischemic encephalopathy	**Data collection**	6	12.5
	Staff engagement	24	50
	Resource constraints	0	0
	Training	18	37.5
Re-Intubation within 48 hours of extubation	**Data collection**	29	60.4
	Staff engagement	3	6
	Resource constraints	8	16.6
	Training	8	16.6
Patient readmitted to ICU within 48 hours	**Data collection**	24	50
	Staff engagement	10	21
	Resource constraints	8	16.6
	Training	6	12.5
Hospital stays more than 28days	**Data collection**	6	12.5
	Staff engagement	31	65
	Resource constraints	3	6
	Training	8	16.6
Necrotizing enterocolitis	**Data collection**	0	0
	Staff engagement	11	23
	Resource constraints	6	12.5
	Training	31	65
Discharge on breast feeding	**Data collection**	3	6
	Staff engagement	6	12.5
	Resource constraints	24	50
	Training	15	31.3
Retinopathy of Prematurity	**Data collection**	31	65
	Staff engagement	4	8
	Resource constraints	3	6
	Training	10	21
Intraventricular Hemorrhage	**Data collection**	6	12.5
	Staff engagement	18	37.5
	Resource constraints	6	12.5
	Training	18	37.5
Total responses to each barrier	**Data collection**	111/ 480	23
	Staff engagement	128/480	27
	Resources	83/480	17
	Training	158/480	33

Table 7: The significant of tracking NICU KPIs expected to impact the management level and impact the professional practice level

KPI	Impact to the management level	Response	%	Impact the professional practice level	Response	%
Late Onset Sepsis	no impact	0		no impact	6	12.5
	Some impact	8	16.7	Some impact	10	21
	Significant impact	40	83.3	Significant impact	32	66.5
Chronic Lung Disease	no impact	6	12.5	no impact	0	
	Some impact	10	21	Some impact	8	16.7
	Significant impact	32	66.5	Significant impact	40	83.3
Hypoxic ischemic encephalopathy	no impact	15	31.3	no impact	11	23
	Some impact	0	0	Some impact	4	8
	Significant impact	33	68.7	Significant impact	33	68.7
Re-Intubation within 48 hours of extubation	no impact	0		no impact	15	31.3
	Some impact	10	21	Some impact	10	21
	Significant impact	38	79	Significant impact	23	47.7
Patient readmitted to ICU within 48 hours	no impact	15	31.3	no impact	20	41.4
	Some impact	10	21	Some impact	10	21
	Significant impact	23	47.7	Significant impact	18	37.6
Hospital stays more than 28days	no impact	20	41.4	no impact	0	
	Some impact	10	21	Some impact	10	21
	Significant impact	18	37.6	Significant impact	38	79
Necrotizing enterocolitis	no impact	0		no impact	15	31.3
	Some impact	8	16.7	Some impact	11	23
	Significant impact	40	83.3	Significant impact	22	45.8
Discharge on breast feeding	no impact	11	23	no impact	15	31.3
	Some impact	4	8	Some impact	0	0
	Significant impact	33	68.7	Significant impact	33	68.7
Retinopathy of Prematurity	no impact	38	79	no impact	38	79
	Some impact	10	21	Some impact	10	21
	Significant impact	0	0	Significant impact	0	0
Intraventricular Hemorrhage	no impact	15	31.3	no impact	0	
	Some impact	11	23	Some impact	8	16.7
	Significant impact	22	45.8	Significant impact	40	83.3

Table 8: Rate of care quality between both hospitals and KPIs acceptability

Rate of Quality of care * Score 1=20%, 2=40%, 3=60%, 4=80%, 5=100%	AIN SHAMS **(N=27)**		AL MATARIA **(N=21)**	
	Professor	2.9 (58%)	**Consultant**	3 (60%)
	Lecturer	3.2 (64%)	**Fellow**	2.5 (50%)
	Assistants	2.8 (56%)	**Specialist**	2 (40%)
	Average (54%)	2.9 (58%)	**Average**	2.5 (50%)
Recommendations	**Nothing**	2 responders	4.2%	
	Irrelevant	17 responders	35.4%	
	Training & Awareness lectures	29 responders	60.4%	
Acceptability			40.8	

Discussion

Neonatal Intensive Care Units (NICUs) play a critical role in providing specialized care for newborns with complex health needs, often born prematurely or with medical conditions requiring intensive monitoring and treatment **(Gómez-Cantarino et al. (2020).** The quality of care provided in these units is paramount, as it directly impacts the outcomes and well-being of these vulnerable patients. Measuring key performance indicators (KPIs) is essential for assessing and improving the quality of care in NICUs **(Hosseini et al. 2023).**

The selection of KPIs in NICUs is crucial as it allows for a comprehensive assessment of the quality of care provided to newborns **(Durrani, Cowsill, and Krishnappa 2022).**

This study aimed to measure key performance indicators (KPIs) for neonatal intensive care units (NICUs) in two tertiary care hospitals. It seeks to comprehensively evaluate the quality of care for newborns in these critical settings. Additionally, the study assessed the feasibility of applying these indicators in NICUs, evaluating data availability and ease of implementation. Furthermore, it aimed to explore the acceptability of these indicators among experts in neonatal care to ensure their relevance and meaningfulness in assessing NICU care quality.

The findings of this study have the potential to inform healthcare providers, policymakers, and researchers about the performance of NICUs in tertiary care hospitals. By identifying areas for improvement and best practices, this research can contribute to the ongoing efforts to enhance the quality of care provided to newborns in these critical care settings. Ultimately, the goal is to improve outcomes for neonates in NICUs and ensure that they receive the highest standard of care possible.

The current study revealed demographic factors; both hospitals exhibit a slightly higher percentage of male patients, with no statistically significant difference between them. While Ain Shams shows a higher proportion of infants with gestational ages over 34 weeks compared to Al Mataria, the difference approaches statistical significance. However, both hospitals have similar distributions of birth weight categories, indicating relatively homogeneous patient populations in terms of these factors.

In consistent with our study **Nikuee et al. (2020)** showed that the frequency distribution of demographic characteristics of neonates admitted to the Neonatal Intensive Care Unit in selected hospitals of Shahid Beheshti University of Medical Sciences reveals

several key findings. In terms of gender distribution, there are a higher percentage of male neonates compared to female neonates, with males comprising 61% of admissions. The majority of neonates admitted are singletons, with only a small percentage being twins or triplets. The mean gestational age of admitted neonates is approximately 31.18 weeks, indicating a population primarily composed of preterm infants. Additionally, the mean weight of admitted neonates is around 1627.75 grams, suggesting a population with low birth weights. In contrast to our demographic data revealed that both hospitals had a slightly higher percentage of male patients, however, gestational age distribution reveals a mean gestational age of 36.2 weeks and 2.6 kg for weight, indicating a near-term population.

Regarding diagnoses, Neonatal Jaundice appears significantly more prevalent in Al Mataria, while Ain Shams shows a slightly higher incidence of Intraventricular Hemorrhage. Other conditions exhibit similar proportions between the two hospitals, with some unique conditions like Tetralogy of Fallot present only in Ain Shams. Overall, while there are variations in certain diagnoses between the hospitals, the majority of conditions show comparable distributions, suggesting similar patterns of neonatal health issues across the studied populations.

The current study revealed Re-Intubation within 48 hours of extubation is significantly more frequent in the Ain Shams group, with 28.4% compared to 23.8% in Al Mataria (χ^2 = 8.607, p = 0.003). In the study done by **Aydon et al. (2018)** revealed that the issue of re-intubation within 48 hours of extubation in Neonatal Intensive Care Units (NICUs) is a critical concern that impacts patient care and outcomes. Studies have shown that re-intubation rates after extubation can be significant, with various factors influencing the need for re-intubation, such as respiratory distress and complications like apnea and increased work of breathing.

Similarly, Chronic Lung Disease (CLD) rate for in-born babies less than 1500 grams tends to be higher in Ain Shams at 47.6% compared to 37.5% in Al Mataria, although this difference is not statistically significant (χ^2 = 1.297, p = 0.055).

Notably, Hypoxic ischemic encephalopathy (HIE) rate for in-born babies, Intraventricular Hemorrhage (IVH) rate, Rate of late onset sepsis, Hospital stays more than 28 days, Necrotizing enterocolitis, and Babies discharged on human breast milk are significantly different between the two groups, with varying prevalence rates and statistical significance. These findings highlight potential variations in NICU performance and patient outcomes between Ain Shams and Al Mataria hospitals, emphasizing the importance of further investigation and potential interventions to improve neonatal care quality and outcomes.

Malmqvist et al.(2020) revealed that Hypoxic-ischemic encephalopathy (HIE) is a condition that results from insufficient oxygen and blood flow to an infant's brain, leading to brain damage and potential long-term disability. The occurrence of HIE in full-term infants is estimated to be from 1.5 to 2.5 per 1,000 live births. It is a crucial indicator for assessing and enhancing the management of oxygen-deprivation events during prenatal, intrapartum (during birth), or postnatal periods. Common risk factors and causes include poorly managed high-risk pregnancies, intrauterine growth restriction (IUGR), uterine rupture, placental issues, umbilical cord complications, errors in fetal monitoring, and delays in performing emergency C-sections.

Intraventricular hemorrhage (IVH) is one of the most common types of brain injury in preterm infants, especially in VLBW and ELBW infants **(Su et al. 2016)**, also **Zhao et al. (2022)** concluded that Appropriate mode of delivery may effectively reduce the incidence of IVH in VLBW premature infants. The antenatal glucocorticoid use may also protect against severe IVH. The focus on steroid prophylaxis, mode of delivery and prevention of perinatal asphyxia should be stressed, so IVH is an important indicator to audit provider's performance.

Fugate et al. (2015) Showed that improved breastfeeding support for very low birth weight (VLBW) infants resulted in more mothers expressing milk promptly, increased initiation of mother's own milk (MOM), and better access to hospital-grade pumps at discharge. These changes boosted parent satisfaction and significantly raised the likelihood of VLBW infants receiving MOM at discharge in 2013 compared to 2010. Overall, these enhancements demonstrate the positive impact of effective breastfeeding support on VLBW infant care so that it is important to be in concern as indicator for health care quality.

In our study rate of LOS is notably higher in Ain Shams group 34% versus Al Mataria group **20.5%** more common in males (29.0% vs. 24.7% in females), can lead to severe consequences for neonates, including increased mortality and prolonged hospitalization. In accordance **Ito et al. (2017)** showed that Male neonates are more likely to die and are at a higher risk of respiratory and gastrointestinal complications than female neonates. Monitoring LOS rates helps identify trends, track improvements, and implement evidence-based practices to reduce LOS. It also promotes infection control practices, allowing for timely interventions and adjustments. LOS rates serve as a benchmark for quality improvement efforts, allowing for targeted interventions. Monitoring LOS rates encourages collaborative learning among NICUs, fostering a culture of continuous improvement and enhancing patient care.

Monitoring the prevalence of chronic lung disease (CLD) in Neonatal Intensive Care Units (NICUs) might help to improve clinical management and reduce morbidity in preterm babies. Early identification of babies at risk for CLD allows healthcare practitioners to conduct preventative tactics and focused therapies. Monitoring CLD rates also helps to support quality improvement initiatives and evidence-based procedures in respiratory care NICUs can also promote collaborative learning and research by exchanging data on CLD rates and management options. Parental education and support are very important in controlling CLD. The current study revealed Chronic Lung Disease (CLD) rate for in-born babies less than 1500 grams tends to be higher in Ain Shams at 47.6% compared to 37.5% in Al Mataria, although this difference is not statistically significant

More females are discharged on breastfeeding (71.6% vs. 68.5% in males). These findings highlight gender-specific differences in neonatal health outcomes, emphasizing the need for tailored care approaches. **Fugate et al. (2015)** Showed that improved breastfeeding support for very low birth weight (VLBW) infants resulted in more mothers expressing milk promptly, increased initiation of mother's own milk (MOM), and better access to hospital-grade pumps at discharge. These changes boosted parent satisfaction and significantly raised the likelihood of VLBW infants receiving MOM at discharge in 2013 compared to 2010.

In terms of staff category, both hospitals have a diverse representation, with a mix of professors, lecturers, assistant lecturers, consultants, fellows, and specialists. Ain Shams has a higher proportion of professors (19%) compared to Al Mataria (12.5%), while Al Mataria has a slightly higher representation of specialists (19%) compared to Ain Shams (16%). Additionally, the age distribution among staff members shows similarities in both hospitals, with the majority falling within the 35-44 and 45-54 age groups. However, Al Mataria appears to have a slightly higher representation of staff aged 55-65 and above 65 compared to Ain Shams. Overall, both hospitals have a diverse and experienced pool of experts across different staff categories and age groups, which likely contribute to the comprehensive expertise available for neonatal care and research in these institutions.

The current study perceived importance of various key performance indicators (KPIs) Data suggests high perception in the importance of KPIs application in the areas of Chronic Lung Disease, necrotizing enterocolitis, discharge on breast feeding and Hypoxic ischemic encephalopathy. While their perception for retinopathy of prematurity and prolonged hospitalization was neutral to low.

These differences in perception suggest varying priorities and perspectives among different levels of expertise within the neonatal care team, highlighting the importance of effective communication and collaboration to ensure comprehensive care delivery and quality improvement initiatives.

The provided data outlines the perceived barriers and responses related to various key performance indicators (KPIs) in neonatal care. Training was notably significant barrier in LOS, NEC, CLD, and IVH. In contrast to data collection was obviously difficult in tracking the rate of ROP, reintubation within 48hrs. of extubation and in readmission after 48hrs. of discharge. Resources constrains is interestingly recorded as barrier especially for discharge on breast feeding. Although Engaging and involving staff members affect tracking prolonged hospital stay and HIE rates as KPIs, all these barriers emphasizing their importance in quality improvement initiatives and training programs for enhancing the overall quality of neonatal care delivery. Additionally, the identified barriers and responses vary across different KPIs, suggesting the need for tailored strategies and interventions to address specific challenges associated with each indicator effectively. Overall, addressing these barriers and implementing appropriate responses is essential for optimizing neonatal care quality and patient outcomes.

Tracking key performance indicators (KPIs) for neonatal intensive care units (NICUs) is essential for both management and professional practice. For management, these KPIs provide crucial insights into the quality of care and patient outcomes, helping identify areas for improvement and allocate resources effectively. Some KPIs, like late onset sepsis and necrotizing enterocolitis, have a significant impact on management decisions. On the other hand, for healthcare providers, tracking these KPIs guides them in delivering optimal care by assessing their practices and making informed decisions. The impact of KPIs on professional practice varies, with some, like chronic lung disease and intraventricular hemorrhage, significantly affecting practice, while others, like retinopathy of prematurity, have less impact. Overall, tracking NICU KPIs is crucial for enhancing the quality of care and optimizing outcomes for newborns in intensive care settings.

The comparison of the rate of quality of care between Ain Shams (N=27) virsus Al Mataria (N=21) hospitals highlights some differences in perceptions among different staff categories. In Ain Shams, professors and lecturers rated the quality of care slightly higher compared to consultants and fellows, while assistants rated it lower. Similarly, in Al Mataria, consultants rated the quality of care higher compared to fellows and specialists. Overall, the average rating of quality of care was higher in Ain Shams (54%) compared to Al Mataria (50%). Regarding recommendations for improvement, the majority of respondents from both hospitals suggested training and improving resources, followed by increasing supplies. Awareness lectures were recommended by a smaller proportion of respondents. The Acceptability rate of 40.8% in the data signifies the collective satisfaction and approval of hospital staff within the Neonatal Intensive Care Unit (NICU) regarding KPIs tracking. This result signifies the need for further evaluation after regular application of KPIs tracking and education about improvement tools.

In the same line **Heenan et al. (2022)** showed that the need for structured, inclusive, and comprehensive processes for selecting health care KPIs and targets, ensuring alignment with strategic goals, reliability of data, and meaningful engagement with end-users.

That demonstrates the importance for using and validating current study KPI to be implemented in the study setting in the future.

Limitation of the study

While the study provides valuable insights into neonatal intensive care unit (NICU) services and key performance indicators (KPIs), it is important to acknowledge its limitations:

Limited Generalizability: The study was conducted in two tertiary care hospitals, which may not be representative of all NICU settings. Factors such as geographic location, patient population, and healthcare infrastructure could influence the applicability of the findings to other hospitals or healthcare systems.

Small Sample Size: The study may have been limited by its sample size, which could affect the generalizability and statistical power of the results. A larger sample size would provide a more comprehensive understanding of NICU performance and facilitate more robust statistical analysis.

Retrospective Design: The study's retrospective design may have introduced bias or limitations in data collection and analysis. Retrospective studies rely on existing data, which may be incomplete or subject to inaccuracies. Prospective studies with standardized data collection methods could provide more reliable results.

Limited Scope of KPIs: The study focused on a selected set of KPIs for NICUs, which may not capture the full range of factors influencing neonatal care outcomes. Additional KPIs related to clinical processes, patient experience, and long-term outcomes could provide a more comprehensive assessment of NICU performance.

Staff Perception Bias: The assessment of staff perceptions of KPIs and improvement recommendations may be subject to bias. Staff members may have different perspectives or motivations, which could influence their responses to survey questions or interviews.

Single-Center Study: The study was conducted in two hospitals, but both were located in the same geographic area. The findings may not be applicable to NICU settings in other regions or countries with different healthcare systems, cultures, or patient populations.

Limited Longitudinal Analysis: The study provided a snapshot of NICU performance at a specific point in time, but longitudinal analysis of KPI trends over time was not conducted. Longitudinal studies would allow for the assessment of changes in performance indicators and outcomes over time, providing insights into the effectiveness of quality improvement initiatives.

Unmeasured Confounders: There may be additional factors or confounders not accounted for in the study that could influence NICU performance and outcomes. Failure to control for these variables could impact the validity and interpretation of the study findings.

Addressing these limitations in future research could further enhance our understanding of NICU performance and contribute to the development of effective strategies for improving neonatal care outcomes.

Conflict of interest: No conflict of interest

Ethical Considerations; approval of the ethical committee of Ain Shams University and Mataria Teaching Hospital

Conclusion

The study comprehensively examined key performance indicators (KPIs) in neonatal intensive care units (NICUs) across Ain Shams and Al Mataria hospitals, focusing on measuring, testing feasibility, and exploring acceptability among experts. Through meticulous analysis of patient records and expert opinions, notable differences and similarities were observed in KPI prevalence, perceived barriers, responses, and impact on patient outcomes. While certain indicators like late-onset sepsis and chronic lung disease showcased significant impacts and consensus for improvement measures such as training and awareness enhancement, others like retinopathy of prematurity revealed divergent perceptions among experts. In summary, the data's value emerges from its ability to promote quality improvement, increase patient safety, and build a culture of continuous learning and innovation inside healthcare organizations. Using these data, hospitals may strive to provide optimal

care experiences for patients and healthcare personnel. . Improving hospital performance by assessing the feasibility and acceptability of applying KPIs among NICU experts for performance evaluation and informing decision-making, guiding resource allocation and contributing to evidence based practice to optimize the quality of care.

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