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ASSESSING THE SAFETY PROFILE OF PEDIATRIC VACCINES: PROSPECTIVE MONITORING OF ADVERSE EVENTS IN CHILDREN UNDER TWELVE YEARS

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ABSTRACT

Background : Vaccination remains a vital global public health intervention, yet maintaining public trust requires rigorous monitoring of Adverse Events Following Immunization (AEFIs). While passive safety surveillance often suffers from under-reporting, systematic prospective monitoring provides accurate, active capture of both solicited (anticipated reactogenicity) and unsolicited (unexpected occurrences) events. Differentiating true vaccine reactions from coincidental childhood illnesses in developing immune systems requires standard causality frameworks like the WHO-UMC and Naranjo scales. This study evaluates the frequency, nature, and severity of these adverse events across distinct paediatric age cohorts to establish a precise, evidence-based safety profile
Objective: To identify, monitor, and assess both solicited and unsolicited adverse events following immunization in children under twelve.
Methods: In this one-year, prospective observational study, 760 children under twelve who experienced vaccination-related problems at a tertiary teaching hospital were enrolled and divided into three age groups. Data on demographics, vaccine details, adverse events, severity, and causality were collected and analyzed using Naranjo's scale and WHO-UMC criteria. Statistical significance was set at $p<0.05$.
Results: 210 solicited adverse events were documented in 174 patients; unsolicited adverse events occurred at varying rates across age groups. Group 3 (>5 years) had more severe adverse events (31.57%) compared to Groups 1 and 2 ($p=0.003$). Local adverse effects were more common in infants and toddlers ($p=0.001$). Most adverse events were mild and self-resolving.
Conclusion: Most adverse reactions following vaccination in children under twelve are mild and transient, with age-specific patterns observed.

Keywords: Adverse events, vaccine safety, paediatric immunization, prospective study, children, solicited, unsolicited.

1. INTRODUCTION

The World Health Organization (WHO) asserts that vaccination is a crucial component of public health, preventing millions of deaths globally. Infants and children under twelve are more susceptible because to their vaccination schedules and developing immune systems. Adverse events following immunization (AEFIs), classified as unsolicited (unexpected and passively reported) or solicited (anticipated and actively monitored), may arise despite the vaccines' predominant safety profile [4]. Systematic prospective monitoring of both solicited and unsolicited adverse events is crucial for maintaining public confidence, early identification of infrequent occurrences, and precise safety assessment [5,6,12,13]. This study aims to furnish comprehensive data regarding the frequency, nature, severity, and etiology of both requested and uninvited adverse events (AEs) in children under twelve years of age post-immunization.

2.MATERIALSANDMETHODS

A one-year prospective observational research was undertaken on the population. Children below the age of 12 were enrolled subsequent to obtaining ethical approval.

Inclusion Criteria: Children under 12 years who were vaccinated during the study period were included. **Exclusion criteria**: encompass adverse events not associated with immunization or children overtheageoftwelve. **Data Acquisition**: Information regarding adverse events, vaccines, demographics, and clinical treatments was gathered via standardized forms. Predefined symptoms including fever, agitation, edema, and pain at the injection site were categorized as requested adverse events (AEs). All incident reports were categorized as "unrequested unfavorable incidents. Three levels of intensity were offered for assessment: mild, moderate, and severe. Causality was evaluated utilizing the WHO-UMC and Naranjo methodologies. A statistical study was conducted employing counts and percentages to illustrate category variables. Chi-square tests were employed to compare incidence rates among age groups, with p.

StatisticalAnalysis

Causality was evaluated utilizing the WHO-UMC and Naranjo scales. Categorical variables were summarized as counts and percentages. The chi-square test was employed to compare incidence rates among age groups. The threshold for statistical significance was established at $p<0.05$.

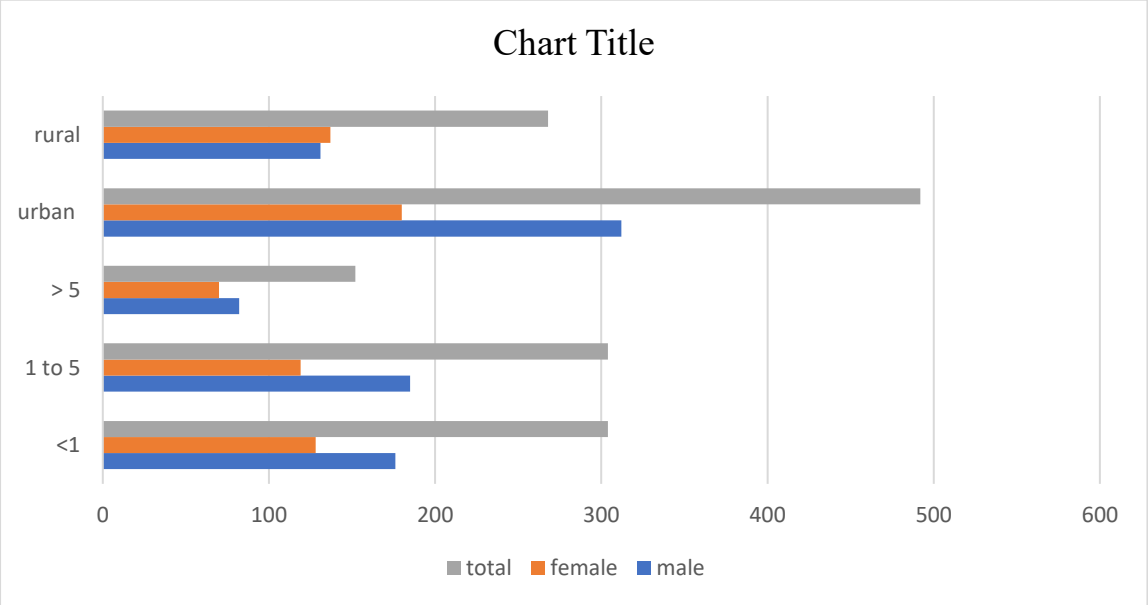
3.OUTCOMES:

Of the 760 enrolled children, 41.71% were female and 58.29% were male. Among the participants, 64.74% resided in urban regions (p=0.04).

Solicited Adverse Events: A total of 174 patients reported 210 solicited adverse events. The incidence was highest in Group 3 (>5 years) at 31.57%, significantly exceeding that of Groups 1 (3.95%) and >5 years (3.29%). Infants had the greatest frequency of unwanted adverse events at 11.84% (p=0.0001). Pyrexia, lethargy, diminished appetite, and gastrointestinal manifestations such as oral ulcers were prevalent systemic symptoms associated with these episodes. Local unsolicited replies occurred infrequently. Only two moderate incidents were documented in babies, with the severity predominantly classified as mild. The principal categorization for causation was "Possible". The majority of unanticipated adverse events resolved spontaneously with minimal medical intervention.

Analysis of System Organ Class: Headaches and other systemic nervous system diseases were more prevalent in older children, while localized adverse events were more frequent in younger children. The predominant uninvited adverse events (AEs) were gastrointestinal symptoms and general problems, particularly in infants.

Figure 1: Distribution by sex, age, and residential location.



A total of 760 participants (58% male, 42% female). Demographic distribution: 40% under 1 year, 40% between 1 and 5 years, 20% over 5 years. Urban inhabitants constituted 65% of the sample, exhibiting a notable male predominance (63% men, p=0.04); rural regions displayed a nearlyequalgenderdistribution.

Table 1: Assessment of all recorded adverse events triggered during the study

Severity	Group-1 (N=304)	Group-2 (N=304)	Group 3 (N=152)	P-Value
	[AEs] n (%)	**[AEs] n (%)**	**[AEs] n (%)**	
Mild	[80] 66 (21.71%)	[76] 58 (19.08%)	[48] 46(30.26%)	0.0001
Moderate	-	[4] 4 (1.32%)	[2] 2 (1.32%)	
WHO causality assessment				0.3714
Certain	[5] 5 (3.59%)	[3] 3(1.97%)		
Possible	[27] 23 (15.13%)	[25] 17(11.18%)	[44] 42(27.63%)	
Probable / likely	[6] 5 (3.59%)	[11] 10(6.58%)	[6] 6(3.94%)	
Unlikely	[2] 1 (0.66%)	[1] 1 (0.66%)		
Action Taken				0.1913
Medicinal/Surgical Treatment	[2] 2 (0.66%)	-	[8] 6 (3.94%)	
None	[78] 64 (21.05%)	[80] 60 (19.74%)	[42] 42 (27.63%)	
Outcome				0.48
Resolved	[80] 66 (21.71%)	[80] 60 (19.74%)	[50] 48 (31.57%)	
Type				0.0134
Local	[17] 16 (10.53%)	[15] 15 (9.87%)	[2] 2 (1.32%)	
Systemic	[23] 20 (13.16%)	[25] 18 (11.84%)	[48] 46 (30.26%)	

Table 2: Summary of Overall Solicited Adverse Events

SOC/PT	Group-1 (N=304)	Group-2 (N=304)	Group 3 (N=152)	P-Value
	[AEs] n (%)	**[AEs] n (%)**	**[AEs] n (%)**	
Overall	**[80] 66 (21.71%)**	**[80] 60 (19.74%)**	**[50] 48 (31.57%)**	0.003
Local	**[34] 32 (10.53%)**	**[30] 30 (9.87%)**	**[2] 2 (1.32%)**	0.001
General disorders and administration site conditions	[34] 32 (10.53%)	[30] 30 (9.87%)		0.12
Injection site pain	[34] 32 (10.53%)	[26] 26 (8.55%)		
Injection site swelling		[4] 4 (1.32%)		
Respiratory, thoracic and mediastinal disorders			[2] 2 (1.32%)	0.11
Nasal discomfort				
Rhinalgia			[2] 2 (1.32%)	
Rhinorrhea				
Systemic	**[46] 40 (13.16%)**	**[50] 36 (11.84%)**	**[48] 46 (30.26%)**	0.0001

Gastrointestinal disorders	[4] 2 (0.66%)		[2] 2 (1.32%)	0.47
Nausea	[2] 2 (0.66%)			
Vomiting	[2] 2 (0.66%)		[2] 2 (1.32%)	
General disorders and administration site conditions	[38] 38 (12.50%)	[34] 34(11.18%)	[12] 12(8.55%)	0.29
Fatigue		[2] 2 (0.66%)		
Pain	[2] 2 (0.66%)	[4] 4(1.32%)		
Pyrexia	[36] 36 (11.84%)	[28] 28(9.21%)	[12] 12(7.89%)	
Nervous system disorders	[4] 4 (1.32%)	[16] 16 (5.26%)	[34] 34(22.36%)	0.001
Headache	[4] 4 (1.32%)	[16] 16 (5.26%)	[34] 34(22.36%)	

This table categorizes the severity and causation of elicited adverse effects. The majority of adverse events were mild, while moderate occurrences were infrequent. Group 3 exhibited a greater incidence of mild incidents (30.26%) relative to the other groups. Causality evaluations determined that the majority of incidents were categorized as "possible," with a minimal number classified as "certain" or "likely. The majority of cases necessitated no intervention, and nearly all adverse events resolved without complications.

Table 3 :**summary of all unforeseen adverse events documented during the trial.**

Adverse Events: Group 1 (N=304), Group 2 (N=304), Group 3 (N=152)

Adverse Events	**Group-1 (N=304)** **[AEs] n (%)**	**Group-2 (N=304)** **[AEs] n (%)**	**Group 3 (N=152)** **[AEs] n (%)**	**P-Value**
Overall	[42] 36 (11.84%)	[14] 12 (3.95%)	[6] 5 (3.29%)	0.0001
Local			[1] 1 (0.66%)	0.1368
Rhinitis			[1] 1 (0.66%)	0.1368
Systemic	[42] 36 (11.84%)	[14] 12 (3.95%)	[5] 4 (2.63%)	0.0001
Abdominal pain			[1] 1 (0.66%)	0.1368
Mouth ulceration	[6] 6 (1.97%)	[3] 3 (0.99%)		0.1766
Decreased appetite	[6] 6 (1.97%)	[2] 2 (0.66%)		0.1081
Malaise	[6] 6 (1.97%)	[2] 2 (0.66%)	[1] 1 (0.66%)	0.2686
Pyrexia	[12] 12 (3.95%)	[6] 5(1.65%)	[1] 1 (0.66%)	0.0606
Cough				
Nasopharyngitis			[1] 1 (0.66%)	0.1368
Rash	[6] 6 (1.97%)	[4] 4 (1.32%)	[1] 1 (0.66%)	0.5335
Dizziness	[6] 6 (1.97%)	[3] 3 (0.99%)		0.1766

This table enumerates unrequested (unanticipated) unfavorable incidents among groups. Group 1 exhibited the greatest rate at 11.84%, whilst Groups 2 and 3 demonstrated significantly lower rates of 3.95% and 3.29%, respectively (p=0.0001). The majority of unsolicited adverse events were systemic. Frequent uninvited adverse events were oral ulceration, diminished appetite, malaise, fever, rash, and vertigo. Local events and respiratory ailments were infrequent.

Table 4: Evaluation of all uninvited adverse events reported during the study is shown
Level of Severity Group 1 (N=304) Group 2 (N=304) Group 3 (N=152)

Severity	**Group-1 (N=304)**	**Group-2 (N=304)**	**Group 3 (N=152)**	**P-Value**
	[AEs] n (%)	**[AEs] n (%)**	**[AEs] n (%)**	

Mild	[40] 34 (11.18%)	[14] 12 (3.95%)	[6] 5 (3.29%)	0.6122
Moderate	[2] 2 (0.66%)	-	-	
WHO causality assessment				0.4881
Certain	[6] 5 (1.64%)	[4] 4 (1.32%)		
Possible	[30] 25 (8.22%)	[7] 5 (1.64%)	[4] 3(1.97%)	
Probable / likely	[4] 4 (1.32%)	[2] 2 (0.66%)	[1] 1 (0.66%)	
Unlikely	[2] 2 (0.66%)	[1] 1 (0.33%)	[1] 1 (0.66%)	
Action Taken				0.2663
Medicinal/Surgical Treatment	[2] 2 (0.66%)	-	[1] 1 (0.66%)	
None	[40] 34 (11.18%)	[14] 12 (3.95%)	[5] 4 (2.63%)	
Outcome				1.000
Resolved	[42] 36 (11.84%)	[14] 12 (3.95%)	[6] 5 (3.29%)	
Type				0.5134
Local			[1] 1 (0.66%)	
Systemic	[42] 36 (11.84%)	[14] 12 (3.95%)	[5] 4 (2.63%)	

Table 5: SOC/PT of overall Unsolicited adverse events

SOC/PT	Group-1 (N=304) [AEs] n (%)	Group-2 (N=304) [AEs] n (%)	Group 3 (N=152) [AEs] n (%)
Overall	**[42] 36 (11.84%)**	**[14] 12 (3.95%)**	**[6] 5 (3.29%)**
Local			**[1] 1 (0.66%)**
Respiratory, thoracic and mediastinal disorders			**[1] 1 (0.66%)**
Rhinitis			[1] 1 (0.66%)
Systemic	**[42] 36 (11.84%)**	**[14] 12 (3.95%)**	**[5] 4 (2.63%)**
Gastrointestinal disorders	**[6] 6 (1.97%)**	**[3] 3 (0.66%)**	**[1] 1 (0.66%)**
Abdominal pain			[1] 1 (0.66%)
Mouth ulceration	[6] 6 (1.97%)	[3] 3 (0.99%)	
General disorders and administration site conditions	**[24] 24 (7.89%)**	**[10] 9 (2.96%)**	**[2] 2 (1.32%)**
Decreased appetite	[6] 6 (1.97%)	[2] 2 (0.66%)	
Malaise	[6] 6 (1.97%)	[2] 2 (0.66%)	[1] 1 (0.66%)
Pyrexia	[12] 12 (3.95%)	[6] 5(1.65%)	[1] 1 (0.66%)
Respiratory, thoracic and mediastinal disorders			**[1] 1 (0.66%)**
Cough			
Nasopharyngitis			[1] 1 (0.66%)
Skin and subcutaneous tissue disorders	**[6] 6 (1.97%)**	**[4] 4 (1.32%)**	**[1] 1 (0.66%)**
Rash	[6] 6 (1.97%)	[4] 4 (1.32%)	[1] 1 (0.66%)
Vascular disorders	**[6] 6 (1.97%)**	**[3] 3(0.99%)**	

Dizziness	[6] 6 (1.97%)	[3] 3 (0.99%)	
Syncope			

4.DISCUSSION:

The study shows large changes in the adverse event (AE) profiles and the distribution of demographics across several intervention groups. There is an important male dominance, especially in urban conditions, consistent with previous paediatrics studies showing that boys may be more inclined to seek medical care. The significant proportion of children under five in the sample is consistent with national immunization objectives and the target demographic for vaccination initiatives.

Group 3 reported the highest number of AEs (neurological and systemic AEs) in accordance with the findings of similar vaccination reactogenicity studies. The most common reported adverse effects (AEs) were small, self-resolving and required little intervention, consistent with existing data on children's responses after vaccination. Consistent with earlier findings, local reactions were more common in Groups 1 and 2.

The notable difference in unsolicited adverse events (AEs) in Group 1 may indicate possible links with other confounding variables or baseline health status. Minimal incidence of mild to severe side effects validates the safety of the therapies. Most AEs were classified as possible or probable based on causality evaluations; however, it was difficult to attribute them to a specific intervention.

The near-complete resolution of AEs independently suggests that they are mild. These findings underscore the significance of ongoing monitoring of both solicited and unsolicited adverse events, particularly in younger populations. Overall the findings are positive, but the differences across groups indicate that targeted monitoring is needed in some of the demographic categories. Future research should examine reactogenicity variation and identify specific risk factors for adverse outcomes.

This is very similar to the approach used in the European Covid Vaccine Monitor (CVM) study analyzed by Ahmadizar et al., which used a prospective, web-based cohort event monitoring system to collect patient-reported outcomes. The two models both show that active prospective tracking captures common local and systemic reactions at substantially higher frequencies than passive frameworks (e.g. spontaneous reporting databases such as EudraVigilance) where reporting rates for the same events can be several orders of magnitude lower.[26]

Systemic Reactions in Older Age Groups: This study notes a clear peak in solicited systemic events, particularly subjective symptoms such as headache, in children over 5 years of age. This is in perfect agreement with the European active surveillance data and key mRNA clinical trials (e.g., Walter et al., Frenck et al., and Ali et al.) which consistently showed higher rates of systemic reactogenicity (e.g., fatigue and headaches) in older children (5–11 years) and adolescents (12–17 years) compared to younger infant groups. This pattern is frequently associated with mature immune responses and the cognitive development necessary to verbalize subjective systemic malaise.

Localized and Unsolicited Reactions in the Infant: In contrast, this study showed that infants below 1 year of age were most vulnerable to unsolicited adverse events (11.84% incidence). However, local reactogenicity (e.g. pain at the injection site) is universally high across all paediatric age groups in both the manuscript and the comparative trials, offering a baseline physical response to immunization irrespective of the formulation or age of the patient[27].

The vast majority of the adverse events identified in this study are transient, self-limiting, and mild; moderate-to-severe events are extremely rare.This observation agrees well with the large European multi-country data and key trials, which show that although common, transient, local and systemic adverse drug reactions (ADRs) are to be expected, serious adverse events are exceedingly rare[28].

5.CONCLUSION:

The research indicates that adverse event patterns differ markedly among intervention groups. Group 3 is linked to an elevated incidence of solicited systemic and neurological adverse events, whereas Groups 1 and 2 exhibit a predominance of local and unsolicited occurrences, especially in younger children. Notwithstanding these disparities, the majority of adverse effects are modest, self-limiting, and resolve spontaneously without intervention. These data emphasize the necessity of monitoring distinct adverse events across several intervention groups and reinforce the overall positive safety profile of the therapies, especially for mild and temporary reactions. Future research should further examine the mechanisms underlying these disparities and develop measures to mitigate the risk of adverse events, particularly in vulnerable paediatrics populations.

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