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Optimizing pediatric medication therapy: evaluating the impact of clinical pharmacy services on health outcomes in children

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ABSTRACT

The physical, mental, emotional, spiritual, and social well-being of children is the focus of child health. Even in traditional Indian society, child health has been given a prominent position. Children in India are subject to a significant level of sickness, malnutrition, and death despite the introduction and periodic implementation of numerous programs for their benefit. Malnutrition in children in India is found to be fairly high in relation to the morbidity rate. There are currently indications that the state of child health in India is improving. Over the past few decades, the nation has implemented numerous policies, tactics, and programs that have contributed to this improvement. A thorough analysis of the literature revealed that research on the health status of children mostly relied on concentrating on child mortality, morbidity, and nutrition. It should be mentioned that the health of children is not solely dependent on the medical care given to them during the neonatal or postnatal periods. The health of the kid is also greatly influenced by antenatal care and intranatal facilities. Child health is also significantly influenced by the mother's general health, her knowledge of personal and child care, and her health care habits.

1. INTRODUCTION

Our most fundamental and vital resource as humans is our health. Each and every person needs it above everything else in order to grow in all areas of their lives. Humans are naturally healthy [1]. Every person is born with the right to health. It is the outcome of living in conformity with the physical, mental, and environmental rules of nature. The adage "the first happiness is health, the second is a full stomach" highlights the significance of health and implies that one cannot enjoy food if they are not in good health. It is among the crucial elements that support the development of skills, long-term sustainability, and economic progress. It is the most valuable thing that man owns. It affects everything he does and determines his fate. It serves as a modest foundation for his happiness. It serves as the cornerstone of his happinessA population's health status is a gauge of its members' standard of living. It is the starting point and a way for a human being to achieve other goals in life. It also takes into consideration the lifespan and general well-being of the elderly and children. It is a crucial component of developing human resources. Improving one's health situation is undoubtedly advantageous for everyone, and it is considered a significant method of developing human capital. Development is seen to be inextricably linked to good health [2]. According to the World Bank, maintaining good health is crucial for ensuring a steady supply of labor because it prevents disruptions brought on by illness and bad health, which lower human output. A person's wellbeing is said to be greatly influenced by their state of health. One of the major causes of morbidity and mortality in affluent nations is drug-related disorders (DRPs).
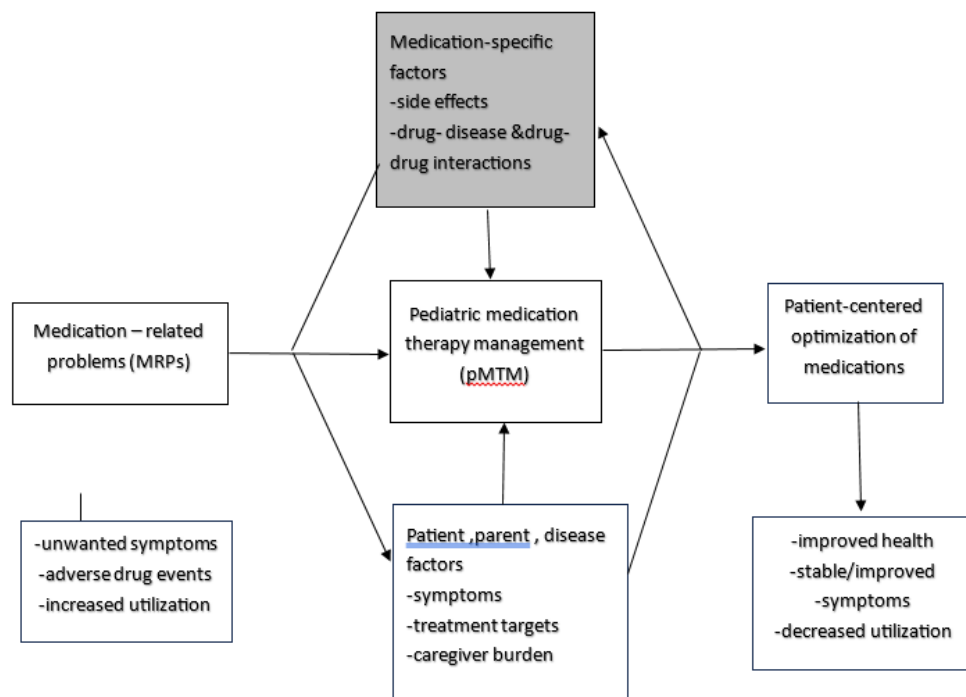
**Figure 1: Optimizing Pediatric Medication Therapy**

It appears that children are more likely to experience medication mistakes and drug-related problems (DRP) than adults [3]. Author (Sargunapathi, R, 2024) Due to a lack of comprehensive data on proper dosage, adverse effects, or contraindications, a large percentage of medications are delivered off-label or off-license, which makes optimum pediatric pharmacotherapy more difficult and puts children's medication safety at risk [4]. Most medication formulations are taken orally as liquids, pills, or capsules. Effective drug absorption and release to the GI tract's absorption location is a fundamental prerequisite of any delivery mechanism. medication penetration or transportation from an oral dose form into the general blood circulation occurs when the medication has been effectively absorbed to its absorption site. A number of physicochemical characteristics, including the active ingredient's permeability and solubility, are important for formulation absorption. Over 40% of newly developed novel chemical entities (NCEs) have low solubility issues. This is the main obstacle to successfully developing a novel formulation that effectively makes the medicine available for systemic circulation. Growth of oral An alternate method of preventing medication absorption through the GIT, such as the intraoral route, is to use rapid dispersible/dissolving tablets. Rapid drug release in saliva and oral mucosal absorption are two ways to deliver the medication straight to the systemic circulation. However, this dose form necessitated a quick and efficient drug release in the oral mucosa. A number of physical and chemical approaches can be applied to develop such a formulation. Childhood can be defined as the time frame from the child's birth till they reach adulthood. "A time when children are allowed to grow and develop to their full potential, healthy children in school and at play, growing strong and confident with the love and encouragement of their family and an extended community of caring adults, gradually taking on the responsibilities of adulthood, free from fear, safe from violence, protected from abuse and exploitation," is how Unicef defines childhood.

1.1 Impact of clinical Scenario in India

Children have a tremendous capacity for growth and advancement and are born with an enduring gift of optimism. The future of every country rests on the condition of its youngsters. However, a kid is a person, not a subperson, over whom the parent has a complete possessory interest, as is correctly stated48. Youngsters are incapable of making decisions for themselves. The adults who provide care, such as parents, social workers, and teachers, are vested with the responsibility and power over the children49 because they cannot develop into contributing members of society unless they are placed in an environment that is conducive to their physical and social well-being. The entire society suffers when children are neglected. Depriving children of their childhood for any reason, whether social, economic, or physical, results in significant losses for the country because it deprives it of human resources that are essential to its overall development, including social stability and

advancement, economic empowerment, peace and order, and most importantly, good citizens [5].

India has a rich cultural legacy and is among the oldest civilizations. It is the world's seventh-largest nation. One significant aspect of Indian culture is religion. The country's population is not evenly distributed. Author (Jha, R., 2024). It is challenging to plan and deliver consistent infrastructure, services, and policies due to this enormous and varied vastness. (Punriboon, C.,2019) The nation with the largest child population worldwide is India. In the past, India's tradition of stable family life and the joint family structure fostered an environment of love, warmth, and care that taught children morals and ethics, assisting them in creating a secure and healthy future. In the past, we regarded our children as God's gifts that needed to be raised with the greatest love and care. However, as we all know, change is unavoidable. As the socioeconomic environment changed, the joint family system began to deteriorate and give way to nuclear families, depriving the children of that supportive environment and forcing the family to compromise on the children's care, which led to a decline in their health. As the socioeconomic and cultural landscape changed over time, beginning with the pre-independence era, the concern for the children was met by neglect, exploitation, and denial, particularly in the state's poor areas, making children a disadvantaged group [6]. During the colonial era, modern healthcare and medicine were introduced to the nation. Prior to this, only individuals who had inherited the caste-based profession in India received training as health professionals. Kings, wealthy merchants, and other affluent people paid for the medical care. This demonstrated how the pre-colonial era viewed the provision of healthcare services as a state duty. Indicating urban bias, caste and class also had a limit excess, and the majority of services were offered in towns. Significant differences between rural and urban areas were also noted in the health care that was offered at the time. Taking note of this, the committee formulated its plan with the rural populace in mind. It suggested that integrated health services be made available to the entire community. Hospitals and other health facilities were intended to serve two purposes: first, to treat patients, and second, to start efforts to avoid disease.
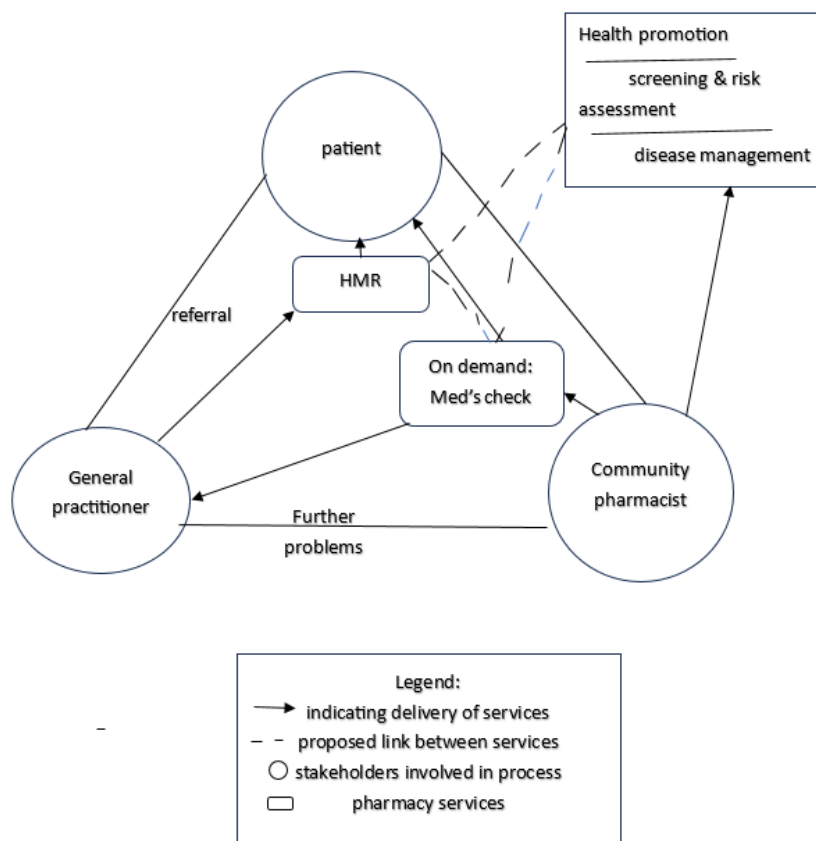
Figure 2: The impact of clinical services

The committee felt compelled to put the recommendations into effect immediately. Additionally, it was felt that one of the main goals of this plan should be to provide training for the medical staff.

2. RESEARCH OBJECTIVES

Even in the twenty-first century, children who live in abject poverty without access to enough food, safe refuge, clean drinking water, sanitary facilities, or educational resources are deprived of their childhood. In order to help doctors maintain the proper administration of medications, pediatric clinical pharmacy services (CPS) are being added to daily patient care in tertiary care facilities [4]. For pediatric CPS, recent papers list a variety of favorable outcome metrics (such as less DRP, shorter hospital stays, and lower costs) [4]. Therefore, in today's pediatric hospitals, clinical pharmacists ought to be viewed as an essential component of multidisciplinary patient care teams. Presenting the advantages of a recently created CPS in a children's tertiary care hospital with a focus on pediatric hemato-oncology is the goal of this paper. The following are the goals of this paper:

- Assess how clinical pharmacy services affect adverse drug events and pediatric medication mistakes.
- Evaluate how clinical pharmacy services affect the quality of life and hospital readmissions of pediatric patients.
- Determine the essential elements of clinical pharmacy services that support better   medication management for children.

2.1 Research question

- Can clinical pharmacy services optimize pediatric drug therapy to improve children's health outcomes?
- What potential variables might influence the use of pediatric CPSs in Indian public hospitals?

3. MATERIALS AND METHODS

200 households in each district were surveyed and interviewed for this study. Children under the age of 14 will be included in the study. According to their percentage of the overall kid population, the number of children in the age groups of 0–1 years, 1–5 years, and 5–14 years will be determined. (Yağız, E. 2022) Through the use of questionnaires as research tools, data on the availability and awareness of various health-related interventions offered by the government will be gathered from all 800 homes. Additionally, the study will use a structured interview schedule to interview key health department government officials, including the Chief Medical Officer, District Program Officer (ICDS), Medical Officer (in charge) of each district, Auxiliary Nursing Midwives, and 10% of all Anganwadi Supervisors in each district. Information about health-related initiatives, challenges, and shortcomings in the execution of health programs and policies will be gathered from these officials. To arrive at the just conclusion of the study, the gathered data has been categorized, tallied, and examined. Both states' statistics have been compared.

3.1 Factors influencing the Health Status of the Children

- To determine the impact of different factors, including social factors, their mothers' fertility factors, their mothers' education and awareness levels, prenatal practices, delivery procedures, and postnatal care, the health levels of the children in the control village were subjected to a cross-analysis.

3.2 Influence of Social Factors on Child Health

Social factors that have been identified as influencing children's health include family size, type, caste, religion, occupation, land ownership, and yearly income. The impact of social determinants on child health has been assessed by taking into account the mothers' replies of the children under five. According to table 5.7, nuclear families appear to be more conducive to raising healthy kids. The results of our study showed that 66% of children from nuclear families are retaining superior health, compared to only 44.4% of children from extended families and 21.4% of children from joint families. The chi-square test has validated the association between the type of family and its impact on the children's health. At the one percent level, the chi-square test result is deemed significant. The children's health is positively impacted by the size of the family. Smaller households with fewer than four members are more conducive to greater child health, according to the study. Of the children from tiny homes, 78.3% are in good health. Children from homes with five or six people have a reasonable level of health (58.6%). Just 6.7% of children from large households with seven or more people, on the other hand, are in good health. The chi-square value of 19.04, which is significant at the 5% level, demonstrates that the children's health is impacted by the size of the family.

Table 1: Influence of social factors on health status of children

Social factors	Number of children by health status							
	Very good	good	average	poor	Very poor	total	Percentage of children with better health	Chi square value and significance
Type of family								26.42
Nuclear family	2	5	22	15	0	44	65.91	1%
Extended family	2	1	1	5	0	6	44.44	
Joint family	0	1	2	3	8	14	21.43	
Family size								19.04
Below 4	3	4	11	5	0	23	78.26	5%
Between 5 - 6	1	3	13	12	0	29	58.62	
Above 7	0	0	1	6	8	15	6.67	
caste								29.34
O.C	3	5	2	1	0	11	90.91	1%
B.C	0	2	9	2	3	16	68.75	
S.C & S.T	1	0	14	20	5	40	37.50	
Religion								30.46
Hindu	4	6	23	19	1	53	62.26	1%
Muslim	0	1	1	3	3	8	25.00	
Christian	0	0	1	1	4	6	16.67	
Occupation								51.26
Govt. employee	0	1	1	0	0	2	100.00	1%
House wife	1	3	3	2	1	10	70.00	
Petty shop	1	0	1	1	0	3	66.67	
Farming	2	2	3	3	1	11	63.64	
Agriculture labour	0	1	17	17	6	41	43.90	
Land ownership								45.03
nil	0	0	7	9	3	19	36.84	1%
0-2.5 acres	0	0	8	8	3	19	42.11	
2.5-5 acres	1	2	7	5	2	17	58.82	
5-20 acres	2	3	2	1	0	8	87.50	
Above 20 acres	1	2	1	0	0	4	100.00	
Annual income								46.28

It is also mentioned that children's health is impacted by the caste system. It is observed that 90.9% of children from the forward castes had better health than only 68.8% of children from the backward castes and 37.5% of children from scheduled castes and scheduled tribes. The children's caste status and health are positively correlated, according to a chi-square score of 29.34, which is significant at the one percent level. (Shahriar, A.Z.M. 2011) The children's health is also affected by the mother's line of work. Sixty-six percent of children whose mothers work in agriculture, sixty-seven percent of children whose mothers manage small businesses, and seventy percent of children born to housewives are in reasonable health. On the other hand, only 43.9% of babies delivered to mothers employed in the agricultural industry are found to be healthy. The chi-square value of 51.26 confirms the association between the children's health and the moms' work. Trisiana, A. (2024) The children's health is positively correlated with the family's land holdings. One hundred percent of children from homes with more than twenty acres of land are healthy. Medium-sized farming families with five to twenty acres of land have superior health outcomes for eighty-seven percent of their children. Even if a reduction in the number of healthy children is shown concurrently with a decline in land possession, the correlation between family land ownership and children's health is confirmed by a chi-square value of 45.03, which is significant at the 1 percent level.

4. INFLUENCE OF FERTILITY FACTORS ON THE HEALTH STATUS OF THE CHILDREN

The mother's health has been found to be a significant determinant of the child's health. Numerous fertility factors, such as the mother's age at marriage, years of marriage, age at first conception, total number of conceptions, and history of abortions, live births, and infant deaths, affect the mother's health. Children's health is also impacted by mothers' usage of family planning. (Khyade, 2016). A mother who has been sterilized and no longer needs to think about other possibilities not only maintains better personal health but also gives her child's health more thought. Children born to women who married before

turning 18 had health problems in almost half of cases. Nonetheless, 71.4 percent of children born to mothers who married between the ages of 18 and 21 seem to be healthier. Children whose mothers married after turning 21 are maintaining good health. According to the mothers' total number of years of marriage and the health of their children, mothers who have only been married for a few years have healthy children. It was found that the longer the marriage, the somewhat lower the children's health state. Just 22% of children whose moms have been married for 3 to 6 years are found to be ill, whereas nearly 40% of children whose mothers have been married for 6 to 9 years are found to have health issues. Seventy-six percent of children born to women who married after nine years are not in good health. The distribution of data pertaining to mothers' years of marriage and their children's health status demonstrates a significant link at the 5% level, as indicated by the chi-square value of 21.5. Children's health state also showed a high correlation with the age at first conception and the timing of subsequent conceptions. Just 49.1% of infants born to mothers who became pregnant before the age of 18 are still healthy, according to the study. Of mothers who became pregnant for the first time between the ages of 18 and 21, approximately 66.7% of the offspring are found to be healthy. Mothers who became pregnant for the first time after turning 21 are found to have healthy children in every case. The correlation between the mother's age at first conception and the health of the offspring is confirmed by a chi-square value of 37.36, which is significant at the 1% level. Both the number of pregnancies and the mother's age at first conception had an impact on the offspring's health. When a mother has fewer than two pregnancies, 81 percent of her offspring are healthy. Between the ages of three and four, only 54.3 moms per center are in good health. It has been observed that when there are more than five conceptions, the health of the offspring is either very poor or bad. The chi-square value of 29.46, which is significant at the 1% level, confirms that there is a link between the total number of conceptions and the health state of the impacted children.

Table 2: Number of children by health status

Fertility factors	Number of children by health status							
	Very good	good	average	poor	Very poor	total	Percentage of children with better health	Chi square value and significance
Age at marriage								43.94
Below 18 years	1	5	22	21	8	57	49.12	1%
18 – 21 years	2	2	1	2	0	7	71.43	
21 – 26 years	1	0	2	0	0	3	100.00	
Total marital years								21.45
Below 3 years	0	2	3	0	0	5	100.00	5%
3 -6 years	3	2	6	2	1	14	78.57	
6 -9 years	1	2	11	7	2	23	60.87	
Above 9 years	0	1	5	14	5	25	24.00	
Age at first								37.36
Below 18 years	3	3	23	22	8	59	49.15	1%
18 – 21 years	0	1	1	1	0	3	66.67	
Above 21 years	1	3	1	0	0	5	100.00	
Total conceptions								29.46
Up to 2	2	4	11	3	1	21	80.95	1%
3 & 4	2	3	14	15	1	35	54.29	
5 & 6	0	0	0	4	6	10	0.00	
Above 7	0	0	0	1	0	1	0.00	
Type of family planning adoption								36.96
permanent	1	2	1	0	0	4	100.00	1%
temporary	2	3	2	2	1	10	70.00	
Not adopted	1	2	22	21	7	53	47.17	
Abortions								18.10
nil	4	5	21	14	1	45	66.67	5%
Between 1& 2	0	2	4	6	2	14	42.86	
Between 3& 4	0	0	1	3	5	9	11.11	
Live births								21.26
Between 1 & 2	3	4	9	6	0	22	72.73	5%
Between 3 & 4	1	2	11	10	1	25	56.00	
Between 5 & 6	0	1	1	2	5	9	22.22	
Above 7	0	0	4	5	2	11	36.36	
Infant deaths								15.69
Nil	4	7	18	16	0	45	64.44	5%

| Between 1 & 2 | 0 | 0 | 4 | 5 | 8 | 17 | 23.53 | |
| Between 3 & 4 | 0 | 0 | 3 | 2 | 0 | 5 | 60.00 | |

The associations between categorical variables were investigated using Pearson's chi-square test. A statistically significant p-value was defined as one at the 95% confidence interval. The Kolmogorov Smirnov test was used to determine whether or not the distribution of continuous data was normal. The results showed that the data did not meet the requirements for a normal distribution. Therefore, the Mann-Whitney U test, which is used for non-parametric data, was employed to compare the differences between the two groups. The odds ratio determined whether different clinical conditions pose a risk for DRPs. Any missing data have been indicated within relevant table cells. The impact of the parameters that have missing data did not generate the need for sensitivity analysis.

Regardless of the level of treatment, such as in a hospital or community setting, pharmacists could enhance the care of pediatric patients. (Sharma, 2024). Pharmacists possess the pharmacology and pharmaceutics knowledge and abilities needed to enhance the use of pediatric medications, including the ability to calculate dosages, be meticulous, communicate effectively, and recognize medication-related errors.

By carrying out specific daily tasks, pharmacists could avoid drug errors. When examining a pediatric patient's prescription, pharmacists can eliminate medication inconsistencies by implementing medication reconciliation, a unique service. In order to find medication-related problems (MRPs) and improve pharmaceutical therapy, the current prescription should be compared with previous prescriptions. The medication review process should include the usage of over-the-counter medications, such as a salbutamol inhaler, since excessive use may be a sign of uncontrolled asthma. To make sure that every prescription drug has a suitable indication, the medication reconciliation procedure should be used at the first and subsequent visits in both community and hospital settings. By evaluating prescriptions in the pharmacy or ward context, pharmacists can optimize drug management; however, the impact may be larger if they are included in ward round talks, which could help identify medication errors earlier.

5. DISCUSSION

As members of the multidisciplinary team in a pediatric ward or HSCT unit, CPs can identify DRP and recommend clinically substantial PI, which the prescribing physicians are likely to accept. As a result, DRP will be prevented, including avoidable side effects [9]. CPS, for instance, reduces significant prescription errors in critically ill pediatric hospital patients, according to a research that tracks pre- and post-pharmacist engagement [10]. Further DRP is prevented as a result of CPS deployment [11]. We speculate that this is because of a learning curve brought on by the ward team's information transmission. Since DRP is thought to be a surrogate for fewer hospital admissions, an overall decrease in DRP may have a positive impact on patient outcomes [12]. The responsible CP started over nine PIs per ward round on average over the course of a six-month research period. The findings of Prot-Labarthe et al., who documented 16.9 interventions/day (mean) launched in two wards [13], are similar to this. Although the acceptance rate of over 75% is high, it is marginally lower than the rates of 86–93% reported in other research [13,14]. The CP would have a learning curve for plausible explanations. While hemato-oncologists tended to rank the relevance of PI higher (80%), self-assessment revealed that 64% of PI were judged important or higher. These results show that the importance of PI for clinical practice was not overestimated by self-assessment. According to the study, CPS can lower the anticipated expenses of medication therapy and follow-up. Although the landscape of pediatric medication research has changed significantly in recent decades in favor of safer and more effective treatments, certain problems still exist.

Factors that can impact the pediatric pharmacotherapy practice and drug development are

- a lack of approved APIs for the pediatric population,
- a deficiency in regulatory clarity,
- low market size and profitability,
- age-appropriate drug formulations,
- a lack of safety data for excipients used in pediatric drug development,
- the route of administration not being age-adjusted,
- complete pharmacokinetic data not being available, and/or
- difficulties in establishing in vivo models that can mimic different pediatric subgroups, leading to the need for novel technologic and galenic requirements.

Some of the described problems appear to be resolved by using nanomedicine. Preclinical and clinical research shows promise in enhancing a wide range of APIs' solubility, organoleptic characteristics, therapeutic effectiveness, and safety. But

before the majority of bench-formulated nanomedicines can be brought to the patient's bedside, a significant obstacle must be overcome, especially when it comes to pediatric nanomedicines. It has been suggested that a workforce work alongside doctors and pharmaceutical developers to standardize processes for creating pediatric formulations. With the introduction of ATMPs, pediatric diseases may be cured and put into full remission. Nonetheless, there are still difficult concerns about their safety and immunogenic side effects. These novel treatments also present difficulties for pharmaceutical companies and healthcare systems, which can be summed up in the "four As": cost, availability, assessment, and authorization. Considering a common international framework established in the trinomial pillars of quality, efficacy, and safety from a fit-by-design perspective, pediatric medicine remains a hot and challenging topic to investigate. Pharmaceutical developers play an unquestionably crucial role in the pre-conception, design, and formulation of these medications up until the clinical phase.

6. CONCLUSION

Few research have been done in India to determine the elements linked to medical practices that improve women's and children's health. From the perspective of health planners and policy makers, the current study has significant implications. The study that was done had drawbacks as well. There were not many patients, and the patient population was very particular. There was no comparison of clinical outcomes between the pre- and post-intervention phases, such as the frequency of medication errors that resulted in damage or the time to readmission. The successful application of CPS merely serves as a stand-in for better patient outcomes by preventing DRP. Due to the lack of other patient care activities (such as patient education), the CPS's scope was limited. Only retroactive estimates of the cost savings were made using extrapolations from published data. The savings from avoiding side effects were the only follow-up cost reductions that were computed.

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