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The prevalence and types of childhood vaccination administration errors

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Abstract
Background: Vaccination administration errors are preventable events that can affect patients via inadequate immunological protection, injury, increased costs, inconvenience, and reduced confidence in the healthcare delivery system.
Objective: To calculate the prevalence of vaccination errors, determine which types of errors are most common, and identify opportunities for prevention.
Methods: A cross-sectional study was conducted at the National Guard Comprehensive Specialized Clinic in Riyadh, Saudi Arabia. The study population consisted of 2580 children who received routine vaccinations at the Well Baby Clinic. A checklist was used to collect data regarding vaccination administration errors.
Results: The prevalence of vaccination administration errors was 0.57%. The most common vaccination errors were vaccine dosing errors, administration of the wrong vaccine, and incorrect vaccination intervals.
Conclusions: Vaccine administration errors are uncommon; however, the impact of vaccination errors on the health of individuals and the population can be severe. Prevention strategies to avoid these errors should be considered.

Keywords: vaccination errors, error prevalence, vaccine safety, patient safety

Introduction

Vaccination administration errors are an important preventable public health concern [1]. Vaccination errors can cause patient harm, inconvenience related to patient recall, increased costs, wasted time and vaccine, and skepticism regarding vaccines specifically and the health care system in general [2-4]. Most importantly, these errors can reduce or eliminate the immunological protection conferred by vaccination. On a large scale, this compromises both patient care and the public protection conferred by herd immunity against infectious diseases [5]; therefore, minimizing vaccination errors is paramount in maintaining human health and well-being [6]. The few studies dedicated specifically to vaccination errors indicate that the most commonly reported errors involve administering the wrong vaccine or incorrect dose [7]. Other errors including extra immunization [8, 9]; improper spacing between vaccine doses [10]; improper administration route [11, 12]; expired [13] or improperly stored vaccines [14]; wrong vaccine administered [15]; and contraindication errors [16]. Factors that contribute to these errors include vaccine names and abbreviations that sound alike and similar packaging [17, 18]. The increasing complexity of provincial immunization schedules and the ever-expanding array of available vaccine products, if left unchecked, could potentially compound the number of vaccine errors going forward [19].
This study aimed to calculate the prevalence rate of vaccination administration errors between January 2020 and June 2020, determine what types of errors occurred during this period, and identify opportunities for prevention.

Methods

A cross-sectional study was conducted at the National Guard Comprehensive Specialized Clinic in Riyadh, Saudi Arabia. The study population comprised children (aged 2 months to 6 years old) who received routine recommended vaccinations (Table 1) at the Well Baby Clinic. The study period was from January 1, 2020 to June 30, 2020.
To prevent vaccination administration errors, the clinic adopted the following practices: the implementation of an electronic system that issues alerts in response to incorrect orders, the requirement for two nurses to attend every vaccination to ensure proper administration of the correct vaccine, and the avoidance of verbal communication for vaccination orders to prevent confusion between similar-sounding names or acronyms.
A checklist of eight vaccination administration errors was used to collect data. The checklist items were: wrong age, wrong interval, incorrect dose, wrong route, wrong vaccine, wrong patient, expired vaccine, and storage and dispensing error. In addition, the checklist also collected information regarding the age of the patient and the source of error (i.e., physician or nurse). The checklist was completed by the nurse in charge of the vaccination. The data used to quantify and analyze vaccination administration errors were obtained from this checklist. The analysis included types and numbers of vaccination administration errors, ages of the children affected, and sources of the errors (i.e., committed by a physician or nurse).

Results

During the six-month study period, 2580 children received 7858 doses of different vaccines according to the recommended national vaccination schedule (Table 1). Regarding the age distribution of these children, 359 (13.9%) were 2 months old, 348 (13.5%) were 4 months old, 379 (14.6%) were 6 months old, 353 (13.7%) were 9 months old, 368 (14.3%) were 1 year old, 253 (9.8%) were 18 months old, 348 (13.5%) were 24 months old, and 172 (6.7%) were between 4 and 6 years old (Table 2).
In total, 45 vaccine administration errors were recorded throughout the six-month study period. Therefore, the

vaccination error prevalence rate was 0.57%. Twenty-six of these errors (57.8%) were related to dose, 11 (24.4%) were due to an incorrect vaccine order, and 8 (17.8%) were caused by incorrect interval timing in a multi-dose vaccine series (Table 3).

No other types of vaccination administration errors were reported. Vaccination administration errors occurred most frequently with the four-month vaccinations (35.5%), followed by the eighteen-month vaccinations (20%) (Table 2).

Table 1: Schedule of children vaccination in Saudi Arabia

At Birth	Hep B
2 months	IPV, DTaP, Hepatities B, Hib, PCV13, Rota
4 months	IPV, DTaP, Hepatities B, Hib, PCV13, Rota
6 months	BCG, IPV, DTaP, Hepatities B, Hib, PCV13
9 months	Measles, MCV4
12 months	OPV, MMR, PCV13, MCV4
18 months	OPV, DTaP, Hib, MMR, Varicella, Hepatities A
24 months	Hepatities A
4-6 years	OPV, DTap, MMR, Varicella

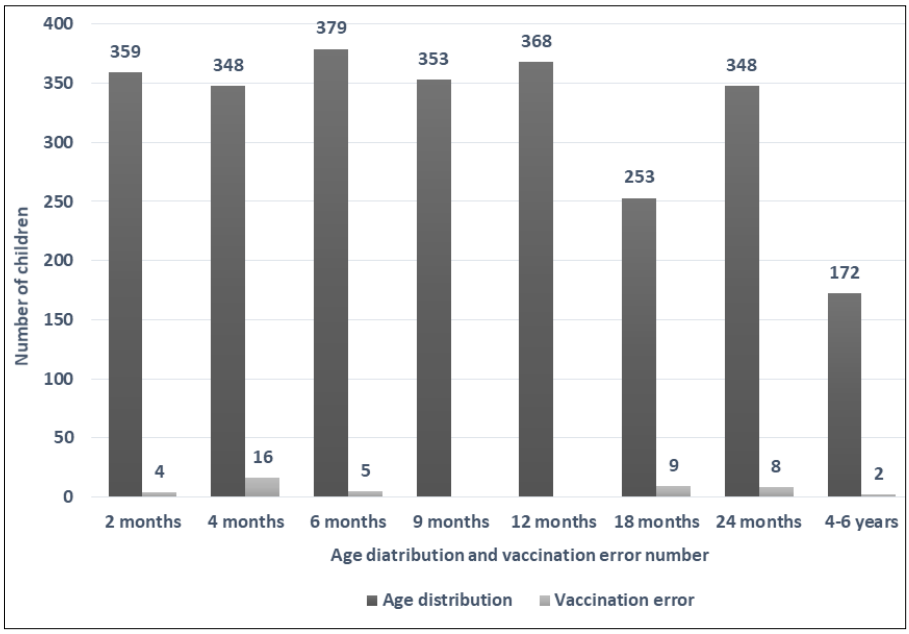

Fig 1: Age distribution and number of vaccination error

Table 2: Vaccination administration error types

Vaccination administration error	Number (% total errors)
Incorrect dose	26 (0.33%)
Wrong vaccine	11 (0.14%)
Wrong interval	8 (0.1%)
Wrong route	0
Wrong age / inappropriate schedule	0
Wrong patient	0
Expired vaccine	0
Storage and dispensing	0
Total errors	45 (0.57%)

Discussion

Every year, hundreds of millions of vaccine doses are administered globally; however, vaccination administration errors are rarely reported or discussed. The consequences of vaccination errors occur on multiple levels: epidemiological (e.g., lack of immunization and possible propagation of an epidemic), individual (e.g., excessive vaccination with no benefit to the patient, adverse effects), and financial [20]. Another potential consequence is fueling the rise of vaccine skepticism and refusal, especially among parents of young children.

The clinical site investigated in this study had a low vaccine administration error rate of 0.57%. This aligns well with previous studies that reported prevalence rates of 4% [21] and 0.15% [22]. Incorrect dosing was the most common error committed (58.9%). Almost all of these errors were related to the Rota vaccine, likely because the two different brands of this vaccine (Rotarix and Rotateq) are administered at different doses. Since Rotarix became unavailable (out of stock) 4 months into this study, Rotateq took its place for the final two months of the study. Physicians were informed in a memorandum of the Rota vaccine brand change and the new recommended dose, however, some continued to order the old Rotarix dose for the new Rotateq vaccine.

Incorrect vaccine was the second most common vaccination administration error (23.5%). Many of these errors involved vaccines with similar antigen types approved for different age groups [21]; for example, tetanus-containing vaccines (e.g., Td, Tdap, DTaP, DT). Vaccines with different age-based formulations are more frequently associated with administration errors than those with a single dosage recommended for all ages [23].

The third vaccination administration error was incorrectly timing a multi-dose vaccine series (17.6%). These interval errors all related to the second dose of the hepatitis A vaccine being administered before the minimum recommended spacing interval had elapsed. Dose intervals are necessary to ensure maximum, long-term protection; therefore, this error could result in an insufficient immune response and require revaccination.

No other vaccination administration errors were reported in the clinic for many reasons including no verbal vaccination order are allowed in the clinic (due to similar-sounding names or acronyms), the presence of an electronic alarm for any wrongly submitted orders, availability of two nurses in the vaccination room (to review the vaccination orders before they administer the vaccines, and regularly monitor storage conditions and expirations dates).

These findings suggest that interventions to reduce vaccination errors should include thorough training and regular continuing education sessions for all medical staff that cover vaccination schedules, dosages, minimum intervals required between vaccines, any age-based administration differences, and changes to standard procedures, as they arise. No verbal orders for vaccines should be allowed to avoid confusion between similar-sounding vaccine products, and vaccine labeling and storage practices should be improved. A greater understanding of the factors that contribute to vaccination errors enables preventing them, thereby mitigating the risks of patient harm and impaired public confidence in vaccination.

Conclusion

Vaccine administration errors are uncommon; however, the negative impact of vaccination errors at the individual and public health levels cannot be overlooked. These vaccination administration errors are more likely to occur with the presence of different brands of the vaccine at different doses, vaccines with similar antigen types approved for dosing in different age groups, and, lastly, errors in minimum interval timing in a multi-dose vaccine series. Potential strategies for reducing vaccination errors include (1) educating and training providers on vaccine timing, dosing, and spacing, (2) facilitating improvements in differentiating between vaccines with similar-sounding names and acronyms, (3) providing training on proper administration techniques, (4) improving monitoring of vaccine storage temperatures, and (5) increasing awareness and establishment of procedures to monitor vaccine expiration.

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