ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 3, Issue – 1, February - 2020, Page No. : 110 - 119

Knowledge of Dentists about Pediatric Drug Dosing and Related Errors: A Pilot Study

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Citation of this Article: Dr. Sangeetha P. Venkatesh, Dr. Prabhawati. P.I ,“ Knowledge of Dentists about Pediatric Drug Dosing and Related Errors: A Pilot Study”, IJDSIR- February - 2020, Vol. – 3, Issue -1, P. No. 110 – 119.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: Although children are at the greatest risk for medication errors, little is known about drug dosing errors in children by dentists.

Objective: To assess the knowledge of dentists about pediatric drug dosing and related errors.

Methods: A survey was conducted in Bangalore, South India. Forty-five dentists participated in our study, of which 15 were general dentists (BDS - group A), 15 were other dental specialists (MDS-group B), and 15 were pediatric dentists (group C). The questionnaire containing questions (MCQ’S) about pediatric drug dosing and related errors were given to them. The obtained data was tabulated and subjected to statistical analysis using Fisher Exact test.

Results: In our study all the dentists (100%) gave specific dosing instructions. Mg/kg regimen was the rule employed by 66.7% of pediatric dentists and 33.3% of other dental specialists for pediatric dosage calculation which was of suggestive statistical significance; $P \leq 0.073$. Almost fifty three percent of pediatric dentists, 20% of other dental specialists and 13% of general dentists mentioned that the letter ‘d’ in Mg/kg/d referred to day which was suggestive of statistical significance; $P \leq 0.070$. Of all the three groups, mathematical calculations used for drug dosing was recognized only by 46.7% of pediatric dentists, which was strongly significant ($P \leq 0.001$). Only 33.3% of pediatric dentists, 20% of other dental specialists and 6.7% of general dentists were aware about ten fold errors and its causes.

Conclusion: The pediatric dentists were better informed about pediatric drug dosing and related errors, when compared to general dentists and other dental specialists. There is lack of awareness about ten fold errors among the dentists.

Keywords: Medication errors, drug-dosing errors, pediatric medication errors, dosing equation, drug dosage, knowledge, ten fold errors.

Abbreviations: PDR- Physicians desk reference, BDS- Bachelor of dental surgery, MDS -Master of dental surgery, MCQ- Multiple choice questions.

Introduction

Drug use is a complex process; there are many drug related challenges at various levels, involving prescribers, pharmacists, and patients. Children are predisposed to encounter medication errors three times more than adults[2] as drug doses in children are usually calculated individually based on age, weight, and clinical condition. Newborns, children and adolescents have different physiological, pharmacokinetic and pharmacodynamic parameters compared to adults. These growth and maturational differences make the therapeutic index of a medication, an important consideration in pediatric drug therapy. In addition young children have less developed communication skills with which it is difficult to describe signs of adverse effects. [1] All these factors make children vulnerable to dosing errors.[3,4] Majority of the dentists prescribe drugs to treat children with oro-facial pain, infections etc. Therefore, we wanted to assess the awareness of oral health care providers, about the issues related to pediatric drug dosing. This task was accomplished by comparing the knowledge of general dentists (BDS), other dental specialists (MDS) and pediatric dentists (MDS).

Materials and Methods

The questionnaire was developed and refined to ensure clarity and item comprehension. The study was conducted over six weeks in November 2008. Permission to conduct the study was obtained from our institutional ethics committee. About 45 dentists participated in our study. Among them 15 were general dentists (group A), 15 were other dental specialists (group B), and 15 were pediatric dental specialists (group C). All the participants were provided with the questionnaire, which consisted, questions (MCQ's) pertaining to drug dosing and related errors in children. The questionnaires were given to them in person. All the 45 dentists responded by filling the questionnaire. The questionnaires were collected on spot after assurance of anonymity. The Respondents were not differentiated by age, sex, type of practice (clinical / academic) or years of experience. We assessed their level of awareness by inter-group comparison. The collected data was tabulated and subjected to statistical analysis using the Fischer exact test. The Fisher Exact test was used to find the significance of study parameters on categorical scale between the three groups.

Results (Refer Table 2)

There were 45 participants in our study. Among them, all the pediatric dentists (100%) agreed that the Child is not a miniature of adult in terms of drug dosing. But only 73.3% of other dental specialists and 46.7% of general dentists agreed to it, which was strongly significant ($P \leq 0.004$). Almost 93.3% of pediatric dentists referred pediatric drug dosing guidelines-means- published dosing recommendations (please refer the discussion for clarification), where as only 60% of other dental specialists and 80% of general dentists did the same. Approximately 67% of pediatric dentists and 33.3% of other dental specialists employed mg/kg regimen as for pediatric dosage calculation. Where as 46.7% of general dentists roughly used the fraction of an adult dose for children. This was of suggestive statistical significance ($P \leq 0.073$).

Of all the three groups only 46.7% of pediatric dentists were aware about mathematical calculations used for drug dosing which was found to be strongly significant ($P \leq 0.001$). Sixty percent of pediatric dentists, 40% of other dental specialists and 13.3% of general dentists recognized the essentials for calculation of medication dosages which was statistically significant ($P \leq 0.038$). Only 33.3% of pediatric dentists, 20% of other dental specialists and 6.7% of general dentists were aware about ten fold errors and its causes. Approximately 53.3% of

pediatric dentists mentioned that the 'd' in Mg/kg/d referred to day, 53.3% of other dental specialists mentioned that it was either day or divided dose, and 46.7% of general dentists stated that 'd' meant divided dose which was of suggestive significance (P≤0.070).

Overall 100% of the general dentists cross checked their prescription, where as only 93.3% of pediatric dentists and 86.7% of the other dental specialists cross checked their prescription. All the participants (100%) in our study gave specific dosing instructions to their patients/ parents/guardian. In our study 100% of pediatric dentists and 100% of general dentists instructed their patients/ parents/guardians to use appropriate measuring devices for dispensing liquid medicaments, but only 86.7% of the other dental specialists did the same.

Discussion

The so-called "pediatric population" is vast and highly heterogeneous, ranging as it does from the newborn preterm to the adolescent on the verge of adulthood.[6] The most important aspect for selection of a drug and establishment of proper pediatric dosage is the acknowledgment that the pediatric patient is not just a small adult.[7,8,9,10] In our study majority of pediatric dentists agreed to this fact when compared to the other dental specialists and the general dentists and was statistically strongly significant.

Texts, PDR, handbooks, and manufacturer labeling (package inserts) are frequently consulted by clinicians for medication dosage recommendations.[11-14] In our study a large part of dentists referred the pediatric drug dosing guidelines and agreed in accordance with other studies[11-16] that dosing errors occur due to discrepancies in published dosing recommendations. Among the three groups, pediatric dentists scored the highest followed by the general dentists and the other dental specialists. In the current study, we did not go in to the details of which published dosing guidelines the participants followed. There are several formulas for calculation of the pediatric drug dosage based on weight, age, Body Surface Area etc. The literature review demonstrates that, even though there is a tendency to follow an existing rule for calculation of the pediatric drug dosage, there are many divergent opinions.[7] Two methods are commonly reported as being favorable for definition of the proper pediatric dosage, namely per weight, and per Body Surface Area. [17-23] In our study Mg/kg regimen was the rule employed by 66.7% of pediatric dentists and 33.3% of other dental specialists for pediatric dosage calculation. Approximately 47% of general dentists roughly used the fraction of an adult dose for children and was found to be of suggestive statistical significance. Guidelines of specific dosages and useful means for calculation of pediatric dosages must be developed in order to enhance the effectiveness and therapeutic limit and prevent serious adverse effects .[24]

There is substantial evidence that doctors have difficulty calculating drug doses correctly.[25] This could be due to the lack of math skills needed to solve the problem [26] specifically, the use of fractions, percentages, decimals, and ratios.[27,28] In our study only 46.7% of pediatric dentists were aware about mathematical calculations used for drug dosing and was found to be statistically strongly significant. The deficiencies could be attributed to lack of formal teaching of the topic. Drug dose calculations should be given a prominent consideration in the undergraduate dental curriculum.

According to Johnson and Johnson, the essentials for calculation of medication dosages are to compute, convert, conceptualize and critically evaluate.[29] The major problems behind many of the miscalculations are associated with an inability to conceptualize the right mathematical calculation to be performed[30] and

understand the mathematical process leading to the solution.[31] Majority of pediatric dentists, and other dental specialists and only a minority of general dentists recognized the essentials for calculation of medication dosages which was found to be statistically significant.

Several studies have documented that the weight-based dosing creates many opportunities for errors, including particularly dangerous 10-fold dosing errors. Tenfold dosing errors in children can easily occur due to a misplaced decimal point or a trailing zero.[32-35] In the present study only 33.3% of pediatric dentists, 20% of other dental specialists and 6.7% of general dentists were aware about ten fold errors and its causes. Over all there is deficit knowledge about ten fold errors among our participants.

The use of dosing equations is an important risk factor for errant prescribing, particularly among children. Confusion regarding the way dosage regimen equations are stated or expressed results in prescriber confusion and dosing errors. Dosage equations may be variably expressed as a total daily dosage to be divided into a number of multiple daily doses (e.g:100 mg/kg/day in 4 divided doses), or an individual dose to be given multiple times per day (e.g.: 25 mg/kg 4 times daily).[36,37,38] In our study 53.3% of pediatric dentists mentioned that the 'd' in Mg/kg/d referred to day, 53.3% of other dental specialists mentioned that it was either day or divided dose, and 46.7% of general dentists stated that 'd' meant divided dose. This was found to be of suggestive statistical significance. The more complicated a dosage regimen is, the more likely errors will occur. All clinicians must be aware of the increased potential for confusion and error when calculations or complicated dosage equations are used and should take appropriate steps to avoid error. [36-38]

The healthcare professional should review the prescription order for appropriateness and dosage accuracy followed by specific dosing instructions in order to minimize errors. [39] In the current study, all the general dentists verified their prescription, but only 93.3% of pediatric dentists and 86.7% of the other dental specialists cross checked their prescription. All the participants in our study gave specific dosing instructions to the patients/ parent/guardian.

Compared with the inpatient setting, care in the ambulatory setting is complicated by several factors, including the need for parental administration of drugs to children.[40] The use of household teaspoons and tablespoons should be discouraged because of the variability and resulting inaccuracies. Appropriate measuring devices should be recommended for liquid medicaments.[41] In our study all the pediatric dentists and general dentists recommended the use of appropriate measuring devices for dispensing liquid medicaments but only 86.7% of the other dental specialists did the same.

Our findings dictate the need for greater understanding of all the aspects of pediatric drug dosing. Dental Practitioners who prescribe and provide medications to pediatric patients should have specific and ongoing training in drugs and dosing for this population. Continued research into recognizing the unique challenges of providing care to the pediatric dental population, should be promoted.

Conclusion

The pediatric dentists were better informed about pediatric drug dosing and related errors, when compared to the general dentists and other dental specialists. There is deficit knowledge about ten fold errors and its causes among the dentists.

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Legends Tables

Table 1: comparison of knowledge regarding the drug dosing and related errors in three groups of dentists studied

Questions	Response	General dentists (n=15)	Other Dental specialists (n=15)	Pediatric dentists (n=15)	P value
1. Child is a miniature of adult- This does not hold good for drug dosing	a) Agree	7(46.7%)	11(73.3%)	15(100%)	0.004**
	b) Disagree	8(53.4%)	4(26.7%)	0(0%)	
2. Do you refer pediatric drug handbook and get updated on it	a) Yes	12(80%)	9(60%)	14(93.3%)	0.113
	b) no	3(20%)	6(40%)	1(6.7%)	
3. Most common method of dosage calculation used by you	a) Youngs formula	2(13.3%)	4(26.7%)	1(6.7%)	0.463
	b) Salisburys formula	0(0%)	0(0%)	1(6.7%)	1.000
	c) Clarks formula	1(6.7%)	3(20%)	1(6.7%)	0.594
	d) Pennas formula	0(0%)	0(0%)	0(0%)	-
	e) Dillings formula	0(0%)	0(0%)	1(6.7%)	1.000
	f) Frieds formula	0(0%)	0(0%)	0(0%)	-
	g) BSA	1(6.7%)	2(13.3%)	1(6.7%)	1.000
	h) Age	0(0%)	0(0%)	0(0%)	-
	i) mg/kg	4(26.7%)	5(33.3%)	10(66.7%)	0.073+
	j) Roughly, frac adult dosage calculated	7(46.7%)	1(6.7%)	0(0%)	0.003**
4. Mathematical	a) Fractions	6(40%)	4(26.7%)	3(20%)	0.601

calculations used for dosing are	b) Percentage	1(6.7%)	1(6.7%)	1(6.7%)	1.000
	c) Decimals	2(13.3%)	2(13.3%)	1(6.7%)	1.000
	d) Ratio	3(20%)	0(0%)	0(0%)	0.096+
	e) Proportion	1(6.7%)	6(40%)	2(13.3%)	0.107
	f) All of the above	0(0%)	0(0%)	7(46.7%)	<0.001**
	g) None of the above	0(0%)	0(0%)	1(6.7%)	1.000
	h) Don't know	2(13.3%)	2(13.3%)	0(0%)	0.524
5. Essentials for calculation of medication dosages are	a) Compute	6(40%)	4(26.7%)	3(20%)	0.601
	b) Covert	2(13.3%)	1(6.7%)	1(6.7%)	0.594
	c) Conceptualize	2(13.3%)	2(13.3%)	1(6.7%)	1.000
	d) Critically evaluate	3(20%)	2(13.3%)	0(0%)	0.343
	e) All of the above	2(13.3%)	6(40%)	9(60%)	0.038*
	f) None of the above	0(0%)	0(0%)	0(0%)	1.0000
	g) Don't know	0(0%)	0(0%)	1(6.7%)	1.000
6. Ten fold errors are caused by	a) Eliminate leading zeroes	3(20%)	4(26.7%)	6(40%)	0.601
	b) Using trailing zeroes	3(20%)	5(33.3%)	4(26.7%)	0.912
	c) Both the above	1(6.7%)	3(20%)	5(33.3%)	0.245
	d) None of the above	3(20%)	2(13.3%)	0(0%)	0.343
	e) Don't know	5(33.3%)	1(6.7%)	0(0%)	0.035+
7. Mg/kg/d--- here 'd' means	a) Day	2(13.3%)	3(20%)	8(53.4%)	0.070+
	b) Divided dose	7(46.7%)	3(20%)	7(46.7%)	0.255
	c) Don't know	1(6.7%)	1(6.7%)	5(33.3%)	0.179
	d) Both the above	5(33.3%)	8(53.4%)	0(0%)	0.003**

8. Do you cross check your prescription	a)Yes	15(100%)	13(86.7%)	14(93.3%)	0.762
	b) No	0(0%)	2(13.3%)	1(6.7%)	
9. Do you give specific dosing instructions to the patients/ parent/guardian?	a) Yes	15(100%)	15(100%)	15(100%)	1.000
	b) no	0(0%)	0(0%)	0(0%)	
10. Do you insist your patients on using appropriate measuring device for dispensing liquid medicaments?	a) Yes	15(100%)	13(86.7%)	15(100%)	0.318
	b) no	0(0%)	2(13.3%)	0(0%)	

Table 2: Comparison of Knowledge of dentists about drug dosing errors in children (Correct answers presented as Number and percentage)

Questions	**General dentists (n=15)**	**Other Dental specialists (n=15)**	**Pediatric dentists (n=15)**	**P value**
1.Child is a miniature of adult- This does not hold good for drug dosing	7(46.7%)	11(73.3%)	15(100.0%)	0.004**
2.Do you refer pediatric drug handbook and get updated on it	12(80%)	9(60%)	14(93.3%)	0.113
3.Most common method of dosage calculation used by you	4(26.7%)	5(33.3%)	10(66.7%)	0.073+
4.Mathematical calculations used for dosing are	0(0%)	0(0%)	7(46.7%)	<0.001**
5.Essentials for calculation of medication dosages are	2(13.3%)	6(40%)	9(60%)	0.038*
6.Ten fold errors are caused by	1(6.7%)	3(20%)	5(33.3%)	0.245
7.Mg/kg/d--- here ‘d’ means	2(13.3%)	3(20.0%)	8(53.3%)	0.070+
8.Do you cross check your prescription	15(100%)	13(86.7%)	14(93.3%)	0.762
9. Do you give specific dosing instructions to the patients/	15(100%)	15(100%)	15(100%)	1.000

parent/guardian?				
10. Do you insist your patients on using appropriate measuring device for dispensing liquid medicaments?	15(100%)	13(86.7%)	15(100%)	0.318

2x3 Fisher Exact test

+ Suggestive significance (P value: 0.05<P<0.10)

* Significant (P value:0.01<P ≤ 0.05)----------? It has to be deleted

** Strongly significant (P value : P≤0.01)