SJP Sarawak Journal of Pharmacy

Nurses' Knowledge on Paracetamol Dose Administration in Paediatrics: A Preliminary Single-centred Study

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ABSTRACT

Introduction: Paracetamol (acetaminophen) is commonly used in the management of pain and fever in children. However, the administration of paracetamol above the recommended dose may result in paracetamol poisoning. In this study, we aimed to explore the knowledge of nurses working in paediatric wards on the therapeutic dose of paracetamol, correct dose calculation and administration.

Methods: We conducted this cross-sectional study from December 2022 to January 2023 among nurses working in the paediatric wards at Miri Hospital. The self-administered questionnaire consisted of eight questions, which gathered information on the respondents' knowledge on the therapeutic dose of paracetamol, correct dose calculation and administration. Results were then summarised using descriptive statistics.

Result: A total of 66 respondents participated in the study. The mean age of respondents was 35.48 ± 4.84 years old. All the respondents understood that paracetamol dosage is weight-based.

The majority of the respondents knew the maximum daily dose of paracetamol but were unable to provide correct responses to the questions on the minimum dosing interval and paracetamol dosing for overweight and obese children, and were unable to identify the implications of paracetamol toxicity.

Conclusion: Our study showed that there are gaps in knowledge among nurses in paediatric wards. Refreshment courses and a quick dosing guide may be beneficial to improve their knowledge on paracetamol dose administration in paediatrics.

Keywords: Paracetamol, acetaminophen, toxicity, dose, children

INTRODUCTION

Paracetamol (acetaminophen) is one of the most common drugs causing toxicity in paediatrics (1). Though many patients with paracetamol poisoning only experience mild adverse effects, about 48% of unintentional paracetamol overdose cases in the United States reported the occurrence of liver failure (2). Paracetamol has been found to be the major cause of acute liver failure in paediatrics, contributing to 14% of all cases (3). The mortality was reported at around 18% of the paediatric overdose cases with severe encephalopathy (4). Therefore, the knowledge of paracetamol dose administration in paediatrics is vital among healthcare providers to minimise the incidences of medication error and to reduce the risk of accidental paracetamol poisoning.

Paracetamol is widely used as an antipyretic or analgesic for the management of fever and pain in children (5). The recommended dose of paracetamol in paediatrics is 10-15mg/kg/dose every 4 to 6 hours with a maximum total daily dose of 60mg/kg/day, but may go up to 90mg/kg/day if needed, as some suggested (6-10). Paracetamol dosed at 10mg/kg has been reported to be unable to achieve a therapeutic level of plasma concentration (11). Hence, the currently available evidence suggests that 15mg/kg would be the optimal dose (5). The use of paracetamol in children is generally safe when administered within therapeutic dosages (9). However, it could cause paracetamol poisoning if the dose was beyond the recommended therapeutic range (12).

A previous study compared the knowledge of paracetamol dose between doctors and nurses and reported a less satisfactory level of knowledge among nurses (13). Moreover, paracetamol is an over-the-counter product and is commonly kept as in-ward stock. Healthcare professionals, particularly nurses who work closely in caring for hospitalised children should be equipped with appropriate knowledge to meet their nursing care needs. Besides, they could also play a crucial role in preventing any medication errors overlooked by the prescribers and pharmacists for timely intervention.

Therefore, we aimed to explore the knowledge of nurses working in paediatric wards at Miri Hospital on the therapeutic dose of paracetamol, correct dose calculation and administration.

METHODS

Study Design and Participants

This was a cross-sectional study conducted among nurses working in the paediatric wards of Miri Hospital from December 2022 to January 2023 using a convenience sampling method. All nurses who were working in the paediatric wards, proficient in reading and understanding the Malay language, and aged 18 years old and above were eligible to participate. All respondents were required to provide written consent before their participation. We excluded those who were on leave during the study period.

Study Instrument and Data Collection

We distributed the validated, self-administered questionnaire developed by Lee and her colleagues to all eligible respondents (14). The questionnaire consisted of 8 items to evaluate the knowledge on the therapeutic dose of paracetamol, correct dose calculation and administration to the paediatric population. Question 6 required the respondents to state the volume of paracetamol syrup they would administer in four scenarios. Rounding of doses to the nearest measurable volume was allowed. The questions were formulated in the Malay language to ease the comprehension of the respondents. The questionnaires took approximately 15 minutes to complete and the participation was voluntary. Upon completion, we expected the respondents to return the questionnaires to the researchers. All identifying particulars of the respondents remained anonymous and all data were confidential.

Data Analysis

We performed data cleaning and descriptive statistics using Statistical Package for Social Sciences (SPSS, version 25). Numerical variables were summarised as mean and standard deviation, whereas categorical variables as frequency and percentage. Ideal body weight (IBW) was calculated according to the formula below (8):

$$\text{Age} < 9 \text{ years old: IBW (kg)} = (2 \times \text{age}) + 9$$
$$\text{Age} \geq 9 \text{ years old: IBW (kg)} = 3 \times \text{age}$$

Ethical Approval

This study was conducted in compliance with the ethical principles outlined in the Declaration of Helsinki and the Malaysian Good Clinical Practice Guideline. This study was registered in

the National Medical Research Registry (NMRR ID-22-00042-I9F (IIR)) and approved by the Medical Research and Ethics Committee, Ministry of Health Malaysia.

RESULTS

Demographic Characteristics

We distributed a total of 70 questionnaires to the eligible respondents. Sixty-six respondents completed and returned the questionnaires, with a response rate of 94.3%. The mean age of the respondents was 35.48 ± 4.84 years old. Most of the respondents were of Sarawak native ethnic groups and had diploma qualification but had not attended post-basic certification in Paediatrics nursing (Table 1).

Table 1: Demographic characteristics of respondents (n=66)

Characteristics	Mean ± SD (Range)	n (%)
Age (years)	35.48 ± 4.84 (27.00-50.00)	
Ethnicity		
Malay		15 (22.7)
Chinese		5 (7.6)
Indian		1 (1.5)
Iban		23 (34.8)
Kayan		5 (7.6)
Bidayuh		4 (6.1)
Kenyah		4 (6.1)
Kedayan		1 (1.5)
Melanau		5 (7.6)
Sino Dusun		1 (1.5)
Lun Bawang		1 (1.5)
Bisaya		1 (1.5)
Educational level		
Certificate		1 (1.5)
Diploma		64 (97)
Bachelor degree		1 (1.5)

Table 1: *continued*

Characteristics	Mean ± SD (Range)	n (%)
Duration of service in paediatric department (years)	8.50 ± 4.88 (0.50-20.00)	
Post-basic certification in paediatrics nursing		
Yes		24 (36.4)
No		42 (63.6)

In this study, we found that all nurses knew that paracetamol dosing is weight-based. The majority reported that the maximum dose of syrup paracetamol is 15mg/kg QID (n=66, 90.9%). However, only 9.1% of the respondents (n=6) responded that the minimum interval of serving paracetamol is 4 hours. In addition, more variabilities were observed for the syrup paracetamol volume in obese child scenarios. Less than half of the respondents (n=28, 42.4%) adjusted the dose based on IBW.

Table 2: Knowledge of dose administration of paracetamol (n=66)

No	Questions	n (%)
1.	The dose of paracetamol should always be calculated based on:	
	A. Body surface area	0 (0.0)
	B. Body temperature	0 (0.0)
	C. Body weight	**66 (100.0)**
	D. Body height	0 (0.0)
2.	What is the maximum dose of syrup paracetamol in children less than 12 years old?	
	A. 10ml/kg QID	0 (0.0)
	B. 15ml/kg QID	6 (9.1)
	C. 10mg/kg QID	0 (0.0)
	D. 15mg/kg QID	**60 (90.9)**
3.	What is the minimum dosing interval of syrup paracetamol that can be administered?	
	A. 4 hours	**6 (9.1)**
	B. 6 hours	57 (86.4)
	C. 8 hours	0 (0.0)
	D. 12 hours	3 (4.5)

Table 2: *continued*

No	Questions	n (%)
4.	What is the maximum frequency of syrup paracetamol that can be administered?	
	A. 3 times a day	0 (0.0)
	B. 4 times a day	**62 (93.9)**
	C. 6 times a day	3 (4.5)
	D. 8 times a day	1 (1.5)
5.	What is the maximum dose per day for syrup paracetamol?	
	A. 30mg/kg	3 (4.5)
	B. 45mg/kg	0 (0.0)
	C. 60mg/kg	**63 (95.5)**
	D. 90mg/kg	0 (0.0)
6 (a)	How much dose would you give if a doctor prescribed syrup paracetamol 120mg/5ml for the following patient: Amir, 4 years old, body weight 16kg, syrup paracetamol 240mg	
	Correct responses	**66 (100.0)** **Range: 10-10.625mL**
	Incorrect responses	0 (0.0)
6 (b)	Wendy, 11 years old, body weight 23kg, syrup paracetamol 345mg	
	Correct responses	**60 (90.9)** **Range: 14.3-14.4mL**
	Incorrect responses	6 (9.1) Range: 19.37-26.25mL
6 (c)	Ali, 6 years old, body weight 31kg (IBW: 21kg), syrup paracetamol 465mg	
	Correct responses	**28 (42.4)** **Range: 13-13.12mL**
	Incorrect responses	38 (57.6) Range: 15-19.4mL
6 (d)	Kristy, 2 years old, body weight 15kg, syrup paracetamol 225mg	
	Correct responses	**65 (98.5)** **Range: 8.0-9.5mL**
	Incorrect responses	1 (1.5) Value: 3.5mL

Table 2: *continued*

No	Questions	n (%)
7.	What is the maximum dose per day of paracetamol if syrup paracetamol and suppository paracetamol are prescribed together?	
	A. 30mg/kg	3 (4.5)
	B. 60mg/kg	**35 (53.0)**
	C. 90mg/kg	27 (40.9)
	D. 120mg/kg	1 (1.5)
8.	What are the toxicity effects of paracetamol if overdosed?	
	I. Increase in ALT level	
	II. Decrease in bilirubin level	
	III. Kidney impairment	
	IV. Hypoglycemia	
	V. Death	
	A. I, II, III and V	45 (68.2)
	B. I, II, IV and V	4 (6.1)
	C. II, III, IV and V	1 (1.5)
	D. I, III, IV and V	**16 (24.2)**

Note: The correct responses are indicated in bold.

DISCUSSION

The current study highlights that all nurses understood that paracetamol dosage is based on body weight. Appropriate paracetamol dosage is crucial to ensure maximum efficacy and minimise adverse effects. In this study, the majority of the respondents acknowledged 15mg/kg QID as the maximum dose of paracetamol syrup in children less than 12 years old (n=60, 90.9%) whereas the remaining respondents selected 15ml/kg QID (n=6, 9.1%). The respondents could have possibly overlooked the unit.

World Health Organization recommended 15mg/kg, with a maximum of 1g per dose, every 4 to 6 hours as necessary, up to 4 doses or 4g in 24 hours as analgesic for infants or children (15). Wimalasiri and peers reported in their study that 98% of the nurses responded wrongly to the maximum daily dose (16). However, in the present study, the majority of the respondents recognised the correct maximum frequency of syrup paracetamol (n=62, 93.9%) and maximum

daily dose (n=63, 95.5%), but the knowledge on the minimum dosing interval of paracetamol is unsatisfactory with only 9.1% of the respondents responding correctly. The knowledge gap in the dosing interval may lead to the administration of potentially supratherapeutic paracetamol dose in the event of persistent fever or pain, thus it is of utmost importance that nurses practice administering doses with a minimum interval of 4 hours in between.

Nevertheless, when syrup and suppositories are concurrently prescribed, 40.9% of nurses understood 90mg/kg as the maximum daily dose. The finding deviates from our local guideline which suggests a maximum daily dose of 60 mg/kg/day in infants less than 3 months and 75 mg/kg/day in children of 3 months and older, regardless of orally and/or rectally (10). Other recent guidelines also recommend using 60 mg/kg/day collectively for all patients, especially for neonates of 32 weeks corrected gestational age and above (17-20). Nonetheless, some literature endorse a higher dose of up to 90mg/kg for 48 hours, if needed (8, 21). However, it is worth noting that higher doses of paracetamol should not be of regular use (22). This is because the literature demonstrated that most of the patients in hepatotoxicity cases received supratherapeutic doses of paracetamol (>90mg/kg/day) (23).

Our study also revealed that there was substantial perplexity among the nurses regarding the appropriate dose of paracetamol in obese and overweight children. Less than half of the respondents reported that doses should be corrected with the child's IBW (n=28, 42.4%). Australian guideline suggests dosing based on lean body weight in obese children with more than 120.0% of their IBW (24). The recommendation is put forth despite little support from published pharmacokinetic studies of paracetamol in overweight or obese children (25). Wiese et al highlighted that two out of three obese children were administered doses over 20 mg/kg of IBW, hence further highlighting the increased risk of overdosing when there is a lack of knowledge on the ideal dose calculation for this population (25). There are also guidelines proposing dose adjustments based on adjusted body weight and lean body weight (10, 24). However, to the best of the authors' knowledge, there is no direct comparison which could indicate the most appropriate adjustment. Future research may focus on determining the most appropriate adjustment and evaluating the effect of various paracetamol dosing practices in overweight and obese children.

Paracetamol overdose is particularly dangerous as it may lead to several toxic effects such as an increase in alanine transaminase level, hypoglycaemia, kidney impairment and death.

However, only 24.2% of the nurses responded correctly and most of them thought that the bilirubin will decrease in paracetamol overdose. Knowledge in this matter is crucial as nurses closely care for the patients and could be the first person to detect any symptoms of toxicity such as abdominal pain and jaundice. Delay in treatment may lead to accumulation of high yield toxic metabolite in the liver and result in liver failure and death (26).

This study indicates that there are gaps in the knowledge of nurses working in the paediatrics wards at Miri Hospital. In the past study, constructive and practical interventions such as pocket cards and training sessions were among the approaches to improve level of knowledge (27). This study has identified the areas at which there are lack in knowledge among the nurses. Therefore, educational programmes that address these areas can be designed accordingly. Subsequently, organising educational programmes and training for nurses could be useful in enhancing their knowledge on paracetamol dose administration. Regular training sessions covering the latest dosing administration guidelines and paracetamol toxicity are also recommended.

In addition, a quick dosing guide can be made easily accessible to nurses with clear instructions provided on the appropriate dosing, frequency and maximum daily dose. Furthermore, the nursing education syllabus should incorporate fundamental exposure to common medications such as paracetamol. This is vital, especially for the nurses working in health clinics that operate without a pharmacist. Therefore, it is crucial to ensure that nurses are equipped with sufficient knowledge of the essential medication.

LIMITATIONS

There were several limitations in this study. Firstly, this was a single-centred study and our local dosing practices may not reflect the practices in other hospitals, or the recommendation by other healthcare providers. Furthermore, we allowed the respondents to self-administer the knowledge questions, thus the correct responses may be overestimated if the respondents were not truthful.

CONCLUSION

This work revealed opportunities for knowledge improvement among nurses in some aspects of the paracetamol dosage, especially among overweight and obese children. The study highlights the need to conduct refreshment courses for nurses on the paracetamol dosage and

the implication of paracetamol overdose or provide a quick paracetamol dosing guide to nurses. Future research should focus on evaluating the intervention to improve their knowledge.

ACKNOWLEDGEMENT

The authors would like to thank the Director-General of Health Malaysia for his permission to publish this article, as well as to express our gratitude to all nurses who have participated in this study.

CONFLICT OF INTERESTS

None.

FUNDING

None.

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