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Pharmacists' Active Interventions in a Children's Hospital: An Australian Context

(Intervensi Aktif Farmasis di Rumah Sakit Anak di Australia)

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Abstract: Pharmacists' interventions were documented to compare pharmacists' active interventions in different settings within a children's hospital and identify the predictors for physician acceptance of the interventions. The investigator observed pharmacists' interventions between 35-37 days on five study wards. The rates and types of pharmacists' interventions on the different wards were compared. Multivariate logistic regression analysis was performed to identify the acceptance predictors of the interventions. The Hematology-Oncology Ward had a higher rate of active interventions (2.43 interventions per 100 medication orders) compared to general settings. Dose adjustment was the most frequent interventions in the general settings, whilst drug addition constituted the most common interventions on the Hematology-Oncology. The acceptance degree of intervention by physicians was high. There were three variables predicting the acceptance: patients' age (OR = 0.893; 95%CI 0.813, 0.981), non high-risk medication (OR = 2.801; 95% CI 1.094, 7.169) and pharmacists' experience (OR = 1.114; 95%CI 1.033, 1.200). The rate of active interventions on Hematology-Oncology Ward was higher than the general wards.The pattern of the interventions on Hematology-Oncology Ward was different compared to that of other wards. The interventions involving younger patients, non high-risk medications, recommended by more experienced pharmacists increased likelihood of acceptance by physicians.

Keywords: Pharmacists' interventions, paediatric.

Abstrak: Intervensi farmasis didokumentasikan untuk membandingkan intervensi aktif farmasis di bangsal berbeda di rumah sakit anak, dan untuk membandingkan faktor yang mempengaruhi penerimaan intervensi farmasis oleh dokter. Peneliti melakukan observasi intervensi farmasis selama 35-37 hari di lima bangsal dan membandingkan prevalensi dan jenis intervensi aktif farmasis di bangsal tersebut. Analisis regresi logistik multivariat dilakukan untuk mengidentifikasi faktor penerimaan intervensi. Bangsal Hematologi-Onkologi menunjukkan prevalensi intervensi aktif yang lebih tinggi (2.43 intervensi per 100 obat yang diresepkan) dibandingkan bangsal umum (bedah dan non-bedah). Penyesuaian dosis adalah intervensi yang paling sering dijumpai di bangsal umum, sedangkan penambahan obat untuk indikasi tidak terobati yang terbanyak dijumpai di bangsal Hematologi-Onkologi. Derajat penerimaan intervensi oleh dokter tinggi di semua bangsal. Ada tiga variabel yang mempengaruhi penerimaan intervensi: usia pasien (OR = 0.893; 95% CI 0.813, 0.981),obat kategori bukan resiko tinggi (OR = 2.801; 95% CI 1.094, 7.169) dan lama kerja farmasis (OR = 1.114; 95%CI 1.033, 1.200). Prevalensi intervensi aktif di bangsal Hemtaologi-Onkologi lebih tinggi dibandingkan bangsal umum. Pola intervensi di bangsal Hematologi-Onkologi berbeda dibandingkan bangsal umum. Intervensi yang melibatkan pasien usia lebih muda, obat dengan kategori bukan resiko tinggi dan direkomendasikan oleh farmasis yang lebih berpengalaman berasosiasi dengan tingginya penerimaan intervensi oleh dokter.

Kata kunci: Intervensi farmasis, pediatrik.

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INTRODUCTION

HEALTHCARE delivery involves a sequence of steps, which starts with diagnosing a patient's condition through to monitoring treatment. To minimise the occurrence of medication misadventure during treatment, these steps need to be conducted in an effective, safe and timely manner. It is common for patients admitted to hospital to receive multiple medications; each medication administered carries the risk of misadventure or error[1]. To date, most investigations of adverse events related to medication use have been undertaken in adults. Despite the evidence that such events may be more common in children, there is a dearth of data on error-related events in this population[2]. The epidemiological characteristics of medication errors (MEs) may be different between children and adults[3]. Children have a unique physiology and an immature ability to metabolise drugs[4,5]. The consequences of MEs have significant ramifications in children with complicated medical conditions such as cancer[6-8]. Children with cancer receive diagnosis-specific antineoplastic drugs with narrow therapeutic indexes that require complex administration regimens[4,5].

Besides inadequate and inconclusive information on medication misadventure in the paediatric population, there has been concern about the lack of strategies to minimise errors and maximise care in the ambulatory and inpatient settings[9]. Multiple studies have analysed error-prevention strategies utilising clinical pharmacists[10-12]. Several reports have shown that ward-based clinical pharmacists reduce MEs[12-14].The largest studies of clinical pharmacists' interventions in acute care in Australia have demonstrated that interventions initiated and undertaken by clinical pharmacists have a significant positive impact on patient outcomes and hospital costs[15,16]. However, the impact of clinical pharmacists in minimising medication misadventures in paediatric oncology has yet to be justified. This study aimed to document and compare the nature of clinical pharmacists' active interventions among inpatients admitted to different practice settings in a children's hospital, and to identify the predictors for physician acceptance of the interventions.

MATERIAL AND METHODS

Study setting. Data were collected using prospective non-disguised observation from September 2011 to August 2012 in three clinical units (general medicine, general surgery and haematology-oncology) in a major children's hospital in Western Australia. There were three wards in the General Medical Unit - General Medical Ward for Infants, General Medical Ward for Young Children and General Medical Ward for Adolescents – one General Surgical Ward and one Haematology-Oncology Ward; a total of five study wards. The general medical wards admitted patients under general paediatrics and a range of non-oncology medical specialties, while the general surgical ward admitted patients under general surgery, opthalmology and otolaryngology.

Ward-based clinical pharmacy services were provided Monday to Friday 0830 to 1700 and from 0900 to 1600 during weekends/public holidays (for intravenous admixture services and urgent drug supplies only). Outside these hours an on-call pharmacist was available for urgent drug inquiries. Ward pharmacists undertook the pharmacy round/full ward visit once a day during weekdays, either in the morning or afternoon. After that, pharmacist could be contacted via pager. During pharmacy rounds, they reviewed patients' medication orders prescribed on the inpatient medication charts and reconciled the medications by comparing the recent medication orders with previous orders in patients' medical records and double-checking with patients and/or parents and carers. Pharmacists also took patient medication histories, including allergy and ADR histories. If there were any discrepancies, pharmacists contacted the doctor to resolve the problem. In addition, ward pharmacists provided drug information to medical and nursing staff and education and counselling to patients and/or their parents. They also monitored the medications stocked on the ward ('imprest'). If there were 'non-imprest' medication orders requiring intravenous admixture, e.g. intravenous antibiotics, the ward pharmacists supplied these medications to the ward.

Documentation of Ward-Based Pharmacists' Active Interventions. Pharmacists working on the study wards were invited to participate in the study. The principal researcher described the direct observation method and the ethics requirements of the study. The rationale for the direct observation approach was to ensure that the data collected was comprehensive and not subjected to reporting bias. Although direct observation has the potential to interfere in the activities of those being observed due to the presence of an observer (Hawthorne effect) the evidence suggests that the observation method has little effect on the behaviour of those being observed[17]. The principal researcher (observer) shadowed pharmacists during their ward rounds and documented their interventions on the five study wards for a total of 35 to 37 non-consecutive days.

The observer followed one ward pharmacist for each weekday and collected the pharmacist's interventions for that ward. On the following day, the observer went to another ward and documented another pharmacist's interventions. This protocol was used to minimise fatigue in the pharmacist under observation.

During observation, the data collected included the patient's demographics, date of admission, diagnosis on admission, medical history, medication history, adverse drug reaction history, current medications, discharged date, the description and the type of intervention, the medication(s) involved, the intervened health care personnel, the degree of acceptance of the intervention and the amount of time required to do pharmacy rounds.The diagnosis on admission was classified using the I*nternational Statistical Classification of Diseases and Related Health Problems*[18] for the general medical and general surgical wards, and the *International Classification of Childhood Cancer*[19] with slight modifications for the haematology-oncology patients. The medications involved in the interventions were categorised using the Australian Medicines Handbook (AMH)[20].The medications were also categorised based on their dose form and risk category[21]. The description of interventions were categorised as described by Condren et al[22]. For the purpose of this study, the term of pharmacist's intervention refers to any activity by a clinical pharmacist related to patient management or therapy and active interventions are those activities leading to a change in drug therapy these can be classified as active and passive[23].

Redictors of Physicians' Acceptance of The Active Interventions. 'Acceptance' of each intervention, as a binary variable (yes/no), was used as the dependent variable in a logistic regression model. Selection of independent variables/predictors, either continuous or categorical, was guided by published research and the direct observation data. The independent variables were grouped into: 1) Patient characteristics: age, gender, diagnosis on admission, clinical area during hospital stay, length of stay, number of medications prescribed. 2) Drug characteristics: therapeutic class[20], dose form, high-risk category[21]. 3) Types of active interventions. 4) Pharmacists' characteristics: gender, years of experience, highest academic qualification, work pattern (full-time/part-time), work post (permanent/ temporary).

Ethics. The study protocol was approved by the Princess Margaret Hospital Institutional Review Board No: 2923 and the Curtin University Human Ethics Committee No: PH-14-11. Pharmacists working on the study wards received the Participant Information Sheet prior to consenting to participate. The method used was one that minimised observer effects. Coding of data from patients' medical records maintained patient confidentiality.

Data Management and Analysis. Data collected during direct observation were transcribed onto Excel spread sheets. The data were checked several times to ensure there were no missing variables. Demographic variables and pharmacists' intervention-related data were summarised using descriptive statistics (mean ± standard deviation or median [range] for variables measured on a continuous scale, and frequencies and percentages for categorical variables). Several pharmacists' intervention-related parameters were compared using the Kruskal-Wallis test. The rates of pharmacists' active interventions were reported as the number of active interventions per 100 medication orders reviewed and treated as continuous variables to enable comparison to the published literature. The rates of active interventions on the five wards were compared using Poisson regression analysis. Poisson regression analysis was also used to determine the influence of pharmacists' level of employment and the duration of pharmacy ward round on the rates of active interventions. The univariate and multivariate logistic regression for predictors of physician-acceptance of pharmacists' active interventions were based on a backward likelihood ratio method. The odds ratios, the significance levels and 95% confidence intervals (95% CI) were calculated for each independent variable. Significant independent variables ($p<0.05$) in the final model were considered to be the predictors of the outcome (physician-acceptance of pharmacists' active intervention). All data were analysed using SPSS version 22.0.

RESULTS AND DISCUSSION

Rates of Ward-Based Pharmacist's Active Intervention. During the observation period, 2891 patients were reviewed clinical pharmacists in the three practice settings. The basic demographic data of these patients are detailed in Table 1. During the study, eleven clinical pharmacists on the five study wards reviewed 2891 patients. Six pharmacists were categorised as Professional Level 1 (PL1), two as Professional Level 2 (PL2) and three as Professional Level 3 (PL3) (Table 2). Nearly half of the pharmacists had postgraduate qualifications, and three-quarters worked full-time. A total of 244 active interventions were observed and documented by the principal researcher, which arose from the 16,700 medication orders reviewed.

Rates of pharmacists' active interventions

Table 1. Demographic data of patients in three clinical settings.

Parameters	General medicine	General surgery	Hematology-oncology
Duration of study (days)	105	37	35
No. of patients	1936	514	441
Gender (%)			
Male	939 (48.5)	311 (60.5)	279 (63.3)
Age* (years)	8.04 (0.02-19.00)	6.17 (0.06-17.00)	6.83 (0.35-17.00)
Length of stay* (days)	9.00 (1-95)	5.00 (1-71)	7.00 (1-82)
Types of medications*			
Oral	3.00 (0-22)	3.00 (0-10)	4.00 (0-21)
Non-oral	1.00 (0-30)	2.00 (0-13)	3.00 (0-14)

*Median (range)

Table 2. Characteristics of pharmacists (n=11) by level of employment*.

Pharmacist level	Number	No. with postgraduate qualification	No. working full-time	No. assigned in permanent post
Level 1	6	2	5	1
Level 2	2	0	1	1
Level 3	3	3	2	2

*Employment of clinical pharmacists in Australia starts with the pre-registration training year, followed by Professional Level 1 (must work under supervision), Professional Level 2 (often rotate among sections of the pharmacy), and Professional Level 3 (responsible to the Director of Pharmacy for the management and efficient performance of a specific unit or function of the hospital pharmacy)[25].

per 100 medication orders are summarised in Table 3.The Haematology-Oncology Ward had the highest rate of active interventions, followed by the General Surgical Ward and the General Medical Ward for Adolescents. The general medical wards for Young Children and Infants had the lowest active intervention rates. The pair-wise differences of active intervention rates were not significantly different between the three general medical wards. The rate of active interventions on the Haematology-Oncology Ward was significantly different to those in general medical settings ($p<0.001$) but not the general surgical ward.

Rates of active interventions were not significantly associated with pharmacists' employment level ($p<0.4$). PL1 pharmacists had the highest rate of active interventions (1.69 active interventions/100 medication orders, SD 1.99), followed by PL3 (1.43, SD 1.59) and PL2 (1.24, SD 1.38) pharmacists, respectively. Pharmacists on average spent 49 minutes (SD 22.01) on ward rounds each day. The rates of active interventions were not significantly associated with the time spent on the ward ($p<0.2$).

Types of Pharmacists' Active Interventions. Table 4 shows the distribution of 244 active interventions by type. For all active interventions, acceptance by physicians was common, at around 90% (n=223/244), and ranged from 78.4% on the General Medical Ward for Adolescents to 97.8% on the Haematology-Oncology Ward ($p<0.05$). Dose adjustment was the most frequent active intervention on the general medical and surgical wards. In the general medical wards, adjusting the dose accounted for more than half of all active interventions in the infant population. The majority of dose adjustments related to pharmacists' interventions to increase suboptimal doses of the correct medication. Other common sources of interventions were wrong/missing dosing interval, therapeutic duplication requiring

Table 3. Pharmacists' active interventions per 100 medication orders reviewed on the five study wards.

Parameters	Infants (Ward A)	Young children (Ward B)	Adolescents (Ward C)	Surgical (Ward D)	Haematology-Oncology (Ward E)
Mean±SD	0.85±1.35	0.81±1.24	1.15±1.19	2.34±2.23	2.43±1.84
95% Confidence interval for mean	0.39 – 1.31	0.38 – 1.23	0.74 – 1.55	1.60 – 3.09	1.79 – 3.06
Overall p-value			p<0.001		

A = General medical ward for infants, B = General medical ward for young children, C = General medical ward for adolescents, D = General surgical ward, E = Haematology-oncology ward.

Table 4. Types of pharmacists' active interventions on the five study wards.

Types of active interventions	No. of active interventions (%)				
	Ward A (n=16)	Ward B (n=28)	Ward C (n=51)	Ward D (n=59)	Ward E (n=90)
Wrong/missing dose	9 (56.3)	12 (42.9)	15 (29.4)	21 (35.6)	24 (26.7)
Wrong/missing dosage interval/frequency	2 (12.5)	7 (25.0)	9 (17.6)	7 (11.9)	6 (6.7)
Drug added	1 (6.3)	1 (3.6)	8 (15.7)	8 (13.6)	36 (40.0)
Drug deleted	1 (6.3)	4 (14.3)	10 (19.6)	6 (10.2)	5 (5.6)
Antibiotic change	0 (0.0)	0 (0.0)	2 (3.9)	2 (3.4)	0 (0.0)
Wrong/missing duration of therapy	0 (0.0)	1 (3.6)	0 (0.0)	0 (0.0)	6 (6.7)
Wrong/missing dose form or strength	2 (12.5)	2 (7.1)	2 (3.9)	4 (6.8)	1 (1.1)
Wrong/missing route	0 (0.0)	0 (0.0)	2 (3.9)	0 (0.0)	0 (0.0)
Wrong drug	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.1)
Scheduling error	0 (0.0)	0 (0.0)	1 (1.9)	0 (0.0)	3 (3.3)
Non formulary to formulary change	0 (0.0)	0 (0.0)	0 (0.0)	3 (5.1)	0 (0.0)
Regular to if required or vice versa	0 (0.0)	0 (0.0)	1 (1.9)	6 (10.2)	3 (3.3)
Intravenous to per-oral change	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.1)
Wrong patient	1 (6.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Illegible order	0 (0.0)	1 (3.6)	0 (0.0)	1 (1.7)	0 (0.0)
Medication administration record error	0 (0.0)	0 (0.0)	1 (1.9)	0 (0.0)	4 (4.4)
Drug interaction	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.7)	0 (0.0)

A = General medical ward for infants, B = General medical ward for young children, C = General medical ward for adolescents, D = General surgical ward, E = Haematology-oncology ward.

deletion, wrong/missing dose form/strength, and untreated indication requiring regular medication. A different trend was found on the Haematology-Oncology Ward, where interventions to prescribe medications regularly constituted the most common active interventions (40.0%), followed by dose adjustment (26.7%); approximately two-thirds of all the active interventions in this unit. Other common active interventions on the Haematology-Oncology Ward were related to improper dosage frequency/interval, drug deletion, and adjustment of treatment duration.

Drug classes implicated in active interventions. Table 5 presents the drug classes implicated in active interventions on the five study wards. Anti-infectives were most often associated with active interventions (n= 100), followed by analgesics (n= 46), gastrointestinal drugs (n= 36), and immunomodulators/antineoplastics (n= 21). The top four drug classes accounted for the major classes of medications prescribed across all study wards. More than one-third of the anti-infectives related interventions took place on the Haematology-Oncology Ward, while 30% of the cases were from the General Surgical Ward. The percentages of active interventions associated with anti-infectives were similar in the general medical wards for Young Children and Adolescents, with the lowest percentage in the youngest patient cohort on the General Medical Ward for Infants. Antibacterials were the predominant anti-infectives involved in the interventions (92% of anti-infectives related active interventions), with the remainder involving antifungals. Antibacterials associated with anti-infective related interventions were trimethoprim-sulfamethoxazole (n=20), vancomycin (n=17), aminoglycosides (n=15), penicillins (n=13) and metronidazole (8). Dose adjustment (n=48) accounted for the most common interventions in relation to the use of anti-infectives, followed by drug addition (n=15) and dose interval/frequency adjustment (n=15). Active interventions related to non-opioid analgesics were observed in general medical and surgical settings, while interventions related to opioid analgesics were predominant in the haematology-oncology setting. Almost 60% of analgesics-related interventions (n=27) occurred on general medical wards, predominantly involving adolescent patients, and more than one-quarter of the interventions were documented on the

Table 5. Drug classes associated with active pharmacists' interventions on the five study wards (n=244).

Drug classes	No. of active interventions (% medication orders*)				
	Ward A	Ward B	Ward C	Ward D	Ward E
Anti-infectives	3(24.2)	16 (38.5)	13 (20.8)	30 (41.4)	38 (41.1)
Analgesics	5 (16.7)	4 (9.2)	18 (29.2)	12 (27.7)	7 (5.9)
Gastrointestinal	3 (22.8)	1 (1.8)	4 (6.5)	9 (10.3)	19 (15.7)
Immunomodulators/ antineoplastics	0 (0.0)	0 (0.1)	2 (1.4)	1 (0.1)	18 (23.2)
Neurological	1 (4.6)	0 (6.4)	4 (5.4)	1 (4.6)	2 (2.2)
Respiratory	0 (4.5)	4 (11.9)	0 (4.2)	2 (4.0)	0 (0.4)
Endocrine	1 (4.6)	0 (4.6)	2 (4.8)	0 (0.7)	2 (1.6)
Blood, electrolytes	2 (10.6)	0 (9.2)	2 (6.5)	0 (1.1)	0 (4.9)
Cardiovascular	1 (4.6)	1 (6.4)	0 (0.9)	0 (0.6)	1 (2.8)
Psychotropic	0 (0.0)	0 (0.0)	1 (11.6)	1 (0.1)	1 (1.1)
Anaesthetics	0 (0.0)	1 (0.9)	1 (0.6)	0 (0.0)	0 (0.0)
Ear, nose, and throat	0 (0.0)	0 (3.7)	1 (3.3)	0 (4.1)	1 (0.5)
Ophthalmic	0 (0.0)	0 (2.8)	0 (0.0)	1 (2.2)	1 (0.5)
Obstetric, gynaecological	0 (0.0)	0 (0.0)	2 (2.9)	0 (0.0)	0 (0.0)
Allergy and anaphylaxis	0 (1.5)	1 (1.9)	0 (1.2)	0 (0)	0 (0.0)
Genitourinary	0 (1.5)	0 (0.0)	0 (0.0)	1 (2.8)	0 (0.0)
Vaccines	0 (1.4)	0 (0.9)	1 (0.6)	0 (0.0)	0 (0.0)
Others	0 (0.0)	0 (0.1)	0 (2.4)	1 (0.1)	0 (0.0)

A= General medical ward for infants, B= General medical ward for young children, C= General medical ward for adolescents, D= General surgical ward, E= Haematology-oncology ward, *= Percentage of medication orders for each class during the study period.

surgical ward (n=12). Drug deletion (n=11) was the most common active interventions associated with this class of medication. The next most common analgesics-related interventions were adjustment of dosage interval/frequency (n=10) and dose adjustment (n=9).

The third major drug class involved in active interventions involved the gastrointestinal system. More than half of the gastrointestinal medication related active interventions (n=19) were observed in the haematology-oncology setting. When categorised according to drug subclasses, antiemetics were involved in around 64% of interventions (n=23), while drugs for dyspepsia accounted for 22.2% of the interventions (n=8). Interventions to add medications accounted for the majority of active interventions related to gastrointestinal drugs (n=15), and almost three-quarters were related to suggestions to chart antiemetics for haematology-oncology patients. The second major active intervention category in relation to gastrointestinal drugs was to change the medications from regular to if required or vice versa (n=7). With regard to immunomodulators/antineoplastics, more than 80% of the interventions (n=18) were recorded on the Haematology-Oncology Ward. When categorised by subclasses of medications, immunosuppresants (n=15) accounted for approximately 71% of the interventions, with the remainder involving antineoplastics. Drug addition (n=12) was the most frequent intervention, accounting for more than half of all active interventions related to this drug class.

Predictors of Physicians' Acceptance of Active Interventions. There were 244 pharmacists' active interventions identified during direct observation on the five study wards. According to Miles and Shevlin24 a sample size of 200 with up to 20 predictors can identify a medium effect with a high level of power (i.e. 80%). Based on literature research and the data collected during direct observation, the following 15 independent variables were selected for initial inclusion: patients' age and gender; study ward during hospitalisation; diagnosis on admission; length of stay; number of medications prescribed; therapeutic drug class; dose form; high-risk category of medication; type of active interventions; and pharmacists' gender, experience, academic qualification, work pattern (full-

Table 6. Multivariate logistic regression model with significant independent variables (predictors).

Variables	SE	p-value	OR	95% CI for OR	
				Lower	Upper
Patient age	0.048	0.018	0.893	0.813	0.981
Medication - Non high-risk - High-risk	0.480	0.032	2.801 1 (ref)	1.094	7.169
Pharmacist experience	0.038	0.005	1.114	1.033	1.200
Constant	0.764	0.318	2.145		

SE = standard error, OR = odds ratio, 95% CI for OR = 95% confidence interval for odds ratio. R2 = 0.103 (Cox & Snell), 0.214 (Nagelkerke).

time/part-time) and term of employment (permanent post/temporary). A contingency table of the dependent variable (physician acceptance of pharmacists' active interventions) versus each independent variable was used to ensure that no cell had a zero cell count and that not fewer than 20% of the cells had a frequency count of less than five. Five independent variables did not meet these criteria: study ward, diagnosis on admission, therapeutic drug class, dose form and type of active interventions. For the purposes of this analysis, the variable 'study ward' was collapsed from five categories to three: general medicine, general surgery and haematology-oncology.

Univariate logistic regression was undertaken for each independent variable. All variables met the criteria for inclusion ($p<0.25$) except patients' gender, length of stay, number of medications prescribed, and dose form of medication. These four variables were not retained for the subsequent analysis. All variables selected from the univariate logistic regression were included for testing in multivariate logistic regression Model using the backward likelihood ratio (LR) method. The regression model revealed that three variables significantly predicted the physician-accepted pharmacists' active interventions: patients' age, high-risk medication and pharmacists' experience (Table 6). Removing these variables produced a significant difference in the log likelihood value and would have a significant effect on the predictive ability of the model. A test of the full model with all three predictors against a constant-only model was statistically significant, $\chi 2$ (3, N=244) = 26.6, p=0.002, indicating that the predictors, as a set, significantly distinguished between accepted and non-accepted pharmacists' active interventions by physicians. The classification was impressive, with 99.5% of the accepted and 4.0% of the non-accepted interventions correctly predicted for an overall success rate of 89.8%. This demonstrated that the overall predicted percentage of the physician-acceptance of pharmacists' active intervention was 90.2% accurate. The interaction test was run for these three variables, resulting in three pairs of possible interaction variables (patient age – high risk medication, patient age – pharmacist experience, high risk medication – pharmacist experience). Multivariate logistic regression was conducted to identify significant interaction variables. The regression was performed by testing one interaction variable at a time along with those three significant independent variables from the regression model. There were no significant interactions identified between variables. Therefore, the regression model with three predictors (Table 6) is presented as the final model.

The final model revealed that patients' age significantly predicted the physicians' acceptance of active interventions. The odds ratio for patients' age when holding all other variables constant, for a one-year increment of patients' age, corresponded with a decrease in acceptance of the intervention of 0.893. Inverting the odds ratio revealed that for every one year of decreasing age, the odds of the intervention being accepted was 1.1 times higher. In addition, the medication category (high-risk versus non-high-risk) significantly predicted physician acceptance of active interventions, with the interventions involving non-high-risk medications being nearly three times more likely to be accepted by the physician than those associated with high-risk medications. The results also uncovered that for every extra year of experience of pharmacists, the acceptance by physicians increased (odds ratio 1.114).

CONCLUSIONS

Pharmacists can optimise patient care in a range of paediatric settings through their active interventions either during pharmacy rounds or dispensing. The rate and nature of pharmacists' interventions appear to be influenced by the clinical setting. Specialty units,

such as the haematology-oncology, had a higher active intervention rate where most interventions were related to drug therapy changes compared to the general medical and surgical units. The interventions are of value if acknowledged, accepted and implemented by physicians. This study found that interventions were more likely to be accepted by physicians for younger patients, non-high-risk medications, and those raised by more experienced pharmacists.

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