Focus and Impact of Pharmacists' Interventions

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ABSTRACT

All pharmacists' interventions were collected over a two-week period and were assessed for type and impact on patient care and medication costs. A total of 361 interventions were collected with a physician acceptance rate of 95.8 percent. Eighty-two of the 361 interventions were reviewed by seven physicians with 93 percent of those being judged to have had a positive effect on patient outcome, 7 percent were judged to have had no effect, while none reviewed were judged to be detrimental. Life-saving interventions were judged to have occurred in 8.5 percent of interventions, while 90 percent of the interventions were perceived to have resulted in improved quality of care and/or physician education. Cost analysis was performed comparing the difference of total medication costs (drug, pharmacy, nursing and drug assay costs) for a 24 hour period prior to and after the intervention occurred. The cost-avoidance over the two week period was calculated to be $679, representing a conservative estimate of an annual cost-avoidance of $17,654. Costs not evaluated were those avoided due to increased quality of care, decreased adverse drug effects and decreased length of hospital stay. Pharmacists' interventions which represent only a portion of a pharmacist's responsibilities, improve the quality of patient care and result in cost avoidance.

Key Words: *clinical pharmacy, cost analysis, interventions, pharmacist*

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RÉSUMÉ

On a dressé la liste de toutes les interventions effectuées par les pharmaciens pendant une période de deux semaines, puis on a évalué leur nature et leur impact sur le soin des patients et le coût de la médication. Le nombre total d'interventions se chiffre à 361, avec un taux d'acceptation par les médecins de 95,8 p. 100. Sept médecins ont passé en revue 83 interventions. Selon eux, 93 p. 100 ont été bénéfiques pour les patients, 7 p. 100 n'ont eu aucun effet et aucune n'a eu de conséquences néfastes. Ils estiment en outre que, dans 8,5 p. 100 des cas, l'intervention a sauvé une vie et que, dans 90 p. 100 des cas, elle a amélioré la qualité des soins prodigués aux patients et (ou) enseigné quelque chose au médecin. L'analyze des coûts vise à comparer le coût total du traitement médicamenteux (coût des médicaments, des services pharmaceutiques, des services infirmiers et du dosage des médicaments) pendant une période de 24 heures, avant et après l'intervention. L'économie réalisée pendant les deux semaines en question se chiffre à 679 $, soit au bas mot, une économie annuelle de 17 654 $. L'estimation ne comprend pas les coûts évités en raison de l'amélioration de la qualité des soins, de la diminution des effets indésirables des médicaments et du racourcissement de l'hospitalisation. Les interventions du pharmacien, qui ne représentent qu'une partie des tâches qui lui sont assignées, améliorent la qualité des soins prodigués aux patients et entraînent une réduction des coûts.

Mots clés: *analyse des coûts, interventions, pharmacie clinique, pharmacien*

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INTRODUCTION

In this era of rising health care costs, pharmacists must be able to provide quality health care at an acceptable cost.[1-5] Patient outcome is the best indicator of the costs of health care but it is very difficult to assess.[4,6] Many studies have documented the positive impact of clinical pharmacy services on costs and patient care in ambulatory and hospital environments.[4,5,7-9] The impact of clinical pharmacy services in pediatric hospital settings has not been reported. Interventions in physician prescribing, made by pharmacists on behalf of the patient, represent one clinical pharmacy activity for which patient and cost data may be obtained. Often, cost-avoidance studies associated with pharmacist interventions are based on direct drug cost.[4,6,10] While this is important, direct drug costs represent only a portion of the total cost of a medication. Some studies have reported an estimated cost savings to patient care which is calculated by estimating the expected duration of therapy, expected length of hospital stay or estimated costs of avoidance of adverse reactions to medications.[8,9,11,12] Costs quoted are based on a prediction of what would have occurred with a specific patient, rather than actually what happened. Pharmacy preparation and dispensing costs, nursing administration costs, and the cost of drug assays are all influenced by pharmacists' interventions and should be considered in an analysis of costs relating to pharmacist interventions.

The Hospital for Sick Children (HSC) is a 540-bed university-affiliated, pediatric teaching hospital with a combination of unit-dose and traditional drug distribution systems. The Department of Pharmacy serves the hospital inpatients through a decentralized system of two satellite pharmacies and one central support pharmacy. The satellite pharmacies are open during the day and the central pharmacy provides 24-hour service. In addition to distributive and teaching functions, approximately 50 percent of the pharmacists' time is spent providing clinical pharmacy services. Their role while on the nursing units includes monitoring drug therapy, providing drug information, participating in medical rounds, detecting and reporting adverse drug reactions, recommending changes in drug therapy, participating in drug utilization evaluations, providing education to nursing and medical staff, and medication counselling to parents and patients. Clinical pharmacy services are provided to all areas of the hospital during the weekday shifts. Prior to the study, the pharmacists were recording only the number of interventions for one week, four times a year, for workload assessment purposes. The assessment gave no information as to the nature of the interventions, nor the quality of the recommendations. This project was, therefore, undertaken to address these issues.

The objectives of the study were: 1) to describe the types of pharmacists' interventions, and the degree of acceptance by the medical staff; 2) to determine the perceived impact of the interventions on patient care by the medical staff, and; 3) to estimate cost changes resulting from the interventions by comparing the costs of drug therapy.

METHOD

During the two-week period, January 14 to 27, 1991, the pharmacists recorded all of their interventions. Interventions were defined as pharmacist-initiated suggestions regarding drug therapy and did not include drug information questions. Interventions were communicated either verbally to the prescribing physician or as written recommendations in the patient's medical chart. When reviewing drug orders in the pharmacy, pharmacists recorded the details of the interventions directly on the pharmacy copy of the physician's order form. While on the wards, the pharmacists documented their interventions on a preprinted Therapeutic Intervention Form (Figure 1) to ensure consistent reporting.

Documented interventions were classified according to admitting medical service, American Hospital Formulary Service therapeutic drug classification,[13] and type of intervention (including underdose, overdose, missing information and nonformulary requests). The intervention acceptance rate was defined as the number of interventions that were accepted by physicians expressed as a percentage of all attempted interventions. To be considered an accepted intervention, a new medication order had to be written. The average number of medication orders, (including intravenous solution and parenteral nutrition orders) per admitting service per patient day

Figure 1 **THE HOSPITAL FOR SICK CHILDREN THERAPEUTIC INTERVENTION FORM**

Date: ____________ Patient Name: ____________

Time: ____________ HSC #: ____________

Pharmacist: ____________ Admit #: ____________

Time Spent: ____________

Drug/Dose/Schedule/Route:

Problem:

Recommendation:

Outcome:

Intervention:

pharmacist initiated suggestions regarding drug therapy. This includes drug and dosage clarification or adjustment, changing to formulary or non-formulary medication, therapeutic drug monitoring suggestions, prevention of adverse drug reactions and drug interactions, drug allergies and parenteral nutrition.

(Survey of Doctors Orders, Pharmacy Department, The Hospital For Sick Children, Audited, March, 1990, unpublished data) and the number of patient days for each admitting service during the 14 day study period was used to calculate the percentage of orders resulting in an intervention.

All interventions were screened for appropriateness and significance in terms of patient outcome by the Pharmacy Education Co-ordinator. Interventions made by the Pharmacy Education Co-ordinator were screened by the other investigator. Both investigators were consistent in their assessments. The Education Co-ordinator summarized the problems identified and the pharmacists' interventions in a mini-case format on the adapted Intervention Evaluation Form[11] (Figure 2). Those interventions deemed by the Education Co-ordinator to have an impact on patient care in terms of either quality of care or cost were subdivided by intervention type. A random sample of each type was sent to seven physicians with clinical pharmacology experience for assessment. The physicians were asked to assess the interventions in terms of what they perceived the impact of the intervention to be on patient care. All of the assessors received 11 identical cases and a further ten cases which differed (one received 11 cases which differed). The coefficient of agreement among the assessors was calculated by dividing the observed number of agreements by the total number of possible agreements.

All cost-avoidance calculations resulting from the interventions were estimated by comparing the total medication cost difference for 24 hours prior to and for 24 hours after intervention. This duration of therapy was based on the assumption that in the absence of pharmacist intervention, physicians would have initiated an action similar to the one proposed by the pharmacist the next time the patient's case was reviewed.[1,7]

Figure 2 **INTERVENTION EVALUATION FORM**

PROBLEM IDENTIFIED

INTERVENTION

EVALUATION

I. The intervention by the pharmacist resulted in a:

- ☐ detrimental effect
- ☐ no effect
- ☐ positive effect
  - ☐ minor effect on patient therapy
  - ☐ modest effect on patient therapy (therapy would have been compromised or side effects may have occurred)
  - ☐ marked effect on patient therapy (had intervention not taken place, severe or life threatening events may have occurred)

II. The above intervention would result in:

	yes	no	don't know
a life saving situation	☐	☐	☐
increased quality of care	☐	☐	☐
avoidance of adverse effects	☐	☐	☐
reduction of hospital stay	☐	☐	☐
potential cost saving	☐	☐	☐
physician education	☐	☐	☐

COMMENTS ______________________________

The difference in total medication costs before and after an intervention was determined by subtracting the medication cost for the 24 hours following an intervention from the total medication cost for the 24 hours prior to the intervention.

For each intervention the total medication cost was calculated as follows:

total medication cost = drug acquisition cost + preparation supply cost + pharmacy labour cost + nursing labour cost + therapeutic drug monitoring service assay cost

where:

drug acquisition cost = cost of drug during January 1991 for HSC to purchase the drug

pharmacy labour cost = pharmacy labour for pharmacists and pharmacy assistants to prepare, label and check prescription based on 55 cents per minute and 4 minutes to fill each medication order[14]

preparation supply cost (dependent on dosage form):
unit-dose intravenous therapy = cost of diluent, + syringes + labels + intravenous bags + alcohol wipes + gloves + syringe tips + prepackaging bags
oral therapy not available in unit dose = cost of prepackaging supplies (foil wrappers, oral syringes, syringe tips, vials, prepackaging bags and bubble packs)

nursing labour cost = (average time for nurse to prepare, check and administer medication based on Project Research in Nursing (PRN) data[15]) x (average salary of registered nurses at HSC $21.12 per hour)

therapeutic drug monitoring service assay cost = cost of reagents + supplies + labour for phlebotomy to obtain blood samples + labour to perform analysis at HSC.

Based on the total medication cost difference calculated for the two week study, an extrapolation to 52 weeks per year was made.

RESULTS

Seventeen full-time-equivalent pharmacists participated in the data collection. Two pharmacists had advanced degrees (Doctor of Pharmacy Degree and Masters in Clinical Pharmacy), seven were Bachelor degree pharmacists with residencies, and eight had a Bachelor degree in pharmacy. One pharmacist whose clinical responsibilities were in the neonatal intensive care unit did not participate.

A total of 361 interventions were collected during the study period. The number of interventions was similar to previous collections of workload assessment data at our institution. The estimated total number of medication orders reviewed by pharmacy during the two week study was 12,615.9. Therefore, the approximate intervention rate based on the number of medication orders reviewed was 2.9%. The medical services with the greatest number of medication orders written were in descending order: the intensive care unit, hematology/oncology, nephrology, neonatal intensive care unit, neurosurgery, general medicine, and cardiology. The medical services who received the most interventions out of the total number of interventions were in descending order: hematology/oncology, general medicine, cardiology, neurosurgery, intensive care unit, and orthopedic surgery. As well, the services who received the most interventions per number of medication orders were in descending order: infectious diseases, metabolics/endocrine/gastrointestinal services, general medicine, orthopedic surgery, and cardiology (Table I). The majority (45.7%) of interventions involved anti-infective agents and central nervous system agents (anticonvulsants, analgesics/antipyretics, and sedatives) (14.7%) (Table II). The two most common types of interventions were a result of underdose (21.9%) and overdose (21.6%) determined by serum drug concentration measurements. Missing information regarding medications on physicians orders was the third most frequent type of intervention occuring in 10.5% of cases. Non-formulary drugs involved 10.5% of the interventions. Interventions informing the physicians that an ordered medication strength was either not practical or unavailable involved 9.7% of cases (Table III). Physicians accepted 95.8% (346/361) of the interventions. Among the 4.2% (15/361) interventions rejected, 60% of the orders involved antibiotics.

Of the 361 interventions, 190 were considered to have an impact on patient care in terms of quality of care and cost by the Pharmacy Education Co-ordinator. Eighty-two of the 190 interventions were randomly selected and sent to seven clinical pharmacologists and fellows for review. The coefficient of agreement among physicians for the eleven identical interventions

Table I. Summary of Interventions by Admitting Service

Admitting Service	Percent (%) of Total Medication Orders	Percent (%) of Total Interventions	Percent (%) of Interventions Per Number of Medication Orders Per Service
Intensive Care Unit	15.5	6.9	1.4
Hematology/Oncology	13.8	17.4	3.9
Nephrology	9.0	6.1	1.9
Neonatal Intensive Care Unit	7.2	1.4*	0.8
Neurosurgery	6.9	7.8	4.0
General Medicine	6.6	14.1	4.2
Cardiology	5.9	9.8	4.1
Plastics	4.7	0.6	0.3
Ear, Eye, Nose & Throat	4.4	2.8	2.9
Orthopedic Surgery	4.3	6.7	4.2
Metabolics/G.I./Endocrine	3.9	4.7	4.9
General Surgery	3.8	3.9	1.7
Infectious Diseases	3.8	5.5	5.2
Chest/Rheumatology	3.5	4.4	3.6
Urology	3.4	3.9	2.8
Neurology	2.5	3.6	3.9
Psychiatry	0.83	0.6	1.0

*NICU pharmacist did not participate

Table II. Summary of Interventions by Therapeutic Drug Classification

Therapeutic Drug Classification	Percent (%) of Total Interventions
Anti-Infectives Agents	45.7
Central Nervous System Agents	14.7
Electolytic, Caloric, and Water Balance	6.1
Gastrointestinal Drugs	4.4
Skin and Mucous Membrane Agents	3.9
Cardiovascular Drugs	3.6
Blood Formation and Coagulation	3.3
Hormones and Synthetic Substitutes	3.3
Antineoplastic Agents	3.0
Serums, Toxoids, and Vaccines	3.1
Autonomic Drugs	1.9
Smooth Muscle Relaxants	1.9
Vitamins	1.9
Unclassified Therapeutic Agents	1.1
Antitussives, Expectorants and Mucolytic Agents	1.1
Eye, Ear, Nose, and Throat Preparations	0.5
Blood Derivatives	0.3

Table III. Summary of Interventions by Type

Type of Intervention	Percent (%) of Total Interventions
Underdose	21.9
Overdose	21.6
Missing Information	10.5
Non-formulary/Policy	10.5
Strength Not Available	9.7
When to Obtain Serum Drug Concentrations	5.5
Wrong Drug	5.3
Duplicate Therapy	2.8
Drug Not Indicated	2.2
Wrong Route	2.2
Illegible	1.4
Wrong Dosage Form	1.4
Approval Required	1.1
Too Many Serum Drug Concentrations	1.1
Others	2.8

Table IV. Physicians' Assessment of Pharmacists' Interventions

Perceived Impact of Intervention	Yes	No	Don't Know
Life-saving situation	7/82 (8.5%)	62/82 (75.6%)	13/82 (15.9%)
Improved quality of care	74/82 (90.2%)	7/82 (8.5%)	1/82 (1.2%)
Avoided adverse effects	31/82 (37.8%)	45/82 (54.9%)	6/82 (7.3%)
Decreased hospital stay	25/82 (30.5%)	34/82 (41.5%)	23/82 (28.0%)
Potential cost savings	44/82 (53.7%)	23/82 (28.0%)	15/82 (18.3%)
Physician education	76/82 (92.7%)	4/82 (4.9%)	2/82 (2.5%)

they reviewed, in terms of the interventions having a positive effect, no effect, or detrimental effect on patient outcome, was calculated to be 86.2% indicating good agreement among the assessors. Of the 82 interventions, 92.7% (76/82) cases were considered to have a positive effect on patient outcome, and 7.3% (6/82) were considered to have no effect. None were judged to have detrimental effects. Among the 76 interventions with positive effects, 18.4% (14/76) were judged to have a marked impact on patient outcome, 53.9% (41/76) had modest impact and 27.6% (21/76) had minor impact. Of 82 interventions assessed, 8.5% (7/82) were judged to have resulted in life-saving situations, 90.2% (74/82) in improved quality of care, 37.8% (31/82) avoided adverse effects, 30.5% (25/82) of the cases were judged to have decreased hospital stay and 53.7% (44/82) had cost saving potential. Physician education was considered to have occurred in 92.3% (76/82) of the cases (Table IV).

Costs were calculated for 255 interventions (255/361; 70.6%). For the remaining 106 interventions costs could not be calculated because the original order could not be carried out as written (e.g., medication not available in the prescribed strength), and they were considered to have no cost implications. Among the 255 interventions, 35.7% (91/255) were found to have increased costs while 55.3% (141/255) resulted in decreased costs, and 9% (23/255) had no net change in cost. Drug assays constituted a net $370 added cost to the total cost, while drug and pharmacy costs were decreased by $1010 due to pharmacists' interventions. Pharmacy costs did not include the time for review of patient and drug data nor the time spent interacting with other health care providers. Nursing savings were $39. Total cost avoidance due to pharmacists' interventions was $679 over the two-week study period or when extrapolated to a year was $17,654.

DISCUSSION

Pharmacists' interventions in physician prescribing on behalf of the patient is a clinical activity for which data are relatively easily obtained. Studies have demonstrated a positive impact of pharmacists' interventions in terms of cost savings and improved patient care.[7-12, 16-18]

During the two-week study period, seventeen pharmacists intervened in physician prescribing on 361 occasions, with an average of 1.6 interventions per pharmacist per day. As a baseline measurement, we calculated our intervention rate based on the number of medication orders. We realize that an intervention is not always in response to a medication order. Interventions may be made to initiate therapy, as well as to order laboratory tests. However, our data do give an indication of the services which most frequently write medication orders and the services where pharmacists were most actively intervening. Not surprisingly, pharmacists tended to intervene on the services which write the most medication orders. Perhaps the most useful method for determining a baseline measurement of pharmacists workload is to calculate the percentage of orders that require intervention for each service.

The infectious disease service had the highest percentage of interventions per medication orders written for their service. The majority of the interventions were dosage recommendations for antibiotics based on serum concentration measurements. This was not surprising as each of the pharmacists at our hospital is responsible for therapeutic drug monitoring on their assigned wards. Therapeutic drug monitoring is essential in pediatric patients because the physiologic processes that determine drug disposition are changing during biological maturation throughout infancy and childhood. These changes result in two characteristics of pediatric therapeutics: drug disposition changes throughout biological maturation and differs from adult norms, and a large interpatient variability in drug disposition is observed for most medications in this patient population.[19] The data and the nature of pediatrics suggest the necessity of following up on serum concentration measurements to detect either under or overdosage of medications. Interventions informing physicians that an ordered medication strength was either not practical or unavailable involved 9.7% of cases. As well, this type of intervention may be specific to a pediatric setting as formulary dosage recommendations are based on a daily mg/kg dose.

The average rate of acceptance of pharmacists' interventions reported at other institutions is 84.4% with a range of 58 to 98%.[20] The rate of acceptance in our study was 95.8%. Although we did not assess the method of intervention, the majority of pharmacists indicated that they communicated verbally with the prescribing physician. Our high acceptance rate is most likely attributable to our method of intervention, as others have reported the best method of pharmacists disseminating information to physicians was by direct personal communication.[16,21] Physician acceptance of pharmacists' interventions must be achieved for pharmacists to effectively prevent drug-related problems. The high acceptance rate of the interventions would seem to indicate that physicians at our institution view pharmacists as a reliable drug information source, and supports pharmacists' interventions as a beneficial service.[1,20]

From the physicians' assessment it is obvious that pharmacists' interventions do result in a positive impact on patient outcome. Life-saving situations, curtailing unnecessary, prolonged hospitalization, adjusting dosage regimens or changing to an alternative medication to reduce adverse reactions contribute to the patients' well being and comfort.[9] The impact of these interventions on patient outcome is not easily calculated, and costs for these were not assessed in our study although they would likely represent considerable additional cost-avoidance. As the pharmacists were involved in many other activities during the study, the cost of pharmacists' time required for these interventions could not and was not calculated.[18]

Although a careful attempt was made to minimize bias, in this study there are several limitations. Some of the limitations include:

1) Self-reporting may have introduced bias. However, the acceptance and number of interventions was consistent with previous data collected at this hospital.
2) The peer review process has inherent bias. Ideally, it would have been appropriate to have all the interventions initially assessed by a physician.[11,22] As this was not realistic for all 361 interventions, the Pharmacy Education Co-ordinator performed the initial review. A random selection of those deemed to be significant in terms of patient quality of care and cost were then assessed by two clinical pharmacologists and five clinical pharmacology fellows. Although our selection of physician assessors was not random, we felt the clinical pharmacologists were the physicians with the most relevant clinical expertise to assess interventions regarding all drug classes. The assessors were blind to their peer's rankings, and it is unlikely that the physicians would inflate their rankings.[11,22]
3) Based on the reported interventions by pharmacists, we calculated an average of 1.6 interventions per pharmacist per day.

We believe this is a very conservative estimate of interventions because we defined interventions to be strictly pharmacist-initiated suggestions regarding drug therapy and did not include interventions which were a result of drug information questions.

4) Cost analysis was confined to a 24 hour period prior to and following intervention implementation, based on the assumption that in the absence of pharmacist's interventions, physicians would have initiated an action similar to the one proposed by the pharmacist the next time the patient's case was reviewed. At The Hospital for Sick Children each patient must be reviewed by a physician every 24 hours. The time frame of 24 hours was chosen to minimize bias in terms of cost. Cost analysis confined to a 24-hour period has been recommended by several investigators.[1,7] As no control group was included in the study, and the study did not follow a patient's hospital course, it was not possible to estimate more accurately how an intervention would influence cost in terms of length of therapy of a medication, length of hospital stay, costs avoided as a result of allergy notification and adverse drug reaction identification.[7] Furthermore, the actual clinical significance of the interventions could not be determined as the prescribing errors were detected and avoided prior to implementation. We realize that interventions do influence length of therapy, length of stay, and patient outcome and have implications in terms of cost. Our cost calculations, therefore, likely underestimate the cost avoidance for the hospital.

5) To estimate nursing time spent administering medications we utilized the validated Canadian nursing workload document, the Project Research in Nursing (PRN) which is used by a number of Canadian hospitals.[15] This nursing workload assessment defines the length of time spent by the nurse in administering medications by different routes. We felt that an accepted workload measurement standard would decrease our bias regarding nursing time spent on administering and preparing medications. However, the data in this document pertain only to adult patients and do not define the type of drug distribution system used in its development. We believe that administering medications to pediatric patients is more labour and time intensive than it is for adult patients. Consequently, we believe the nursing cost avoidance estimated in our study is an underestimate.

In conclusion, the reported impact of pharmacists' interventions on the quality of patient care and cost as perceived by the physicians and Pharmacy Education Coordinator were substantial. Forty-six percent of the interventions were judged to have an impact on both the quality and cost of patient care. Although the total medication cost-avoidance due to pharmacists' interventions was estimated to be only $679 over the two-week study period, 8.5% of the interventions were judged to have been life-saving, 37.8% were perceived to have prevented adverse effects and 30.5% were judged to have shortened the hospital stay. All of these factors may represent a significant cost-avoidance to the hospital for which we did not account. There was a high degree of acceptance of pharmacy input to patient care, as measured by the percentage of accepted recommendations. The results of this study provide justification for clinical pharmacy services in a pediatric teaching hospital as pharmacists improved the quality and decreased the cost of patient care.

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