Economic Impact and Clinical Benefits of Pharmacist Involvement on Surgical Wards

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ABSTRACT

A one-year pilot project was performed to assess the economic and clinical benefit of pharmacist involvement on the surgical wards of a 600-bed tertiary care, teaching hospital. A total of 405 recommendations were collected with a physician acceptance rate of 90%. From these recommendations, 1416 patient follow-ups were performed to document outcome. The total documented cost avoidance of the pharmacists' activities was $ 33,265.58. The total annual drug expenditure for the department of surgery declined by $59,662 representing a 9% decrease over the previous year with the greatest decline involving antimicrobials which decreased by $52,587 compared with the previous year. Most of the cost-avoidance in this area was attributable to antimicrobial selection and dosing adjustment in renal impairment. Pharmacist-directed pharmacokinetic monitoring of aminoglycosides resulted in a clinical success rate of 93.8% for treatment regimens and a 6.2% incidence of nephrotoxicity. Housestaff education aimed at improving prescribing practices were identified and provided for select agents including midazolam, ketorolac, vancomycin and aminoglycosides. As well, select recommendations were documented which illustrated the benefit to patient care of pharmacist involvement. Pharmacist involvement on the surgery services produced both financial and clinical benefits.

Key Words: *clinical pharmacy, cost-avoidance, surgical services*

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RÉSUMÉ

On a mené un projet pilote d'une année pour évaluer les avantages économiques et cliniques de l'assistance des pharmaciens dans les départements de chirurgie d'un hôpital universitaire de soins tertiaires comptant 600 lits. Les pharmaciens ont formulé en tout 405 recommandations dont 90 % ont été acceptées par les médecins. De ces recommandations, 1 416 ont fait l'objet d'un suivi afin d'en documenter les résultats. Les économies de coûts réalisées grâce aux activités des pharmaciens s'élève à 33 265 $. Les dépenses annuelles totales en médicaments pour le département de chirurgie ont diminué de 59 662 $, soit une baisse de 9 % par rapport à l'année précédente. Cela était attribuable notamment à une utilisation moins massive des antimicrobiens qui s'est traduite par une économie de 52 587 $, comparativement à l'année précédente. La majorité des économies dans cette classe est attribuable au choix des antibiotiques et à l'ajustement posologique dans l'insuffisance rénale. La surveillance pharmacocinétique des aminosides, supervisée par les pharmaciens, s'est traduite par un taux de succès clinique de 93,8 % en termes de régimes thérapeutiques et de 6,2 % en termes d'incidence de néphrotoxicité. La formation interne du personnel visait à améliorer les habitudes de prescription et a permis un choix plus judicieux de certains médicaments comme le midazolam, le kétorolac, la vancomycine et les aminosides. Certains recommandations ont aussi été documentées, ce qui a permis d'illustrer les avantages de la participation des pharmaciens dans les soins aux patients. Cette participation dans les services de chirurgie a entraîné des avantages financiers et cliniques.

Mots clés : *économie de coûts, pharmacie clinique, services chirurgicaux*

INTRODUCTION

The primary role and responsibility of a pharmacist is to provide drug therapy expertise for the purpose of achieving optimal patient care. In the present economic climate the pharmacist can provide cost effective drug therapy while maintaining high quality patient care and providing financial benefits to health care institutions.

The need to document the impact of a pharmacist on patient care activities is an ongoing issue for the profession.[1-3] Attempts to financially justify this professional service in

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health care institutions have been met with variable success.[1,4,5] The importance of the pharmacist, in this regard, has long been recognized by the Canadian Council on Health Facilities Accreditation.[6]

The duration of cost containment studies has been relatively short, varying from two weeks to three months.[1,4,5,7] The problem with short study periods is that they may less accurately reflect true pharmacy practice in a given area of a hospital. To compound the problem, annualized extrapolations of financial benefits can grossly over- or under-estimate savings because of seasonal variation in patient populations and more accurate results could be achieved by longer study periods. Another weakness of earlier research has been that the outcomes of the pharmacists' recommendations are generally not evaluated. True benefits to patient care and financial budgets can only be achieved through individual and sustained follow-up of all pharmacist-initiated recommendations.

At the St. Boniface General Hospital, a 600-bed tertiary care, teaching hospital, the surgical wards consist of neurosurgical, orthopedic, general surgical, urological, and cardiovascular/thoracic surgical beds. Decentralized clinical pharmacy services had been extensively provided to patients located on the general medical floor, the intensive care units, and the dialysis unit, but not the surgical wards. A one-year pilot project was proposed by hospital administration, pharmacy, and surgery to provide pharmacy services to these surgical wards.

The objective of this 12-month surgical project was to identify areas of pharmacotherapeutic influence of a clinical pharmacist as it relates to the surgical patient and to document the financial impact of these activities on the surgical drug budget. The study also attempted to identify the educational needs of the surgical staff.

METHODS

A full-time clinical pharmacist position was assigned to monitor and make recommendation on patients' drug therapy on the surgical wards from April 1992 to March 1993, inclusive. The additional staff position was created from a transfer of funds from the surgical drug budget for this study period. Computer printouts and pharmacy dispensary staff facilitated the development of a daily list of targeted parenteral drugs, which had the potential for significant toxicity or excessive drug cost (Table I). This list served to identify potential problem therapies. Aminoglycoside therapies were promoted as primary therapy when appropriate with the intent of avoiding the need for more expensive antimicrobials consequent to inadequate aminoglycoside concentration or an episode of nephrotoxicity. The need to switch to a third-generation cephalosporin, imipenem, or ciprofloxacin from an aminoglycoside, because of clinical failure or nephrotoxicity was recorded. For the purposes of this study, the definition of clinical success with aminoglycosides was discontinuation of this therapy after completion of treatment course or a change to oral route antibiotic after at least three days of intravenous aminoglycoside. Nephrotoxicity was defined as a rise in serum creatinine greater than 40 μmol/L from baseline. Recommendations for drug dosing adjustment in renal impairment were based upon creatinine clearance calculations using the Cockcroft and Gault equation.[8] For obese patients, a dosing weight was calculated as 40% of the difference between the total and ideal body weight plus the ideal body weight. Cost-avoidance for third-generation cephalosporins was achieved through dosage adjustment based on population-derived pharmacokinetics of the agent, the patient's body weight, renal function, and the MIC values of the agent for the known or suspected pathogens (i.e., dual individualization).[9]

Table I. Targeted parenteral agents with a potential for significant toxicity or excessive drug costs

Aminoglycosides
Amphotericin B
Cephalosporins
Chlordiazepoxide
Ciprofloxacin
Clindamycin
Fluconazole
Imipenem
Ketorolac
Midazolam
Octreotide
Piperacillin
Ranitidine
Metronidazole
Vancomycin

The pharmacist utilized DELPHIC (biochemistry, microbiology, hematology), Microscan (microbiology), and Rx Manager (pharmacy) computer systems software to assist with data collection. All patients with potential problem therapies underwent a chart review. During daily rounds on the surgical wards, the pharmacist would discuss recommendations for alterations in drug therapy with the physician and these would be documented in the patient's chart. The pharmacist would follow-up on all recommendations, whether accepted or rejected/modified, for the duration of the patient's treatment course in order to assess outcomes.

Documented cost-avoidance included those drug cost recoveries achieved as a direct result of the pharmacist's recommendation. This cost-avoidance was determined by calculating the difference between the cost of the old and new regimens for the number of hospital days that the new regimen was received.

In the case of a switch from parenteral to oral therapy, cost-avoidance was calculated based on 48 hours of treatment. Specific areas where improvement in prescribing practices could be achieved were identified for educational intervention. As well,

select recommendations were identified to illustrate the benefit of the pharmacist's involvement to patient care.

RESULTS

One full-time-equivalent position made up of two half-time-equivalent pharmacist positions (R.A. and R.D.) participated in the study and data collection. Five hundred and five potential problem therapies, as previously defined, were identified during the 12-month study period. Four hundred and five recommendations were made from these potential problem therapies, of which 364 (approximately 90%) were accepted by physicians. Patient follow-up was done by the pharmacist to ensure a positive outcome. The number of issues which were followed to evaluate outcome was, 1416. This included some patients followed who were on potentially toxic agents; however, no pharmacist-initiated recommendations for change in regimen were made. Surgical admissions, patient days, and nursing acuity are shown in Figure 1 for 1991-92 and 1992-93 fiscal years. Total surgical admissions averaged 500 patients per month. From 1991-92 to 1992-93 there was a decline of 7.8% in the number of patient days, a decrease of 7.7% in admissions, and a 2.1% rise in nursing acuity score.

The total documented cost-avoidance for the year was $33,265.58 from the 364 accepted recommendations. The total drug budget for the department of surgery for 1992-93 was $618,133, a decline of approximately 9% over the previous year. The largest cost decline was for antimicrobials, representing a 15% decrease over the previous year. The majority of cost-avoidance was achieved in the areas of antimicrobial selection and dosing adjustment for renal impairment. Figure 2 demonstrates the antimicrobials which provided the greatest opportunity for cost-avoidance. Most recommendations were for less costly alternatives to cefoxitin, and to adjust vancomycin dosage in renal dysfunction. Recommendations involving the use of alternate agents for vancomycin in patients with non-anaphylactoid penicillin allergies (e.g., rash to penicillin) provided additional opportunities for cost-avoidance. Piperacillin provided cost-avoidance through recommendations to use a q6h interval rather than a commonly prescribed q4h interval and substitution of piperacillin with ampicillin, gentamicin, and metronidazole for certain infectious diseases. Clindamycin cost-avoidance was realized through substitution with cefazolin and metronidazole in non-pulmonary infections. Cefuroxime cost-avoidance came about through dosing adjustment in renal impairment or substitution with less expensive alternatives for patients who were

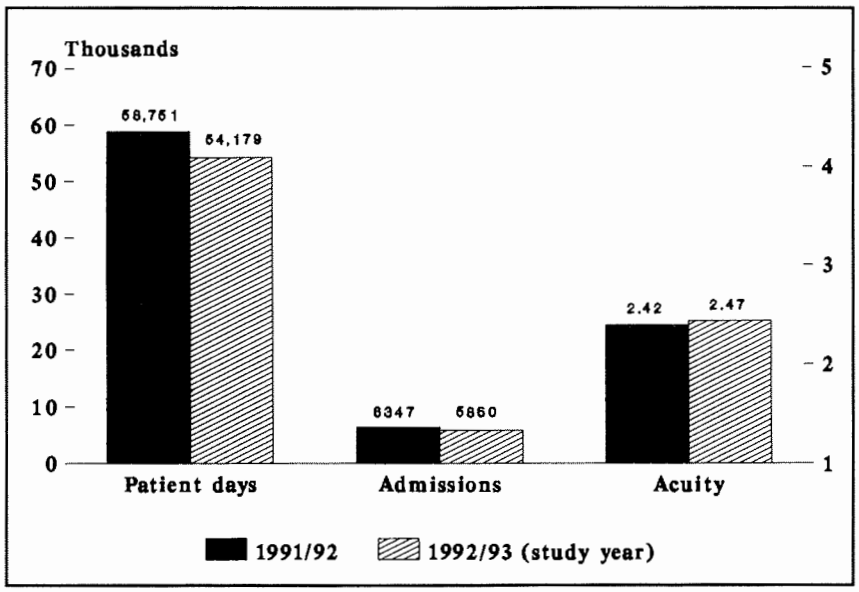

Figure 1. Surgical patient statistics

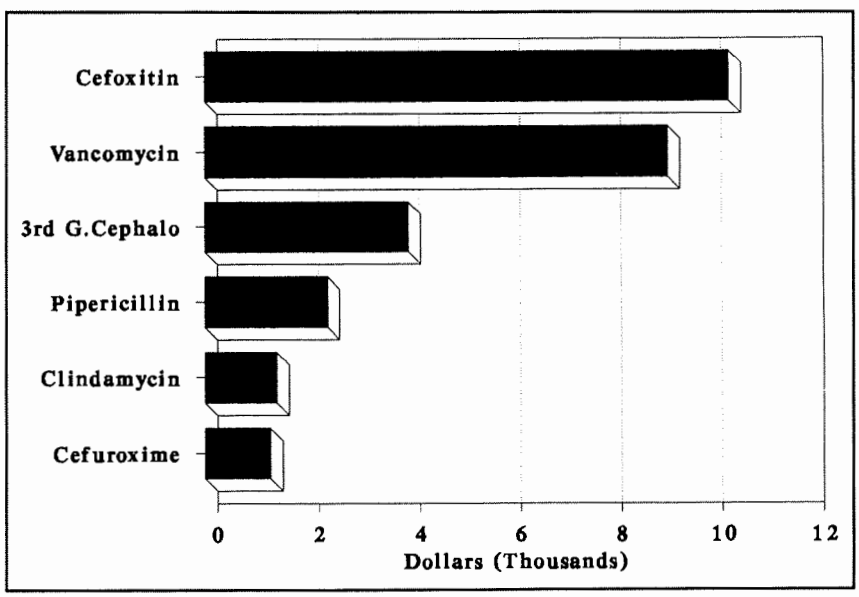

Figure 2. Drug orders which provided the greatest documented cost-avoidance

culture-negative or who had beta-lactamase negative organisms on culture.

Seventy-one percent of recommendations were to decrease drug costs (i.e., decrease dose, use of an alternative, delete a drug, convert from IV to PO therapy, prevention of vial wastage). Fifteen percent of recommendations were to increase drug costs for specific cases with the intention of minimizing treatment failure (i.e., increase dose, add a drug to therapy). The remaining recommendations were difficult to quantify from a cost-avoidance perspective (e.g., pharmacy consult, rescheduling administration times, clarify order).

There was a substantial decline in cefoxitin utilization during the project year which resulted from the recommendation to substitute the more cost-effective alternative cefazolin and metronidazole. The actual budgetary drop in cefoxitin expenditures over the previous year was approximately $30,000. The documented cost avoidance was $10,400.

One-hundred and twenty-three patients on aminoglycosides were followed during the project. Eighty-one regimens (66%) were for the treatment of suspected or documented infections, while 42 regimens (34%) were for prophylaxis. The success rate was 93.8% (76/81) for aminoglycoside treatment regimens. Of 81 cases there were only two treatment failures (2.5%). One patient had a diagnosis of pneumonia, but post-mortem findings demonstrated metastatic disease. The other patient received two weeks of aminoglycoside therapy for an unresolving pneumonia and intra-abdominal sepsis before being switched to imipenem.

The incidence of nephrotoxicity was 6.2% (5/81). In all patients renal function normalized without sequelae.

Table II summarizes some of the educational information provided to the surgical staff for cost-effective drug substitution.[10-14] This list was researched and compiled during the study year. As well, additional opportunities for drug therapy education were identified. This resulted in newsletters (e.g., midazolam, ketorolac), a vancomycin and aminoglycoside dosing ruler, an alcohol withdrawal protocol, and inservices to the surgical team on antimicrobial selection and dosing. The majority of teaching was performed informally when the pharmacist rounded with the surgical resident and intern. Most recommendations on patient-specific drug therapies were communicated through these informal teaching rounds. The dosing of aminoglycosides was the most frequent topic discussed and usually the recommendation involved administering a similar total daily dose less often. The cost-avoidance associated with this recommendation was small, usually less than $5, and hence, cost-avoidance was not calculated for aminoglycoside dosing recommendations.

Table III is an example of the type of information provided to surgical housestaff to promote aminoglycoside use. This example demonstrates the comparative cost advantage of using an aminoglycoside over a third-generation cephalosporin even though aminoglycosides require drug level ordering, interpreting, and monitoring.

Table II. Recommendations for cost effective drug substitutions

Cefoxitin - Consider cefazolin and metronidazole for all cefoxitin orders.[10,11]

Chlordiazepoxide, parenteral - Use the oral diazepam loading regimen, wherever feasible, in the treatment of alcohol withdrawal, similar to that used by the Addiction Research Foundation, Toronto.

Clindamycin - Consider cefazolin and metronidazole when appropriate for clindamycin orders. There were specific situations where it may be appropriate to maintain the more costly clindamycin (e.g., treatment of lung abscess or necrotizing pneumonia).

Ketorolac - Parenteral ketorolac is only necessary for patients with narcotic contraindications who could not take either orally or rectally administered NSAIDs; there is no role for oral ketorolac.[12]

Midazolam - Reserve midazolam for patients requiring sedation and amnesia, and not for all preop sedation; diazepam is recommended for sedation.[13]

Piperacillin - Utilize the combination ampicillin, gentamicin, and metronidazole, where appropriate for piperacillin orders; piperacillin is only recommended in combination therapy of pseudomonal infections.

Vancomycin - Ensure patients receive prophylactic vancomycin only if they have had a history of immediate or accelerated allergic reactions to penicillin i.e., cephalosporins still appropriate for patients with a history of rash to penicillin.[14]

Table III. Cost advantage of an aminoglycoside over a third-generation cephalosporin based regimen

	Gentamicin	Cefotaxime
Cost of Drug[1]	$ 98.00	$ 476.00
Drug Levels[2]	$ 12.00	-
Metronidazole & Ampicillin[3]	$ 126.00	$ 126.00
Pharmacist Monitoring[4]	$ 50.00	-
Lab Technician[5]	$ 20.00	-
Creatinine/Urea[6]	$ 12.00	$ 2.00
TOTAL	**$ 318.00**	**$ 604.00**

Based on the following:
1 two weeks of gentamicin 80 mg IV q8h and cefotaxime 1 g IV q8h.
2 two sets of peak/trough levels at $ 6.00 per set.
3 treatment of intra-abdominal sepsis, additional ampicillin 1 g IV q6h, metronidazole 500 mg IV q8h
4 pharmacist consulting fee
5 lab technician obtaining two sets of levels at $ 10.00 per set.
6 three per week for gentamicin monitoring at $ 2.00 per analysis; one per two weeks for cefotaxime.
Assumptions: 1. the initial two weeks of a treatment course
2. dosing based on normal renal function

In addition to the formalized assessment of cost-avoidance and general education of housestaff, patient specific recommendations had the potential of avoiding costs and improving patient outcomes. While a complete description of these is not possible a few case examples are presented to illustrate this contribution. In one case a patient with documented Clostridium difficile colitis who was refusing metronidazole was ordered vancomycin parenterally which the pharmacist suggested should be given orally. With this change the patient improved on oral vancomycin. In another case, an order was received for a cephalosporin for an enterococcal infection based on culture and sensitivity. The pharmacist suggested that a cephalosporin should never be used for enterococcal coverage and a subsequent review revealed laboratory error. An elderly female with recent NSAID-related peptic ulcer perforation was ordered ketorolac which again was corrected by the pharmacist. A lung transplant patient was receiving omeprazole and ketoconazole. The pharmacist suggested that omeprazole had the potential to substantially reduce the absorption of ketoconazole and omeprazole was discontinued. While some of these had some effect on direct drug costs they were more likely to have a marked impact on patient care, and hence, indirect drug costs.

The importance of ongoing monitoring was evident in an elderly female who was receiving high dose cefotaxime relative to her body weight and renal function for management of endocarditis. As well, on that dose bacterial titers were performed and found to be more than adequate. Although the pharmacist suggested a dose reduction, the order was not changed. Several days later the patient displayed inappropriate behaviour, hyperreflexia and ultimately obtundation. This time, a dose reduction occurred and within 24 hours there was a resolution of symptoms. Several other recommendations had the potential to both improve outcome and secondarily, to favourably alter cost-avoidance.

DISCUSSION

Pharmacist recommendations resulted in a documented cost-avoidance of $33,265 in the surgical drug budget for the one-year study period. The majority of target drugs were antimicrobials. Total drug expenditures in surgery showed a budgetary decline of $59,662, 88% of which was derived from antimicrobials. The reasons for the difference in documented cost-avoidance versus the actual decline in the drug budget is probably multifactorial and may be unrelated to pharmacy activities. An uncontrollable factor was the reorganization of the neurosurgical unit with the loss of a number of patient beds. A portion of the budgetary decline may have been due to this small decline in patient days, and admissions over the previous year. However, some of the total budgetary decline may have been secondary to the pharmacist's educational influence on prescribing practices. One of the limitations of our study was the underestimation of cost-avoidance caused by the surgical housestaff acquiring more cost-effective prescribing habits. This is probably one reason for the greater decline in the cost for cefoxitin therapy versus the calculated cost-avoidance for that agent.

The financial impact of our aminoglycoside dosing service on improved antimicrobial efficacy was difficult to quantify. When aminoglycosides are optimally dosed, the true savings are believed to be realized through fewer therapeutic failures, and therefore, fewer conversions to more expensive antimicrobial alternatives such as cefotaxime or imipenem. Although there was no control arm, the 93.8% success rate for the treatment of documented or suspected infections in our patient population with aminoglycosides suggests that the pursuit of this change in drug utilization was both cost-effective and clinically successful. The reported incidence of nephrotoxicity of 6.2% observed in our study population is consistent with literature values of between 6% and 10%.[15] Destache et al have demonstrated findings of cost-savings and patient safety with the institution of an aminoglycoside dosing service.[16]

From these experiences, it is evident that aminoglycosides can be used cost-effectively and successfully in the surgical area. The reluctance of physicians to prescribe aminoglycosides may be the result of unfamiliarity with pharmacokinetics, the need for more intensive monitoring, and fear of drug toxicity. Our introduction of an aminoglycoside dosing ruler, and an individualized aminoglycoside drug order review process at the dispensary level would be expected to facilitate the use of these agents.[17] However, clinical interpretation of drug concentrations cannot be done from the dispensary and an on-site pharmacist would still be necessary to assist with monitoring drug therapy.

In conclusion, the study demonstrated that considerable cost-avoidance could be achieved by a pharmacist assigned to the surgical services with most of this direct cost-avoidance being achieved in antimicrobial utilization. Furthermore, it was recognized that direct drug costs represent only a portion of the total health care cost and pharmacists' recommendations for individual patients' therapies may lead to substantial indirect drug cost-avoidance.

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