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Evaluation of Pharmacists' Interventions at a University Teaching Hospital

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ABSTRACT

Objectives: The primary purpose of this pilot study was to help justify the positions of clinical pharmacists by identifying and describing the interventions most likely to have the greatest impact on patient care in terms of severity of medication-related problems and associated costs. A secondary objective was to identify potential problems related to data collection and cost estimation, to allow appropriate changes in documentation procedures for future data collection.

Methods: All clinical interventions by staff pharmacists reported at a university medical centre during the period September to November 2001 were analyzed retrospectively. The focus was on interventions that prevented adverse drug events (described as very serious and serious on documentation forms). The cost impact was analyzed in terms of cost savings attained by shortening a planned course of drug therapy and cost avoidance achieved by avoiding adverse drug events.

Results: Five pharmacists reported a total of 47 interventions. Approximately twice as many of the avoided adverse drug events were deemed serious as were deemed very serious. A substantial proportion of the interventions (21 [45%]) took approximately 15 to 30 min to perform. Order clarification and corrections and provision of drug information accounted for the most interventions (17 [36%] and 15 [32%], respectively). Approximately 60% of all interventions were classified as subtherapeutic dosing (10 [21%]), untreated disease states (6 [13%]), potential overdose (6 [13%]), and failure to receive drug (5 [11%]). According to published work on the cost of adverse drug events, the total cost avoidance for the 33 preventable adverse drug events reported by pharmacists in this study was US$84,631 and the cost–benefit ratio was 1.2. One of the problems noted in the economic analysis was the difficulty in assigning more specific cost figures to each of the interventions that was estimated to result in more than US$1000 in cost savings.

Conclusions: Pharmacists can play an important role in preventing medication-related problems (particularly adverse drug events), and the interventions they perform are cost-beneficial.

Key words: interventions, medication errors, cost–benefit analysis

RÉSUMÉ

Objectifs : Le principal objectif de cette étude pilote était de contribuer à justifier les postes de pharmaciens cliniciens, en déterminant et en décrivant les interventions les plus susceptibles d'exercer l'effet le plus important sur les soins aux patients, sur le plan de la gravité des problèmes liés à la pharmacothérapie et des coûts qui y sont associés. Un deuxième objectif était de déterminer les problèmes potentiels liés à la collecte des données et à l'estimation des coûts afin d'apporter les changements nécessaires aux méthodes de documentation pour les collectes de données futures.

Méthodes : Une étude rétrospective de toutes les interventions cliniques consignées par les pharmaciens dans un centre médical universitaire a été effectuée pour la période de septembre à novembre 2001. L'attention a été portée aux interventions qui ont prévenu les événements indésirables liés aux médicaments (décrits comme très graves et graves sur les formulaires de documentation). La répercussion sur les coûts a été analysée en matière d'économies réalisées par l'abrégement de la pharmacothérapie prévue et l'évitement des événements indésirables liés aux médicaments.

Résultats : Cinq pharmaciens ont consigné un total de 47 interventions. Il y avait environ deux fois plus d'événements indésirables évitables liés aux médicaments jugés graves que très graves. Une proportion considérable d'interventions (21 [45 %]) ont nécessité un temps d'exécution d'environ 15 à 30 minutes. Les clarifications et les corrections d'ordonnances et la prestation d'information sur les médicaments représentaient la plupart des interventions (17 [36 %] et 15 [32 %], respectivement). Environ 60 % de toutes les interventions ont été classées dans les catégories suivantes : posologie sous-thérapeutique (10 [21 %]), affections non traitées (6 [13 %]), surdose potentielle (6 [13 %]) et absence de traitement médicamenteux (5 [11 %]). Selon les données publiées sur le coût des événements indésirables liés aux médicaments, des coûts totaux de 84 631 $ US ont été évités pour les 33 événements indésirables évitables liés aux médicaments déclarés par les pharmaciens dans le cadre de cette étude, pour un ratio coûts-bénéfices de 1.2. L'une des difficultés de l'analyse économique a été l'attribution d'une valeur plus spécifique aux interventions engendrant des économies estimées à plus de 1 000 $ US chacune.

Conclusions : Les pharmaciens peuvent jouer un rôle important dans la prévention des problèmes liés à la pharmacothérapie (particulièrement les événements indésirables liés aux médicaments) et leurs interventions sont avantageuses par rapport à leurs coûts.

Mots clés : interventions, erreurs de médication, analyse coût-avantage

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INTRODUCTION

After assessing a patient's condition or disease state, pharmacists perform interventions that prevent or ameliorate potential or actual medication-related problems.[1] However, in a cost-conscious system, the value of pharmacists must be justified through documentation of these interventions. Such documentation is also necessary to ensure that pharmacists will continue to be placed in such positions in the future.

The term "medication-related problems" (also known as "drug-related problems") is an overarching expression used to describe the focus of pharmacists' interventions. Other terms, such as adverse drug events, adverse drug reactions, drug misadventures, and medication errors, are often used interchangeably, but each of these has a potentially different meaning in the realm of health care.[2-4] For the purposes of this article, the definition of an adverse drug event is consistent with its most common use in the literature: patient harm resulting from the administration of a medication. Adverse drug events may be subdivided into preventable and nonpreventable categories.[5-7] A potential adverse drug event is a problem that does not actually cause harm to the patient, possibly through the intervention of a pharmacist. All potential adverse drug events are considered preventable.

The cost implications of adverse drug events have been well documented.[6,7] For example, one study involving 2 teaching hospitals found an average increase in hospital costs of US$4685 per preventable adverse drug event.[7] A variety of publications have described pharmacists' attempts to improve patient outcomes or reduce costs (or both) by avoiding adverse drug events and other medication-related problems.[8-17]

Although the morbidity, mortality, and costs associated with medication-related problems have been well established, many pharmacy departments continue to feel pressure to justify the value of clinical pharmacist positions to hospital administrators. This justification usually takes the form of documentation of clinical pharmacy activities and services. Given a limited amount of time to perform and document interventions, coupled with an ever-increasing focus on the bottom line, it is incumbent upon pharmacists to focus their documentation efforts on those activities that are most likely to substantially improve patient care while reducing associated costs. Many of the studies demonstrating savings by pharmacists have focused on restrictive strategies such as formulary adherence, but the high cost of adverse drug events, as demonstrated in recent landmark trials,[7] provides pharmacists with an additional method of justifying their value.

The primary purpose of this pilot study was to help justify the positions of clinical pharmacists by identifying and describing those interventions that were most likely to have the largest impact on patient care, on the basis of the severity and associated cost of the medication-related problems addressed by the interventions. A secondary objective was to identify potential problems related to data collection and cost estimation, to allow appropriate changes to be made in documentation procedures for future data collection.

METHODS

Setting

University Medical Center (UMC) is a 360-bed tertiary-care teaching institution located in southern Arizona. The hospital is affiliated with the University of Arizona's Colleges of Medicine, Nursing, and Pharmacy. The pharmacy department provides centralized drug distribution and intravenous admixture services (with the exception of services provided by one satellite admixture area). Until approximately January 2001, clinical faculty from the College of Pharmacy provided a substantial portion of clinical pharmacy services, assisted by residents, specialized residents, and students. Despite the activities of the clinical faculty and their trainees, many areas of the hospital had inadequate, inconsistent, or nonexistent clinical pharmacy services. A few staff pharmacists had moved into clinical positions before 2001, but beginning in approximately January 2001, a more formal redistribution of pharmacists from centralized to ward-based clinical activities was initiated. This pilot study was a retrospective evaluation of the clinical interventions performed by a group of these clinical staff pharmacists at the hospital.

Although documentation of clinical interventions was an ongoing activity, for the purposes of this study only data collected for the 3-month period from September through November 2001 were evaluated. Clinical staff pharmacists documented their clinical interventions using a written form adapted from personal digital assistant (PDA) software developed for this purpose. This retrospective study was approved by the local Human Subjects' Committee.

Data Selection and Collection

At the time of this study, the pharmacists followed general procedures for the documentation of interventions. To limit the time required for documentation, pharmacists documented only interventions that prevented adverse drug events likely to result in substantial patient harm and associated costs; such events were listed as serious

or very serious on the documentation forms. Definitions and explanations for recording information on the documentation instrument were adapted from a previous investigation, which focused on developing a reliable tool for documentation of clinical activities.[18] The clinical staff pharmacists were given examples of what would entail a serious or very serious problem, to ensure consistency in the documentation process. For reasons of patient confidentiality, the forms contained no patient identifiers. The clinical staff pharmacist was required to include the date of the intervention; the patient's name, medical record number, date of admission, and sex; the estimated severity of the preventable adverse drug event requiring an intervention (i.e., serious or very serious); an explanation of the intervention; the estimated cost impact of interventions (categorized as less than $100, as more than $100 but less than $1000, or as more than $1000; all amounts in US dollars); and the time required to perform the intervention.

Data Analysis

After the data collection sheets for the study period were retrieved, each intervention and the problem it was intended to address were assigned to intervention and medication-related problem categories by an investigator (L.M.O.) not involved in the documentation process. This step was taken to ensure consistency in the assignment of categories, since there are no standard criteria in the literature for classifying interventions by pharmacists or categorizing the types of medication-related problems that necessitated the interventions. For this study, the interventions were classified according to categories used by Leape and others[16] in an investigation assessing the benefits of a pharmacist in an intensive care setting. The medication-related problems that precipitated the interventions were subsequently categorized into groups that best characterized the data, using terminology employed in other studies of pharmacists' clinical activities.[18] The number and percentage of interventions and medication-related problems in each category were entered in an Excel spreadsheet. Because there was no control group, the spreadsheet data were reported using descriptive statistics.

It was intended that the cost impact would be analyzed from the standpoint of cost savings (e.g., through shortening of a planned course of drug therapy) and cost avoidance related to preventable adverse drug events. Interventions involving an estimated cost saving of more than $1000 were then reviewed by an independent panel of 3 pharmacists (not involved in the investigation) to determine more precisely the potential cost savings.

To determine cost avoidance due to prevention of an adverse drug event, the same independent panel reviewed each intervention to determine the probability of the adverse event occurring in the absence of the intervention. As in Nesbit and others,[15] the probabilities of adverse drug events were set at 0, 0.01, 0.1, 0.4, or 0.6, corresponding to zero, very low, low, medium, or high likelihood of the event. If 2 or 3 panel members chose the same probability value, this value was used in the cost avoidance calculation. If all of the panel members chose a different probability value, the average value (rounded to the nearest probability value) was used in the calculation. Each probability value was multiplied by the estimated cost of a preventable adverse drug event, as reported by Bates and others[7] and updated according to the consumer price index. The cost avoidance per intervention was calculated, along with the total cost avoidance associated with all prevented adverse drug events.

A cost–benefit analysis was performed using the average salary (including benefits) of a beginning clinical staff pharmacist at the institution and the cost avoidance figures. Because the clinical staff pharmacists collected data for different lengths of time, the number of months of documentation by each pharmacist was summed, and the cost–benefit analysis was based on the assumption that one pharmacist had performed all of interventions over the total number of months. A simple sensitivity analysis was conducted by halving and doubling the cost avoidance values to give a range of probability estimates. The analysis was conducted from the standpoint of the institution; no discounting was performed since all calculations and events were considered to have taken place within a 1-year period.

RESULTS

Five clinical staff pharmacists recorded their interventions over a total of 10 months (some of the pharmacists were unable to record interventions for the entire 3-month documentation period because of other responsibilities such as inpatient staffing requirements). The number of interventions was variable from one 2-week period to another (Table 1).

Approximately twice as many interventions were considered serious as were considered very serious (Table 2). The interventions could be classified into 8 intervention categories (Table 3) and 15 medication-related problem categories (Table 4). Antineoplastic agents (13 or 28%), anticoagulants (11 or 23%), and antibiotics (7 or 15%) accounted for most of the potentially preventable adverse drug events.

Table 1. Interventions to Prevent Adverse Drug Events by Time Period and Individual Clinical Staff Pharmacist

	No. (and %) of Interventions	
By time period		
September 1–15	4	(9)
September 16–30	11	(23)
October 1–15	4	(9)
October 16–30*	9	(19)
November 1–15	9	(19)
November 16–30	10	(21)
By clinical staff pharmacists (CSPs)		
CSP 1	20	(43)
CSP 2	11	(23)
CSP 3	9	(19)
CSP 4	5	(11)
CSP 5	2	(4)

*Data for October 31 were omitted to ensure uniform periods for the analysis.

Table 2. Interventions by Severity of Potential Problem and Performance Time

	No. (and %) of Interventions	
Severity rating		
Serious	27	(57)
Very serious	14	(30)
Not reported	6	(13)
Time required for intervention (min)		
<15	5	(11)
15–30	21	(45)
30–45	2	(4)
45–60	1	(2)
>60	3	(6)
Not reported	15	(32)

Table 3. Interventions by Category

Type of Intervention*	No. (and %) of Interventions†	
Order clarification or correction	17	(36)
Provision of drug information	15	(32)
Formulary management	4	(9)
Assessment of adverse drug event	3	(6)
Assessment of drug interaction	2	(4)
Consideration of special order or investigational drug	2	(4)
Recommendation of alternative medication	1	(2)
Other	3	(6)

*Categories adapted from Leape and others.[16]
†Percentages do not sum to 100% because of rounding.

Table 4. Interventions by Category of Medication-Related Problem

Type of Medication-Related Problem	No. (and %) of Interventions*	
Subtherapeutic dose	10	(21)
Untreated disease state	6	(13)
Potential overdose	6	(13)
Failure to receive drug	5	(11)
Nonformulary agent	4	(9)
No indication for use of prescribed drug	3	(6)
Distributional error	2	(4)
Inappropriate drug choice	2	(4)
Adverse drug event	2	(4)
Drug interaction	2	(4)
Inappropriate frequency	1	(2)
Inappropriate duration	1	(2)
Inappropriate monitoring parameters	1	(2)
Inappropriate combination	1	(2)
Inappropriate administration time	1	(2)

*Percentages do not sum to 100% because of rounding.

The cost impact of 37 of the interventions was documented (the estimated cost impact was not reported for the remaining 10 interventions). Seventeen interventions had an estimated cost impact of more than US$1000 each, 13 interventions an estimated cost impact of more than US$100 but less than US$1000, and 7 interventions an estimated cost impact of less than US$100.

The attempt to derive a better estimate of cost savings for interventions with an impact of more than US$1000, through the independent panel, did not work. Although the probabilities of occurrence (in the absence of the intervention) that were assigned to preventable adverse drug events were fairly consistent among the panel members, the members expressed frustration with attempts to assign more specific cost figures. A common comment was that just about any figure could be chosen for a given intervention, depending on the assumptions. Therefore, the cost savings estimates derived from this exercise were not analyzed further.

The cost avoidance of the 33 interventions related to preventable adverse drug events was analyzed on the basis of a previous investigation by Bates and others,[7] who assumed that each preventable event cost the institution US$4685. This figure was updated to US$5642 according to the consumer price index for December 2001 and was then multiplied by the probability of occurrence for each adverse drug event. In total, 18 of the interventions were associated with a probability factor of 0.6, 9 interventions were associated with a probability factor of 0.4, and 6 interventions were associated with a probability factor of 0.1. The total

calculated cost avoidance was US$84,631 (range based on sensitivity analysis: US$42,316 to US$169,262). The estimated cost avoidance of US$84,631 was achieved by the equivalent of one full-time pharmacist working for a total of 10 months; extrapolated to a 12-month period, the estimated cost avoidance was US$101,557. At the time of the study, the starting annual salary, including benefits, for a clinical staff pharmacist was US$85,000; therefore, the cost–benefit ratio was approximately 1.2. Thus, approximately $1.20 was saved for each $1 spent on a pharmacist's salary.

The cost impact of the interventions was also evaluated in relation to the categories of medication-related problems (Table 4); interventions with a cost impact greater than US$1000 occurred in 9 categories.

DISCUSSION

This pilot study differed from previous studies of pharmacy interventions[8-15] in that the documentation focused on problems that were perceived to be serious or very serious and the interventions were not limited to restrictive strategies such as formulary adherence. Before initiation of this study, both administrative and clinical pharmacy personnel realized the importance of documentation, as clinical staff pharmacists began performing functions on hospital wards. However, members of both groups had concerns about the time required for documentation, which might detract from patient care activities. Therefore, it was decided that the pharmacists would focus on documenting interventions perceived to be of substantial importance, while data on activities perceived to be of lesser importance (e.g., evaluation of blood drug concentrations with no recommended changes) would be garnered through other means. For any site considering documentation efforts aimed at justifying pharmacists' clinical activities, the amount and type of information collected must be considered in relation to the time involved in the collection process. The balance between these 2 factors will vary by institution, depending on the method used for data collection (e.g., computers, PDAs, pen and paper).

In the landmark study of adverse drug events by Bates and others,[19] analgesics (29%), sedatives (10%), and antibiotics (9%) accounted for most preventable events. In this investigation, antineoplastic agents, anticoagulants, and antibiotics accounted for most of the potentially preventable adverse drug reactions. The differences are likely related to the patient populations: Bates and others[19] studied a variety of patients in 2 tertiary care institutions, whereas most of the work by clinical staff pharmacists in the current study was performed on oncology and cardiovascular wards.

In this pilot evaluation, some of the interventions prevented adverse drug events that had the potential to cause serious patient harm. For example, several of the interventions addressed prescribing errors related to chemotherapy agents that could have resulted in profound patient immunosuppression. The obvious potential for patient harm in such cases led to a consistently high estimation of the probability of occurrence of an adverse drug event in the absence of the intervention (e.g., 0.4 or 0.6). In contrast, in a study by Nesbit and others[15] only 2% of the adverse events had probabilities of occurrence of 0.4 or 0.6. However, those authors recorded 4959 interventions of various types and importance over a 1-year period. Given the focus of this study on interventions with relatively high severity, the authors are confident that the greater probabilities of occurrence are appropriate.

Because the cost avoidance figures were based on the product of a probability of occurrence and the estimated cost of a preventable adverse drug event, it is not surprising that the interventions also had greater cost avoidance than those reported by Nesbit and others.[15] The latter evaluation involved 3 pharmacists who discovered 992 potentially avoidable adverse drug events with a total cost avoidance of US$488,436 over a 12-month period.[15] The current evaluation involved the equivalent of one pharmacist working for a 10-month period, identifying 33 preventable (i.e., avoidable) adverse drug events with a total cost avoidance of US$84,631. Extrapolating the cost avoidance figure to a 1-year period yielded a cost–benefit ratio of 1.2 (based on a salary of US$85,000 per year). In other words, the positions of the clinical staff pharmacists could be justified solely on the basis of cost avoidance associated with preventable adverse drug events, regardless of other activities that are more difficult to quantify in terms of cost impact.

A substantial number of clinical staff pharmacist activities pertain to practice expectations that are difficult to quantify in terms of importance or cost. Examples of such items include education of patients and other health care professionals and participation in multidisciplinary activities such as cardiopulmonary resuscitation teams. While data extracted from national databases suggest a decrease in mortality rates when pharmacists provide such services,[17] it is more difficult to demonstrate concrete benefits at a local level. The lack of interventions for items such as patient education is almost certainly related to the focus of the data collection (i.e., issues deemed by the pharmacist to be serious or very serious). Although not reported on the

data collection forms, provision of these services can be included in group activity summaries that are collected in the health care system.

The major limitation of this evaluation was its retrospective nature (no control group) with the possibility of missing, incomplete, or inaccurate data. This limitation was mitigated somewhat by the concurrent nature of the data collection by the clinical staff pharmacists through their usual documentation procedures. Another limitation relates to the estimation by the pharmacists of the value of their interventions according to predefined criteria and estimated cost savings. This limitation is particularly applicable to interventions in which problems were identified before they escalated in terms of seriousness or cost.

Since this investigation was performed, a number of changes relating to documentation by clinical staff pharmacists have been implemented at the authors' institution. For example, the open format of written documentation used during the period of investigation required a substantial amount of time for subsequent data analysis and formatting before presentation to administrative personnel. In part because of the results of this investigation, a uniform system for electronically documenting clinical activities has been instituted. The system automatically performs economic analyses of the intervention data with summary statistics that may be considered in pharmacists' performance evaluations and are used to help justify the clinical positions to hospital administration.

References

1. Smith SR, Utterback CM, Parr DD, Waller DJ. Pharmacist clinical intervention program. *Top Hosp Pharm Manage* 1993;13(2):1-15.
2. American Society of Health-System Pharmacists. ASHP guidelines on adverse drug reaction monitoring and reporting. *Am J Health Syst Pharm* 1995;52:417-9.
3. American Society of Hospital Pharmacists. ASHP guidelines on preventing medication errors in hospitals. *Am J Hosp Pharm* 1993;50:305-14.
4. Manasse HR Jr. Medication use in an imperfect world: drug misadventuring as an issue of public policy, part 1. *Am J Hosp Pharm* 1989;46:929-44.
5. Kohn LT, Corrigan JM, Donaldson M, editors. *To err is human: building a safer health system.* Washington (DC): Institute of Medicine; 1999.
6. Johnson JA, Bootman JL. Drug-related morbidity and mortality: a cost-of-illness model. *Arch Intern Med* 1995;155:1949-56.
7. Bates DW, Spell N, Cullen DJ, Burdick E, Laird N, Petersen LA, et al. The costs of adverse drug events in hospitalized patients. *JAMA* 1997;277:307-11.
8. Mutnick AH, Sterba KJ, Peroutka JA, Sloan NE, Belz EA, Sorenson MK, et al. Cost savings and avoidance from clinical interventions. *Am J Health Syst Pharm* 1997;54:392-6.
9. Weidle P, Bradley L, Gallina J, Mullins CD, Thorn D, Siegel LP. Pharmaceutical care intervention documentation program and related cost savings at a university hospital. *Hosp Pharm* 1999;34:43-52.
10. Taylor CT, Church CO, Byrd DC. Documentation of clinical interventions by pharmacy faculty, residents, and students. *Ann Pharmacother* 2000;34:843-7.
11. Taylor, JT, Kathman SM. Documentation of cost savings from decentralized clinical pharmacy services at a community hospital. *Am J Hosp Pharm* 1991;48:1467-70.
12. Janning SW, Stevenson JG, Smolarek RT. Implementing comprehensive pharmaceutical services at an academic tertiary care hospital. *Am J Health Syst Pharm* 1996;53:542-7.
13. Bjornson DC, Hiner WO, Potyk RP, Nelson BA, Lombardo FA, Morton TA, et al. Effect of pharmacists on health care outcomes in hospitalized patients. *Am J Hosp Pharm* 1993;50:1875-84.
14. Gandhi PJ, Smith BS, Tataronis GR, Maas B. Impact of a pharmacist on drug cost in a coronary care unit. *Am J Health Syst Pharm* 2001;58:497-503.
15. Nesbit TW, Shermock KM, Bobek MB, Capozzi DL, Flores PA, Leonard MC, et al. Implementation and pharmacoeconomic analysis of a clinical staff pharmacist practice model. *Am J Health Syst Pharm* 2001;58:784-90.
16. Leape LL, Cullen DJ, Dempsey-Clapp M, Burdick E, Demonaco HJ, Erickson JI, et al. Pharmacist participation on physician rounds and adverse drug events in the intensive care unit. *JAMA* 1999;282:267-70.
17. Bond CA, Raehl CL, Franke T. Clinical pharmacy services and hospital mortality rates. *Pharmacotherapy* 1999;19:556-64.
18. Overhage JM, Lukes A. Practical, reliable, comprehensive method for characterizing pharmacists' clinical activities. *Am J Health Syst Pharm* 1999;56:2444-50.
19. Bates DW, Cullen DJ, Laird N, Petersen LA, Small SD, Servi D, et al. Incidence of adverse drug events and potential adverse drug events. *JAMA* 1995;274:29-34.

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