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ORIGINAL ARTICLE

The Outcome of Clinical Pharmacists' Interventions in a Taiwanese Hospital on Pharmacoeconomics and Cost Saving

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Objective: In this study, we indented to evaluate the cost implications after preventing drug adverse events of inpatients by the proper interventions made by clinical pharmacists in a Taiwanese hospital.
Methods: Five clinical pharmacists who were assigned to intensive care units, neurology, cardiology, and nephrology wards documented all interventions with a standardized form. The data were retrospectively evaluated for the following information: (1) categories of drug-related problems; (2) general descriptions of the interventions; and (3) the clinical outcomes of the pharmacist-provided interventions. These pharmacist-provided interventions were independently reviewed by one clinical pharmacist and one physician to determine the probability that an adverse drug event (ADE) would have occurred without the intervention, the severity of potential ADEs, and the clinical significance of the interventions. The potential cost avoidance of the interventions was estimated calculating the payments for the potential ADEs.
Results: A total of 460 interventions provided by pharmacists were documented from December 2010 to May 2011. The most commonly documented interventions made by pharmacists were the recommendations of dosage adjustments (48.7%). Approximately, 89.3% of pharmacist recommendations ($n = 411$) were accepted by physicians in the therapeutic team. The potential cost saving of the documented interventions during a 6-month period was calculated to be between 3,692,019 and 9,110,880 in National Taiwan Dollars (NTD), and the potential benefit:cost ratio was estimated as high as 8.4:1.
Conclusion: Interventions provided by hospital clinical pharmacists significantly prevented potential ADEs by monitor actively drug therapy and patient safety at the intensive care unit, cardiology, neurology, and nephrology care units. To the best of our knowledge, this is the first study to document the potential cost saving and obtained a benefit:cost ratio of 8.4:1 based on the implementation of a proper medication management and use provided by five clinical pharmacists for 6 months in a Taiwan hospital.

1. Introduction

The role of the pharmacists has been constantly evolving worldwide; it has become a vital part of the health care system. According to a survey by the International Pharmaceutical Federation in 2005, the scope of practice for hospital pharmacists includes medicine procurement, preparation, delivery, and outcome monitoring plus a significant role in the therapy management and use.[1]

In addition to supplying proper and safe medications, hospital pharmacists also have to monitor patients for therapeutic outcomes and potential adverse drug reactions (ADR). The literature has pointed out that the addition of clinical pharmacists in the care of hospital inpatients can reduce ADR or medication errors while improving medication adherence, knowledge, and appropriateness.[2] With a yearly increase of medical expenses, previous studies also have examined the economic effects of clinical pharmacists' interventions.[3–11] Some focused on specific services provided by clinical pharmacists.[3,4] A Chinese hospital was found that pharmacist interventions on antibiotic use for 10 months can decrease the total cost of hospitalization.[3] At another hospital in Taiwan has shown that of a pharmacist-managed levofloxacin intravenous-to-oral conversion service has resulted in a saving of about 40% on the

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total inpatient expenditures.[4] Some studies have focused on pharmacoeconomics made by pharmacists in certain wards or certain hospitals.[5–9] A clinical pharmacist made 35 recommendations/100 patient days within the 24-week study period in a pediatric intensive care unit (ICU) of a children's hospital.[5] The total direct cost savings from this study period was US$1,977, which can be extrapolated to US$9,135 per year. Another study analyzing 2,150 pharmacist interventions in a hospital emergency department for 1 year and the estimated cost saving was US$1,029,776.[6] Finally, 129 interventions made by a clinical pharmacist in a surgical ICU over 4.5 months leads to a calculated cost saving of US$205,919–280,421.[7]

These pharmacoeconomic effects made by pharmacists are compared in systemic reviews.[10–12] Despite limitations in study design and differences in statistical analysis, the majority of these studies showed positive economic benefits to cost provided by pharmacist interventions. Information evaluating the economic effects after clinical pharmacists' interventions in Taiwanese hospitals is lacking.

Since the separation of prescribing and dispensing in 1997, Taiwanese pharmacists have been working hard to expand their scope of practice to not limit themselves as someone whose job focuses on dispensing medications only. The Standards Governing the Establishment of Medical Care Institutions from the Ministry of Health and Welfare in Taiwan stipulate one hospital pharmacist dispensing prescriptions to 40 hospitalized patients, but without requesting specific clinical obligations for pharmaceutical care. Since 2007, the functions and responsibilities of Taiwanese pharmacists include "functions related to pharmaceutical care" based on the revised Pharmacist Act. Although not required by any regulations, many hospital pharmacists in Taiwan practice therapeutic drug monitoring and renal dosing monitoring for specific drugs, such as aminoglycosides, vancomycin, and phenytoin. Patient education on medications and regulation of formulary are also part of the responsibilities for clinical pharmacists in Taiwanese hospitals. Some clinical pharmacists also work with the multidisciplinary teams to provide patients with more well-rounded care, especially in the ICU. This study was the first attempt at evaluating the cost implications of five clinical pharmacists after preventing potential adverse events in hospitalized patients by intervening in their medication management and use at the ICU, cardiology, neurology, and nephrology wards for 6 months in a Taiwanese hospital.

2. Methods

Shuang-Ho Hospital is a teaching hospital of Taipei Medical University with 880 beds that provides acute care, medical and surgical services to the people in New Taipei City, Taiwan. Five clinical pharmacists were assigned to provide clinical services in ICUs, neurology, cardiology, and nephrology wards. These pharmacists were selected based on their education background and work experience. A degree of master or above was not required but preferred. They received at least the training of postgraduate year 1–2 before they were assigned the task of medication management and use. In addition to the patient care duty, these pharmacists also participated in administrative and teaching responsibilities. Four clinical units of ICU, neurology, cardiology, and nephrology were chosen because the current pharmacy staffs are not enough to provide the clinical pharmacist services to all patients in the hospital. The participating clinical pharmacists screened through all patients' medication uses in these four wards every day to make sure all medications were effective and safe for each patient. Although no specific protocols are available, the pharmacists followed the guidelines developed by the Shuang-Ho Hospital Pharmacy Department for therapeutic drug monitoring and renal dosing monitoring for specific drugs, such as aminoglycosides, vancomycin, and phenytoin. If the pharmacists encountered any drug-related problems, they would communicate with the physicians and/or other health care professionals to solve drug-related problems such as proper dosage, ADR, drug–drug interactions, and efficacy.

All interventions made by the pharmacists were recorded through a Google document, which were analyzed later using Microsoft Excel. These data included background information of the patients, the categories of drug-related problems, general descriptions of the interventions, and the results of the interventions. The categories of drug-related problems included: (1) failure to receive drugs; (2) drug interactions; (3) drug used without an indication; (4) drug duplication; (5) untreated indications; (6) adverse drug reactions; (7) discrepancies between the lists of medications before and after admissions or transfers; (8) improper selection of drug or dosage form; (9) improper dosage or durations; and (10) others. The evaluation of all the interventions was carried out using the model of Lee et al.[8] One clinical pharmacist, who was not participating in this study, and one physician reviewed the interventions independently to determine the probability that an adverse drug event (ADE) could have occurred without the intervention; the severity of potential ADEs and the significance of the interventions were also estimated. The evaluating pharmacist is an experienced clinical pharmacist who is on faculty appointment of our medical school. The physician is an internist who has many years of experience and is familiar with drug-related problems. The probability value of an ADE without the pharmacist's intervention was estimated to be 0–1.0, with 1.0 defined as very likely to occur, 0.5 as neither likely nor unlikely to occur, and 0 defined as completely unlikely to occur. The severity of the potential ADEs was scored as 0.4 being potentially lethal, 0.3 being serious, 0.2 being significant, 0.1 being minor, or 0 being no error. The significance of the interventions was ranked as 0.5 being extremely significant, 0.4 being very significant, 0.3 being significant, 0.2 being somewhat significant, 0.1 being not significant, and 0 being insignificant.

The potential cost saving of an intervention was estimated by using the formula from the payment system of the National Health Insurance (NHI) in Taiwan times the probability of the ADE that would have happened if not for the proper pharmacist intervention. The estimated payments for the potential ADE were calculated by the payment for the specific diagnosis related groups (DRGs) designated for the specific ADE.[13] The standard payment rate was established for each DRG. Then the specific payment for each institute was calculated by taking various factors into consideration, including the location, teaching, human resources, facilities, and patient population of that institute. Therefore the payment was usually an estimated range, instead of a specific value.

$$\text{Tw} - \text{DRG payment} = \text{relative weight} \times \text{standardized payment rate} \times (1 + \text{hospital base rate} + \text{pediatric adjustment rate} + \text{case mix index adjustment rate})$$

For example, if the probability of an intervention that could prevent a patient from experiencing acute renal failure caused by the high dose of gentamicin is 0.8, then the cost saving would be calculated by the above formula using the specific DRG for drug-induced toxicity times 0.8.

3. Results

The five participating pharmacists documented a total of 460 interventions during the 6-month study period. The most commonly documented interventions were recommendations of dosage adjustments for improper dosage or duration (48.7%, Figure 1). For example, a patient with pneumonia and renal impairment was prescribed moxifloxacin 250 mg daily. However, moxifloxacin does not require dose adjustment for patients with renal impairment. The pharmacist recommended that the dose of moxifloxacin be increased to 400 mg effective daily dosage for pneumonia and the order was changed. The second most common category of interventions was regarding the selection of proper drugs or dosage forms (13.04%). For example, a physician prescribed immediate-release nifedipine capsule three times a day for a patient's hypertension. However, the pharmacist suggested that sustained-release nifedipine was a better choice for maintenance therapy of hypertension to avoid tachycardia and ischemia, and the order was changed. The next most commonly seen category was medication changes due to the discrepancies between the lists of medications before and after admissions or transfers (11.52%). When the pharmacists screened through the admission orders for newly admitted patients, they would check the orders against the medication lists that the patients were taking before admission. If a discrepancy existed between the two, the pharmacists would investigate the reason and make appropriate recommendations accordingly. The distribution of all categories of drug-related problems is described in Figure 1.

Among the 460 interventions raised by five clinical pharmacists during a 6-month study period, only 10.7% (n = 49) were not accepted by the physicians because the physicians did not agree with the recommendations or did not consider there would become a drug-related problem. The average score for the probability of an ADE was 0.4, ranging from 0 to 0.9. A score of 0.4 indicates that an ADE may be unlikely to occur without the intervention. The average score for the severity of potential ADEs was 0.2, which means less than serious, and the average score for the significance of the interventions was 0.3, which means more than somewhat significant (Table 1).

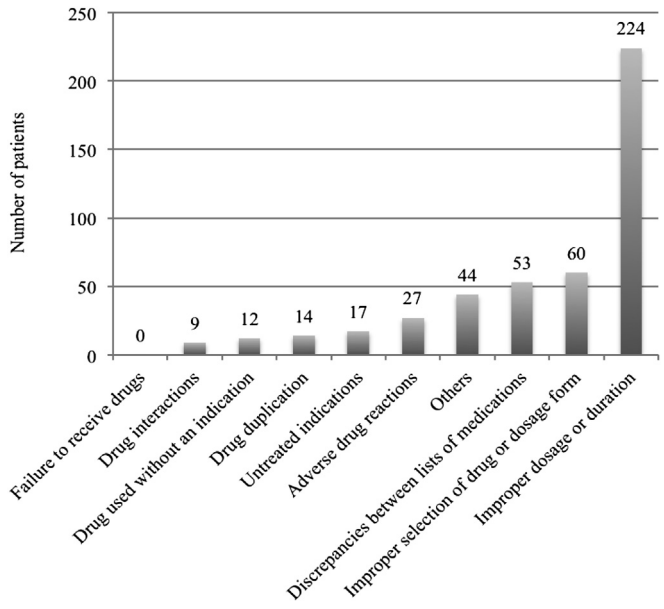

Figure 1 Categories of drug-related problems.

Table 1 The scores for the probability of an ADE, the severity of potential ADEs, and the significance of the interventions.

	Probability of an ADE	Severity of potential ADEs	Significance of the interventions
Range	0–0.9	0–0.4	0–0.5
Average ± standard deviation	0.4 ± 0.2	0.2 ± 0.1	0.3 ± 0.1
Median	0.3	0.2	0.3

ADE = adverse drug event.

According to the payment range for the DRGs published by the Bureau of NHI and using the average payment for each DRG, the potential cost saving for the interventions among these 6 months was calculated to be between New Taiwan Dollar (NTD) 3,692,019 and NTD 9,110,880 (approximately US$126,970 and US$313,330, respectively). If we used the average monthly salary for a pharmacist in Taiwan of NTD 48,000 and estimated the time needed for these interventions as 0.75 full-time equivalency, the calculated cost of five pharmacists for 6 months would be NTD 1,080,000. The benefit:cost ratio of clinical pharmacists was estimated to be between 3.4:1 and 8.4:1.

4. Discussion

The present results suggest that proper interventions in medication management and use made by pharmacists were accepted by 89% of physicians, which may prevent potential ADEs leading to cost saving for the hospital. The benefit of patient care services provided by pharmacists has been well established in the literature.[3–11] ADEs, ARSs, and/or medication errors are reduced while the hospital length of stay is shortened; the appropriateness of therapy, patient's knowledge, and adherence of medications are improved. At the same time, no evidence of harm resulted from the addition of clinical pharmacist services in the care of inpatients.[2]

The present results confirm many previous studies. For example, the most common category of interventions was for dosage adjustments (48.7%, Figure 1), which is consistent with previous reports of a study in a pediatric ICU[5] and another study in a Veterans Affairs medical center in America.[8] "Adjusting dosage or frequency" has been the most frequent type of recommendation in the Veterans Affairs medical center study, whether in the inpatient (51.6%), outpatient (33.2%), or nursing-home setting (44%). Pharmacists possess unique knowledge of pharmacokinetics and pharmacodynamics so they can evaluate each patient's individual status and recommend the most appropriate dosing of medication for personalized treatment plans. This proper pharmacy intervention can prevent potential ADEs, and thus ensure that the treatments are provided to patients with the most optimal efficacy or therapeutic outcomes.

The present second most frequently seen type of intervention was the selection of proper drugs or dosage forms for the treatment. For example, an order of levofloxacin only for a patient with recent history of methicillin-resistant *Staphylococcus aureus* would not be sound but a pharmacist would recommend adding vancomycin and then prevent the potential methicillin-resistant *Staphylococcus aureus* infection. Another example would be an order of intravenous vancomycin for treating *Clostridium difficile* colitis; the attending pharmacist would advise to change the route of vancomycin to oral in order to treat the colitis. Pharmacists can ensure

patients receive the most appropriate treatments in the most proper dosage forms.

In a systematic review article of clinical pharmacists and inpatient medical care,[2] 11 out of the 36 studies were focused on medication review and reconciliation. The five clinical pharmacists in the current study compared the medication lists for newly admitted patients against the admission orders. The discrepancies found between the two lists were the third most common interventions in this study. It is proven that pharmacists can take a more accurate medication history, identifying allergy history and prescription errors. They can also improve communication among outpatient physicians, pharmacists, and the inpatient team at admission and discharge of the patients. These are all part of the benefits that pharmacists can bring to inpatients clinically regarding the medication reconciliation during admission and also during discharge of patients.

The evaluations of the interventions in the current study reveal that ADEs might be unlikely to occur without these interventions most of the time; the severity of potential ADEs was less than serious ADEs. The probability of ADE was low possibly because many of these drug-related problems would not result in ADE. Examples of ADEs include untreated indication, improper drug selection, subtherapeutic dose or overdose, and drug use without an indication. However, the total of 460 interventions issued by five pharmacists in 6 months still may save approximately US$126,970–313,330 by preventing potential ADEs. The present result agrees with a similar trend observed by previous studies in America.[5–7] Although the estimated amounts of cost saving are somehow different in these studies, they prove that the clinical services provided by pharmacists can save money for hospitals in addition to improving patient safety and efficacy in the medication management and use.

The first limitation of the study is the method of calculating potential cost saving. Various studies utilized different methods to calculate the cost avoidance from pharmacist provided interventions. One Taiwanese study on the program of intravenous antibiotic to oral conversion found a significant decrease in the cost of drug and the inpatient expenditures.[4] Another study evaluated the interventions from a pharmacist assigned to a surgical ICU,[7] yielding a cost avoidance of approximately US$205,919–280,421 based on the probability of ADE occurrence. The calculated cost savings are listed as US$150,307 for length of stay reduction and US$111,848 for readmission reduction; this significant cost saving has been found in an Australia study that assessed pharmacists' interventions in multiple hospitals.[9] We utilized the payment range for the DRGs published by the Bureau of NHI (www.nhi.gov.tw/webdata/webdata.aspx?menu) to estimate the cost of the potential ADE if it would be prevented by pharmacist interventions in this Taiwanese hospital. Because the payment for a specific DRG is not fixed, it is difficult to estimate a specific number for the cost of an ADE. At the same time, the calculations were based on estimations of potential ADEs, therefore it is not a precise method to calculate true values of cost savings. A potential limitation might come from the possible discrepancies between the two independent evaluators—the pharmacist and the physician—but the present study found no significant differences in the independent evaluations.

Although the present study was a single-center study with a relatively small sample size, the high acceptance rate of 89.3% of the pharmacist interventions by the physicians is consistent with a study from America with a 92.4% acceptance rate.[6] Despite the fact that not every recommendation was accepted, this still showed a great confidence from the physicians in the competence of these professional pharmacists. It is beneficial for the patients that physicians and pharmacists work together as a therapy team to provide personally effective, efficient, and safe medication therapies. At the same time, the estimated benefit:cost ratio of 3.4:1–8.4:1 suggest further that it is also advantageous for the hospital to encourage pharmacists to provide clinical services to all inpatients. Therefore it is reasonable to recommend pharmacists in Taiwanese hospitals to start providing a patient-oriented clinical service program on medication management and use to all patients.

In conclusion, the clinical pharmacists in a Taiwanese hospital provided significant proper interventions in medication management and use and thus prevented potential ADEs by routinely monitor drug therapies in inpatient care units. The present study is the first to present the estimated cost saving achieving NTD 9,110,880, with the potential benefit:cost ratio reaching as high as 8.4:1 based on the pharmacoeconomic outcomes made by clinical pharmacist interventions in Taiwan.

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