Original Research

Impact of pharmacist's interventions on cost of drug therapy in intensive care unit

Surasak SAOKAEW, Sirada MAPHANTA, Pornchanok THANGSOMBOON.

ABSTRACT[*]

Pharmacist participation in patient care team has been shown to reduce incidence of adverse drug events, and overall drug costs. However, impact of pharmacist participation in the multidisciplinary intensive care team on cost saving and cost avoidance has little been studied in Thailand.

Objective: To describe the characteristics of the interventions and to determine pharmacist's interventions led to change in cost saving and cost avoidance in intensive care unit (ICU).

Methods: A Prospective, standard care-controlled study design was used to compare cost saving and cost avoidance of patients receiving care from patient care team (including a clinical pharmacist) versus standard care (no pharmacist on team). All patients admitted to the medical intensive care unit 1 and 2 during the same period were included in the study. The outcome measures were overall drug cost and length of ICU stay. Interventions made by the pharmacist in the study group were documented. The analyses of acceptance and cost saving and/or cost avoidance were also performed.

Results: A total of 65 patients were admitted to either ICU 1 or 2 during the 5 week- study period. The pharmacist participated in patient care and made total of 127 interventions for the ICU-1 team. Ninety-eight percent of the interventions were accepted and implemented by physicians. The difference of overall drug cost per patient between two groups was 182.01 USD (1,076.37 USD in study group and 1,258.38 USD in control group, p=0.138). The average length of ICU stay for the intervention group and the control group was not significantly different (7.16 days vs. 6.18 days, p=0.995). The 125 accepted interventions were evaluated for cost saving and cost avoidance. Pharmacist's interventions yielded a total of 1,971.43 USD from drug cost saving and 294.62 USD from adverse drug event cost avoidance. The net cost saved and avoided from pharmacist interventions was 2,266.05 USD. Interventions involving antibiotic use accounted for the largest economic impact (1,958.61 USD).

Conclusions: Although the statistical was not significant, having a pharmacist participated in ICU patient care team tend to reduced overall drug cost, cost saving, and cost avoidance. The largest cost impact and intervention requirement involved antibiotic use.

Keywords: Cost Savings. Pharmacists. Intensive Care Units. Thailand.

IMPACTO DE LAS INTERVENCIONES DE FARMACÉUTICOS EN EL COSTE DEL TRATAMIENTO FARMACOLÓGICO EN UNA UNIDAD DE CUIDADOS INTENSIVOS

RESUMEN

La participación del farmacéutico en el equipo de cuidados del paciente ha demostrado reducir la incidencia de eventos adversos medicamentosos, y los costes totales de medicamentos. Sin embargo, el impacto de la participación del farmacéutico en equipos multidisciplinarios de cuidados intensivos sobre el ahorro y la evitación de costes en Tailandia ha sido poco estudiado.

Objetivo: Describir las características de las intervenciones y determinar si las intervenciones del farmacéutico condujeron a cambios en ahorro de costes o evitación de costes en una unidad de cuidados intensivos (UCI).

Métodos: Se diseñó un estudio prospectivo controlado con cuidados usuales para comparar los ahorros de costes y las evitaciones de costes de pacientes recibiendo cuidados de un equipo de atención a paciente (que incluía un farmacéutico clínico) contra una atención normal (sin farmacéutico en el equipo). Todos los pacientes ingresados en las unidades 1 y 2 de cuidados intensivos médicos fueron incluidos en el estudio. Los resultados medidos eran coste total de medicamentos y duración de la estancia en la UCI. Se documentaron las intervenciones realizadas por el farmacéutico en el grupo de estudio. También se realizaron análisis de aceptación y ahorro de costes y/o evitación de costes.

Resultados: Un total e 65 pacientes ingresaron en las UCI 1 o 2 durante las 5 semanas del estudio. El farmacéutico participó en la atención de pacientes y realizó 127 intervenciones para el equipo de la UCI 1. El 98% de las intervenciones fueron aceptadas e implantadas por los médicos. La diferencia del coste total de medicamentos por paciente entre los dos grupos fue de 182,01 USD (1.076,37 USD en el grupo estudio y 1.258,38 USD en el control, p=0.138). La media de duración de estancia entre grupo de estudio y control no fue significativamente diferente (7,16 días vs. 6,18 días, p=0.995). Se evaluaron los ahorros y

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evitaciones de costes de las 125 intervenciones aceptadas. Las intervenciones del farmacéutico llevaron a un total de 1.971,43 USD de ahorros y a 294,62 USD de coste de eventos adversos evitados. El coste neto ahorrado y evitado por las intervenciones del farmacéutico fue de 2.266,05 USD. Las intervenciones que involucraban el uso de antibióticos significaron el mayor impacto económico (1.958,61 USD).

Conclusiones: Aunque, no fue estadísticamente significativo, el haber participado un farmacéutico en el equipo de cuidados de la UCI produjo una tendencia a la reducción global del coste de medicamentos, ahorro de costes y evitación de costes. El mayor impacto en los costes envolvió el uso de antibióticos.

Palabras clave: Ahorro de costes. Farmacéuticos. Unidades de cuidados intensivos. Tailandia.

INTRODUCTION

The role of pharmacist in health care delivery continues to evolve beyond dispensing and directly related activities.[1,2] Numerous studies has been shown pharmacist make valuable contributions to improve clinical, economic, and humanistic patients' outcomes.[3-29] Furthermore, many studies have evaluated the role of the pharmacist especially in intensive care unit (ICU).[4,6-9,20,22,23,26] The rationale for putting a pharmacist in an ICU is that those patients are sicker and thus require a greater complexity of care. Having a pharmacist on a team in an ICU has been shown to reduce the incidence of adverse drug events (ADEs)[4,25,29] and decrease costs associated with care.[3,22,23,25,27-29] However, the study of the impact of pharmacist's interventions in intensive care unit in Thailand are limited.

As a result, we conducted a study of the effectiveness of pharmacist participation in a multidisciplinary team in medical ICU to provide optimal patient care through avoidance or treatment of drug related problems. The objectives of the study were to determine the type and quantity of patient care interventions recommended by a pharmacist and to specifically examine cost saving and cost avoidance that resulted from pharmacist recommendations in medical ICU.

METHODS

Setting, design, and sample

The study carried out in 2 medical ICUs at Buddhachinaraj Hospital, a large tertiary care hospital (940-bed size hospital), in Phitsanulok province, Thailand, during February 28, 2005, through April 1, 2005. There are 20 beds in each unit. Patients were admitted to ICU based on disease severity and physician's judgment for appropriated care.

Both of two units were included in the study, one as the intervention group and the other as the control group. Patients had equal chance of being admitted to the control group or the intervention group. The admitting process was based on the availability of beds and physician service. The demographics and Acute Physiology and Chronic Health Evaluation (APACHE) scores in both groups were compared to determine if they were similar. We compared outcome, direct drug cost and length of ICU stay (LOS), between the study group and control group during the same period. For the study group, we calculated cost saving and cost avoidance resulted from pharmacist intervention. This study was approved by the Institutional Review Board/Human Subject Research Committee at Buddhachinaraj Hospital.

Pharmacist's activities and interventions

The treatment team consisted of a medical intensive care team plus a clinically trained pharmacist with a Pharm.D degree. Before morning rounds each day, the pharmacist reviewed all patient profiles and relevant data, including the physician's orders, laboratories, progress and consultation notes as appropriate, and formulated plans for modifying individual patient regimens. The pharmacist then participated in morning rounds. This provided an opportunity for the pharmacist to evaluate the treatment and suggest changes in patient drug regimens. After rounds, both newly admitted patients and patients previously admitted to the ward were discussed. The pharmacist suggestions for modifying therapy were presented. The pharmacist was full responsibility for providing drug information, pharmacotherapeutic consultation, and relevant as needed for five days a week. During 8.00 a.m. to 5.00 p.m. of the day, pharmacist maintained contact with the team physicians as needed. In all case, the pharmacist aimed to provide optimal patient care through avoidance or treatment of drug related problem, base on literature. All interventions were documented in the data collecting form.

Data analysis

To perform analysis of the result, each intervention was assigned to an intervention category. The categorization of interventions was then verified by the clinical pharmacists. Since there is no standardized method of categorizing interventions made by pharmacist, the interventions were assigned to the categories used by Leape and colleagues[4] in an intervention illustrating the benefit of a pharmacist in an ICU unit. The interventions that accepted and implemented by team were also categorized as either cost saving and/or cost avoidance.

Cost saving

Intervention that resulted in drug treatment with a lower or higher direct drug cost was evaluated in term of cost saving. Cost saving were calculated as the difference in actual costs between the previous therapy and the new therapy that was recommended by the pharmacist. Labor cost, supplies cost, or other indirect costs were not included in any calculation.[3,22,23] The saving resulting from the change in drug therapy was

generally assumed to extend to the end of therapy with the new agent.[3,11,22,30] In the case of conversion from intravenous (i.v.) to oral dosage forms, the cost difference between the dosage forms was calculated for 2 days after the switch (it assumed that without the pharmacist's interventions, physician would have switched to oral dosage forms within 2 days).[11,22]

The formula we used to estimate cost saving is in common use equation[11,23]: Cost difference in USD = (cost of drug therapy multiple by frequency per day and multiple by duration of therapy, assumed to extend to the end of therapy with the new agent, before intervention) minus (cost of drug therapy multiple by frequency per day and multiple by duration of therapy after intervention plus cost of drug that was used before intervention).

Example 1. A patient was receiving ceftazidime (1 g every 8 hrs) to treat Pseudomonas aeruginosa. Three days later, patient's renal function was worsening; calculated creatinine clearance was 16.6 ml/min. The pharmacist then gave team an intervention. After intervention, the order was changed, base on renal guideline, to ceftazidime (1 g every 24 hrs). The duration of therapy was 7 days. The cost of each 1 g-vial of ceftazidime was 1.7 USD. So, the cost for this case is, (1.7 USD/1 g-vial x 3 times/day x 7 days) – [(1.7 USD/1 g-vial x 1 time/day x 4 days) + (1.7 USD/1 g-vial x 3 times/day x 3 days)], 13.6 USD. It means 13.6 USD decreased or saved.

Example 2. A patient with underlying diabetes whose blood was sent to measure electrolyte and trace element. When the result came back, pharmacist screened and saw the potassium concentration result was 8 mEq/L (K=8 mEq/L). The pharmacist then gave team an intervention. After intervention, physician ordered Kayexalate 30 g every 4 hrs for 4 doses. The cost of 30 g-powder packed Kayexalate is 4.7 USD. Thus, the cost for this case is, (4.7 USD/30 g-powder packed Kayexalate x 4 doses), 18.8 USD. It means 18.8 USD increased. In contrast, this intervention, trough monitoring potassium and prevention of serious cardiac complications and subsequent admission or may be death, was calculated as cost avoidance as well.

The net cost saving over the duration of study period was calculated by subtracting the total decrease in drug costs from the total increase in drug costs.

Cost avoidance

The intervention with potential to avoid an adverse drug events (ADE) were assessed for cost avoidance by a member panel of clinical specialists.[28-30] The panel comprised seven members. Four members with doctor of pharmacy degree, three of the seven members had completed master's degree and had been experienced in ADR center for many years, and one of them was a clinical pharmacy specialist instructor who holds the Ph.D. degree and Board Certified Pharmacotherapy Specialist.

The panel evaluated each intervention to estimate the probability, in the absence of the intervention, of an ADE occurring on the basis of the clinical details surrounding the intervention. The probability of an ADE in the absence of the intervention was set at 0 (zero; e.g. information requested), 0.01 (very low; for problem orders e.g. clarifications, missing information, nonexistent strengths), 0.1 (low; for prevented a potentially significant reaction e.g. 2-4 x normal dose, dose inadequate to produce therapeutic effect; incorrect schedule/route with potential for therapeutic failure/toxicity; duplicate therapy with potential for additive toxicity), 0.4 (medium; for prevented a potentially serious reaction e.g. allergy to drug ordered, no allergy information, 4-10 x normal dose; no adjustment of renal failure), 0.6 (high; for prevented a potentially fatal or severe reaction e.g. 10 x normal dose; narrow therapeutic range; life-threatening reaction/anaphylaxis).[11,30] Literature was used to assign probability estimates, when available. When no literature estimate was available, judgment based on patient's clinical data was used to assign the intervention to a probability category.[30] We assumed that no intervention would increase the likelihood of a preventable ADE. The cost of each adverse event was set at 53 USD on the basis of average cost of adverse drug reaction form the previous trial.[31] Cost avoidance was calculated for each intervention by multiplying the estimated probability of an ADE in the absence of the intervention with the average cost of an ADE (53 USD).[29,30]

Example: A patient with pneumonia was receiving amoxicillin/clavulanate potassium (1000 mg/ 200 mg every 8 hrs) to treat Stapphylococcus aureus. The pharmacist calculated creatinine clearance; it was 12.5 ml/min. The pharmacist then gave team an intervention. After intervention, the order was changed, base on renal guideline, to amoxicillin/clavulanate potassium (1000 mg/ 200 mg every 12 hrs). The panel estimated the probability of an ADE, in the absence of the intervention, was 0.4 (medium). So, the cost avoidance of this case is, (0.4 x 53), 21.2 USD.

The net change in drug costs over the duration of study period calculated by cost saving plus cost avoidance. All cost in Thai baht (THB) was converted to US dollars (1 USD about 38.36 THB).

Statistical analysis

Patient variables between the study and control group were compared using chi-square analysis for sex and Mann-Whitney U test for age, APACHE score, direct drug cost, and length of stay (LOS).[32] The level significance was set at 0.05.

RESULTS

There were 65 patients admitted to the medical ICU during the study days. There was not significantly different with respect to age, sex, and APACHE score between study and control groups (Table 1).

In term of direct drug cost per capita, it was 1,076.37 USD in study group compared with

1,258.38 USD in control group. The difference of direct drug cost between two group was 182.01 USD, but did not statistical significant (p=0.138). The average LOS was 7.16 days (SD 6.62) in the study group and 6.18 days (SD 3.79) in the control group (p = 0.995) (Table 2).

Table 1 Patient Characteristics			
Characteristic	Study group (n=32)	Control group (n=33)	P Value
Age, mean (SD), year	62.66 (14.49)	65.00 (15.16)	0.527
Sex, No. (%)			
Male	18 (56.25)	18 (54.55)	0.890
Female	14 (43.75)	15 (45.45)	0.890
APACHE score, mean (SD)	17.31 (8.09)	19.75 (8.51)	0.240
APACHE = Acute Physiology and Chronic Health Evaluation			

Table 2 Direct Drug Cost and Length of ICU Stay Comparisons			
Comparator	Study group (n=32)	Control group (n=33)	P Value
ICU drug cost, USD	34,443.80	35,530.79	0.138
ICU drug cost per capital, USD	1,076.37	1,258.38	0.138
Length of ICU Stay, mean (SD), day	7.16 (6.62)	6.18 (3.79)	0.995

Of the 127 interventions provided by pharmacist, 125 interventions accepted and implemented by team (98.4%). These interventions were categorized and analyzed as either cost saving and/or cost avoidance. Interventions made by pharmacist resulted in direct cost saving of 1,971.43 USD and cost avoidance of 294.62 USD during study period. The total cost saving and cost avoidance was 2,266.05 USD (Table 3). The most common intervention was "providing required information on written orders" followed by "the team initiated for help and adjust dose per renal dosing guideline" (Table 3).

Table 3 Cost saving and cost avoidance classified by interventions (Study group)				
Intervention	No. of Interventions n = 127 (%)	Cost Saving (USD)	Cost Avoidance (USD)	Total cost Saved and avoided (USD)
Missing required information on written prescriptions/orders	33 (25.98)	-306.28	-18.02	-324.30
Team initiated request for help (e.g. drug storage, compatibility, etc.)	27 (21.26)	0.00	-8.48	-8.48
Adjust dose per renal dosing guideline	20 (15.75)	-599.97	-167.98	-767.95
Drug-drug interactions	10 (7.87)	0.00	-12.72	-12.72
Recommend antibiotic coverage (empiric therapy, change or discontinue after culture and sensitivity result, and length of therapy)	10 (7.87)	-875.42	-14.31	-889.72
Recommend supplement therapy (e.g. K, Mg, Ca)	9 (7.09)	30.24	-16.96	13.28
Inappropriate schedule, dose, rate, or frequency prescribed for indication	7 (5.51)	-69.53	-38.15	-107.68
TPN/Enteral nutrition monitoring/intervention	3 (2.36)	9.96	-0.53	9.43
Recommend switching route of administration as appropriate (e.g. IV to PO when NG out)	2 (1.57)	-160.43	0.00	-160.43
Recommend to check laboratory for appropriate therapy	2 (1.57)	0.00	-5.83	-5.83
Recommend stopping contraindicated drugs	1 (0.79)	0.00	-0.53	-0.53
Wrong unit of measure (e.g. mg instead of mcg)	1 (0.79)	0.00	-5.30	-5.30
Miscellaneous	2 (1.57)	0.00	-5.83	-5.83
Total	127 (100)	-1,971.43	-294.62	-2,266.05
- indicated decrease cost of drug therapy				

In addition, cost saving and cost avoidance were classified by drug class. We found that anti-infective was the major cost reduction (1,958.61 USD) followed by anticoagulants (132.36 USD). The most common drugs used in ICU were anti-infective, cardiovascular drugs, electrolytes trace elements and fluid, and anticoagulants, respectively, which required more interventions than other drugs (Table 4).

DISCUSSION

The number of adverse drug events and the subsequent cost of these events can be reduced by pharmacist intervention.[3-5,10-18] In the current study, we aims to describe the characteristics of the interventions and to determine pharmacist's interventions led to change in cost saving and cost avoidance in an intensive care unit (ICU). This study documented a role for a pharmacist in a

multidisciplinary ICU, and demonstrated a substantial reduction in drug costs as a result of pharmacist - initiated therapeutic consultations / interventions.

Table 4 Cost saving and cost avoidance classified by drug classes (Study group)				
Drug classes	No. of Interventions n = 127 (%)	Cost Saving (USD)	Cost Avoidance (USD)	Total cost Saved and avoided (USD)
Antiinfectives	51 (40.16)	-1,750.89	-207.72	-1,958.61
Cardiovascular drugs	18 (14.17)	0.55	-19.08	-18.53
Electrolytes, trace elements, and Fluid	15 (11.81)	2.09	-17.49	-15.40
Anticoagulants	14 (11.02)	-102.69	-29.67	-132.36
Psychoactive and CNS agents	6 (4.72)	0.00	-6.36	-6.36
Gastrointestinal drugs	5 (3.94)	1.82	-1.06	0.77
Antidiabetic agents, Insulin	2 (1.57)	0.00	-5.83	-5.83
Antiasthmatic agents	2 (1.57)	0.00	0.00	0.00
Analgesics	1 (0.79)	0.00	0.00	0.00
Others*	13 (10.24)	-122.31	-7.42	-129.73
Total	127 (100)	-1,971.43	-294.62	-2,266.05
- indicated decrease cost of drug therapy * Others drug or cannot classified into drug class e.g. TPN/Enteral intervention				

Critically ill patients with multiple system disease require multiple drug therapy; in addition, changes in their pharmacokinetic and pharmacodynamic variables due to multiple organ dysfunctions can affect the absorption, metabolism, elimination, and interaction of drugs. Thus, critical ill patients present unique pharmacologic challenges to the clinician. Although these challenges may be similar to those in general or surgical patients, their frequency and importance are increased in the ICU population.[23]

Monitoring for adverse drug reactions was an importance responsibility of the pharmacist. Many medications taken by ICU patients have significant adverse effect profiles and multiple known drug-drug interactions.

In addition to direct patient care activities, the pharmacist provided in-service education to the team, participated in research, and identified indigent patients and enrolled them in medication assistance programs. Other professionals on the team indicated that the direct (e.g. pharmacotherapy recommendations) and indirect (e.g. drug information) services provided made the pharmacist a valuable member of the team.

In our study documented that the 98% percent of the pharmacist's interventions were accepted and implemented by team exceeds the overall 95% acceptance rate (8.7% accepted with changing therapy) previously reported for pharmacists' recommendations.[20] The quality and importance of the pharmacist's interventions are reflected in the independent evaluation of potential impact on patient care. Similarly favorable results have been reported in other centers despite some variability in the calculation of savings. For example, Bearce and colleagues[33] multiplied the cost difference per day by the number of days that the patient was in ICU, regardless of whether the patient remained on the drug in question for the entire stay or not. Warrian

and Irvince-Meek[34] multiplied the cost difference per day by the average length of stay. However, calculating the cost difference based on the number of days the patient was receiving therapy fails to capture the benefit of a consultation that led to discontinuing a drug-one cannot know how many days this drug would have been continued if the consultation were not made. We believe that our approach to drug cost is as reasonable as others employed.

There are limitations to the conclusion of this study. First, the crude cost calculations do not include the pharmacist's time spent in chart review and making rounds with the team to identify potentially meaningful interventions. Furthermore, according to the pilot study, the sample size in this study was not calculated and got very small size that reflect the fact that there is not enough statistical power to detect the significant different between two groups. However, the results in cost saving and cost avoidance in the study group tend to be reduced. In addition, it is likely that not every pharmacist would demonstrate the same skill level as the others. Thus, these finding may not necessarily be extrapolated to other clinical pharmacist in other institutions.

Our study demonstrated that the participation of a clinical pharmacist in patient care rounds, chart review, and providing interventions resulted in benefits in term of cost saving and cost avoidance. These results suggest that a dedicated clinical pharmacist in ICU by providing interventions is likely to decrease total drug cost and play a crucial role on the ICU team.

CONCLUSIONS

Our results indicated that a pharmacist's interventions in intensive care unit had a positive

potential impact on overall drug cost, cost saving, and cost avoidance and were well accepted by the team. The need to further develop the methodology to estimate the cost will be a major challenge. More studies are needed in this field.

## ACKNOWLEDGEMENTS

CONFLICT OF INTEREST

None declared.

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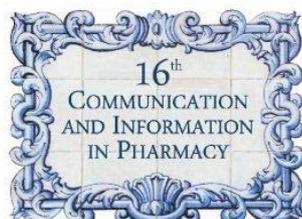
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Communication and
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This is a preliminary short announcement for the 16th ISPW

Host Institution and Venue

Faculty of Pharmacy, University of Lisbon, Portugal

Dates

23rd to 26th August 2010

Key note Speakers and further information soon to be announced at

www.ff.ul.pt/16ISPW

For any inquiries, please use the following email address: 16ISPW@ff.ul.pt

Hope to have you here in Summer 2010!