SPECIAL ARTICLE

Clinical Pharmacy Services, Pharmacy Staffing, and the Total Cost of Care in United States Hospitals

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This study evaluated direct relationships and associations among clinical pharmacy services, pharmacist staffing, and total cost of care in United States hospitals. A database was constructed from the 1992 American Hospital Association's Abridged Guide to the Health Care Field and the 1992 National Clinical Pharmacy Services Database. A multiple regression analysis, controlling for severity of illness, was employed to determine the relationships and associations. The study population consisted of 1016 hospitals. Six clinical pharmacy services were associated with lower total cost of care: drug use evaluation (p=0.001), drug information (p=0.003), adverse drug reaction monitoring (p=0.008), drug protocol management (p=0.001), medical rounds participation (p=0.0001), and admission drug histories (p=0.017). Two services were associated with higher total cost of care: total parenteral nutrition (TPN) team participation (p=0.001) and clinical research (p=0.0001). Total costs of care/hospital/year were lower when any of six clinical pharmacy services were present: drug use evaluation $1,119,810.18 (total $1,005,589,541.64 for the 898 hospitals offering the service), drug information $5,226,128.22 (total $1,212,461,747.04 for the 232 hospitals offering the service), adverse drug reporting monitoring $1,610,841.02 (total $1,101,815, 257.68 for the 684 hospitals offering the service), drug protocol management $1,729,608.41 (total $614,010,985.55 for the 355 hospitals offering the service), medical rounds participation $7,979,720.45 (total $1,212,917,508.41 for the 152 hospitals offering the service), and admission drug histories $6,964,145.17 (total $208,924,355.10 for the 30 hospitals offering the service). Clinical research $9,558,788.01 (total $1,013,231,529.06 for the 106 hospitals offering the service) and TPN team participation $3,211,355.12 (total $1,027,633,638.43 for the 320 hospitals offering the service) were associated with higher total costs of care. As staffing increased for hospital pharmacy administrators (p=0.0001) and clinical pharmacists (p=0.007), total cost of care decreased. As staffing increased for dispensing pharmacists, total cost of care increased (p=0.006). Based on this total cost of care model, optimal hospital pharmacy administrator staffing was 2.01/100 occupied beds. Staffing for dispensing pharmacists should be as low as possible, and definitely fewer than 5.11/100 occupied beds. Staffing for clinical pharmacists should be as high as possible, but definitely more than 1.11/100 occupied beds. The results of this study suggest that increased staffing levels of clinical pharmacists and pharmacy administrators, as well as some clinical pharmacy services, were associated with reduced total cost of care in United States hospitals.

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Whereas substantial numbers of studies have reported improved patient care and, in some cases, reduced costs at individual clinical sites,[1–26] none have evaluated the impact of clinical pharmacy services and pharmacy staffing on the total cost of care in our health care system. The 1998–2000 American College of Clinical Pharmacy strategic plan sets priority on "research that assesses the value of clinical pharmacy services" (5th ranked of 57 objectives).[27] These studies are critical in determining how clinical pharmacy services and pharmacy staffing affect health care. The total cost of care in hospitals is an important health care outcome measure and has received critical scrutiny over the last several years.

Two literature reviews have extensively documented the value of clinical pharmacy services.[2, 28] Of 104 studies published between 1988 and 1995, 89% described positive financial benefits of these services,[28] with a mean cost:benefit ratio of 16.70:1 (every dollar invested in clinical pharmacy services resulted in a cost reduction of $16.70). These studies, however, focused primarily on partial health care costs (drugs, salary reductions) rather than on total cost of care delivered to the patient.

Through clinical pharmacy services, pharmacists promote rational drug therapy. Presumably, improved drug therapy should have a profound impact on the total cost of care by decreasing lengths of hospital stays, adverse drug reactions, infection rates, law suits, number of personnel to care for patients, and so on. Thus, clinical pharmacy services may increase the efficiency of health care and reduce costs. Drug costs accounted for 3.5% and total pharmacy personnel costs for 1.6% of the total cost of care (total operating cost) in United States hospitals in 1992.[29–31] Thus pharmacy's share of the hospital budget was 5.1%. Unfortunately, by primarily focusing on drug cost savings, our profession may have limited itself to measuring cost reductions on only a small part of health care.

Based on data from 1992, we showed that pharmacist staffing and some clinical pharmacy services had a direct relationship with reduced hospital mortality rates.[32–34] In addition, increased staffing levels of clinical pharmacists and some clinical pharmacy services had a direct relationship with reduced drug costs in United States hospitals.[29] Although these studies documented a major beneficial effect of these services on important health care outcomes, they did not address the impact of pharmacists and clinical pharmacy services on the total cost of care.

Outcome measures (e.g., total cost of care) must adjust for the influence of patient characteristics.[35–40] If they do not adjust for severity of illness, conclusions for hospitals that treat most severely ill patients would be inaccurate, leading to erroneous conclusions about the cost of health care. Multiple-site studies on the effect of pharmacists and clinical pharmacy services on the total cost of care are critical, since they minimize biases associated with single-site studies and can determine which services are likely to improve clinical outcomes and reduce costs across the entire system.

We tested direct relationships and associations among 14 clinical pharmacy services, pharmacy staffing, and severity of illness-adjusted total cost of care in 1016 hospitals in the United States from 1992. This fourth in a series of articles on the value of clinical pharmacy services focuses on the total cost of health care. To our knowledge, it is the first to explore the relationship between both clinical pharmacy services and pharmacist staffing and the total cost of care in many hospitals in the United States.

Methods

Sources of Data

Data for 14 clinical pharmacy services and pharmacist staffing were obtained from the 1992 national clinical pharmacy services database, the largest hospital and clinical pharmacy database in the United States.[41] The total cost of care for each hospital was obtained from the American Hospital Association's (AHA) Abridged Guide to the Health Care Field.[30] The national clinical pharmacy services survey questionnaire was updated from previous surveys[42, 43] and pretested by 25 directors of pharmacy. It was mailed to the director of pharmacy in each acute care, general medical-surgical hospital listed in the AHA database. Study methodology, variables, and demographic results are published elsewhere.[41]

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The two databases were integrated into one, and SAS, release 6.12, implemented on a personal computer (Pentium 450 Mz), was used for all statistical analysis.[44] All data were for inpatients only.

The AHA listed 4822 general medical surgical hospitals in 1992.[30] Variables from the AHA database were matched for 3422 hospitals (demographics, severity of illness), which constituted 100% of hospitals that could potentially be included in this study. The hospitals had information on 14 clinical pharmacy services, pharmacist staffing from the national clinical services database, and total cost of care, demographic, and severity of illness variables from the AHA database.[30, 41] Only general medical-surgical hospitals were used so as to provide more homogeneous total cost of care information. Total cost of care for psychiatric, alcohol and drug rehabilitation, or rehabilitation hospitals would not be appropriate, since their costs are substantially different.[30] From 1597 hospitals in the two databases, data were matched for 1016 hospitals, which constituted the study population.

Variables and Analyses

Centrally delivered clinical pharmacy services used in the analysis were drug-use evaluation (DUE), in-service education, drug information, poison information, and clinical research. Patient-specific clinical pharmacy services were adverse drug reaction (ADR) monitoring, pharmacokinetic consultations, drug therapy monitoring, drug protocol management, total parenteral nutrition (TPN) team participation, drug counseling, cardiopulmonary resuscitation (CPR) team participation, medical rounds participation, and admission drug histories. We defined clinical pharmacy services specifically to indicate active participation by pharmacists in patient care (Appendix 1).

Hospital pharmacist staffing data were taken from full-time equivalent (FTE) data collected in the national clinical pharmacy services database survey.[41] Hospital pharmacy administrators were defined as FTE pharmacy directors, assistant directors, and supervisory pharmacists. Dispensing pharmacists were defined as FTE pharmacists who spent most (> 50%) of their work time primarily in dispensing activities. Clinical pharmacists were defined as FTE pharmacists who spent most (> 50%) of their work time providing clinical pharmacy services (nondispensing). Each staffing category was mutually exclusive. Staffing data were for inpatients only. Total cost of care was taken from the AHA database and defined as total operating costs of the hospital in 1992 (all payroll and nonpayroll expenses).[30]

Severity of illness was controlled by forcing three variables into the multiple regression analysis model: percentage of intensive care unit (ICU) days (calculated as ICU days divided by total inpatient days), annual number of emergency room visits divided by the average daily census (ADC), and percentage of Medicaid patients (calculated as Medicaid discharges divided by total discharges). These variables were validated as severity of illness measures in similar studies.[29, 32–37, 39, 40, 45] They were chosen because they are the only ones validated as adjusters for severity of illness using these national databases.[29, 32–40] Although other variables were used to adjust for severity of illness with smaller patient populations (Acute Physiology and Chronic Health Evaluation [APACHE] scores, specific patient case mix, patient age, number of surgical patients, physician experience, length of shifts, patient work loads, etc.), they were not available for the study hospitals. Diagnosis-related groups are not reliable severity of illness adjusters since many hospitals inflate these measures.

Statistical Analyses

Simple and multiple regressions were used in the analysis. Parameter estimates 95% confidence intervals (CIs) were calculated for both simple and multiple regression analyses. For multiple regression analysis, stepwise procedures were used to select variables for the model.[46, 47] Severity of illness variables were forced into the multiple regression model before any other variables were allowed to enter. After that, stepwise regression was used to select the remaining variables. Variables selected by this method were confirmed by forward and backward regression techniques, both of which selected the same set of variables. The correlation matrix for independent variables and the variance inflation factor were used to examine possible effects of multicolinearities among the variables. These indicated no apparent problems among the set of independent variables.

Multiple regression analysis allowed us to determine which clinical pharmacy services and

pharmacist staffing variables explain total cost of care in United States hospitals. The intent was to build a multiple regression model to determine if clinical pharmacy services and pharmacist staffing were associated with total cost of care. Direct relationships among variables were also explored. Multiple regression analysis is the more important of our analysis models, as it adjusted for severity of illness and it allowed for interaction among variables.

A comparison of clinical pharmacy services and pharmacy staffing variables found to be statistically significant in the multiple regression model was developed further. The difference in the total cost of care/occupied bed, based on whether the hospital provided the clinical pharmacy service, is presented. Only clinical pharmacy services that had statistically significant associations with total cost of care (multiple regression model) were included in this analysis. These figures reflect actual cost differences between hospitals offering the services and those that do not. The a priori level of significance for all tests was set at 0.05.

Results

A total of 1016 hospitals (64%) of the 1597 general medical-surgical hospitals from the 1992 National Clinical Pharmacy Services Database were matched from the 3422 hospitals having information available on all variables from AHA database (potential pool of study hospitals). These 1016 hospitals (30%) were the study population. The mean number of hospital admissions/year for the hospitals was 8110 (6786/hospital, or 8,239,816 total, 34% of total United States admissions).[48] The mean total cost of care for the hospitals was $341,066.45 ± $156,947.23/occupied bed/year, or $52,450,370.92 ($58,751,974.61/hospital/yr). A total of $53,289,576,854.72/year was spent on inpatient care. The ADC was 151.63 (142.49 patients/day).

Table 1 shows severity of illness, 14 clinical pharmacy services, and pharmacist staffing information. Table 2 shows simple regression analysis for severity of illness variables, 14 clinical pharmacy services, and pharmacist staffing described as slope, standard error (SE), probability, and CI. Slope measures the rate of change for the variable and is expressed as either positive (presence of this service was associated with higher total cost of care) or negative (presence of this service was associated with lower total cost of care). Seven clinical pharmacy services were associated with lower total cost of care: DUE, in-service education, drug information, pharmacokinetic consultations, drug protocol management, medical rounds participation, and admission drug histories. Seven services were associated with higher total cost of care, however, only five had statistically significant differences: poison information, clinical research, drug therapy monitoring, TPN team participation, and drug counseling. As staffing increased for hospital pharmacy administrators (p=0.0001) and clinical pharmacists (p=0.0001), the total cost of care decreased. As staffing increased for dispensing pharmacists (p=0.0001), the total cost of care increased.

Table 1. Severity of Illness, Characteristics, and Clinical Pharmacy Services of 1016 Hospitals

Variable	Value
Severity of illness	Mean ± SD
ICU days/total inpatient days	0.054 ± 0.037
Number of emergency room visits/ ADC	194.331 ± 114.821
Medicaid discharges/total discharges	0.127 ± 0.094
Central clinical pharmacy services	No. (%)
DUE	898 (88.4)
In-service education	677 (66.6)
Drug information	232 (22.8)
Poison information	158 (15.6)
Clinical research	106 (10.4)
Patient-specific clinical pharmacy services	
ADR monitoring	684 (67.3)
Pharmacokinetic consultations	540 (53.1)
Drug therapy monitoring	435 (42.8)
Drug protocol management	355 (34.9)
TPN team participation	320 (31.5)
Drug counseling	307 (30.2)
CPR team participation	282 (27.8)
Medical rounds participation	152 (15)
Admission drug histories	30 (3)
Pharmacy staffing/100 occupied beds	Mean ± SD
Hospital pharmacy administrators[a]	1.89 ± 2.45
Dispensing pharmacists[b]	5.47 ± 2.76
Clinical pharmacists[c]	0.48 ± 1.03
Pharmacy technicians	5.78 ± 3.04

ICU = intensive care unit; DUE = drug-use evaluation; ADR = adverse drug reactions; TPN = total parenteral nutrition; CPR = cardiopulmonary resuscitation; ADC = average daily census.
[a]Based on FTE pharmacy directors, assistant directors, and supervisory pharmacists.
[b]Based on FTE pharmacists who spend most (> 50%) of their work time primarily in dispensing activities.
[c]Based on FTE pharmacists who spend most (> 50%) of their work time providing clinical pharmacy services (nondispensing).

Table 3 shows the multiple regression analysis for severity of illness variables, 14 clinical pharmacy services, and pharmacist staffing. Statistically significant associations were found

Table 2. Simple Regression Analysis Controlling for Severity of Illness and Total Costs of Care in 1016 Hospitals

	Slope	SE	Significance	95% CI
Severity of illness variables				
ICU days/total inpatient days	-18709741	50133047	0.709	-117086135, 79666650
Number of emergency room visits/ADC	-208760	14670	0.0001	-237548, -179972
Medicaid discharges/total discharges	21502688	19536121	0.271	-16833164, 59838541
Central clinical pharmacy services				
DUE	-96526	12920	0.0001	-121880, -71173
In-service education	-23260457	3842191	0.0001	-38000015, -15720900
Drug information	-42305673	4187502	0.0001	-50522836, -34088510
Poison information	24195033	5031706	0.0001	14321285, 34068782
Clinical research	94855482	5245931	0.0001	84561357, 105149606
Patient-specific clinical pharmacy services				
ADR monitoring	5738554	3927621	0.144	-1968650, 13445740
Pharmacokinetic consultations	-20520861	3670787	0.0001	-27724070, -13317652
Drug therapy monitoring	20520861	3670787	0.0001	13317652, 27724070
Drug protocol management	-9562901	3856163	0.013	-17129874, -1995927
TPN team participation	32371944	3837758	0.0001	24841084, 39902801
Drug counseling	23308578	3948704	0.0001	15560009, 31057146
CPR team participation	7036021	4112299	0.087	-1033570, 15105612
Medical rounds participation	-90058684	4328054	0.0001	-98551653, -81565716
Admission drug histories	-46914993	10793837	0.0001	-68095807, -25734179
Pharmacy staffing/occupied bed				
Pharmacy administrators	-709070734	73128651	0.0001	-852571546, -565569923
Dispensing pharmacists	238965841	68619364	0.0001	104313631, 373618050
Clinical pharmacists	-1132247023	174048517	0.0001	-1473783519, -790719528
Pharmacy technicians	44914993	60837119	0.461	-74466067, 164296054

Table 3. Multiple Regression Analysis[a] for Clinical Pharmacy Services and Total Cost of Care in 1016 Hospitals

	Slope	SE	Significance	95% CI
Severity of illness variables				
ICU days/total inpatient days	-6401564	37318718	0.864	-79634078, 66830950
Number of emergency room visits/ADC	-117687	13169	0.0001	-143529, -91845
Medicaid discharges/total discharges	8361167	14517697	0.564	-20120685, 36857019
Central clinical pharmacy services				
DUE	-34871	10013	0.001	-52220, -12986
In-service education	4065042	3035004	0.181	-1456864, 10909877
Drug information	-11749402	3787169	0.003	-1945776, -4035633
Poison information	-2493654	4056630	0.539	-9192036, 7336647
Clinical research	42922279	5252510	0.0001	31228819, 52876731
Patient-specific clinical pharmacy services				
ADR monitoring	-6599253	3157982	0.008	-12823341, -401524
Pharmacokinetic consultations	2712481	3482930	0.436	-6062564, 8142026
Drug therapy monitoring	-1087643	3164931	0.267	-7299010, 5123723
Drug protocol management	-17423551	3427653	0.001	-23890565, -10367791
TPN team participation	10789291	3173382	0.001	3701384, 16665752
Drug counseling	4587125	3206425	0.182	-2024598, 10900879
CPR team participation	-1293912	3205433	0.687	-7827186, 5051088
Medical rounds participation	-4770426	2123771	0.0001	-9308924, -80345
Admission drug histories	-6106570	2264491	0.017	-10693217, -196798
Pharmacy staffing/occupied bed				
Pharmacy administrators	-324890768	59962354	0.0001	-446657112, -202098023
Dispensing pharmacists	143308531	51687725	0.006	41878944, 244738118
Clinical pharmacists	-38864012	1417998	0.007	-42267227, -35561902
Pharmacy technicians	4536291	47300992	0.924	-88284974, 97357556

[a] $R^2 = 48.92$, adjusted $R^2 = 47.70$.

with DUE (p=0.001), drug information services (p=0.003), ADR monitoring (p=0.008), drug protocol management (p=0.001), medical rounds participation (p=0.0001), and admission drug histories (p=0.017) and lower total cost of care. Statistically significant associations were found

Table 4. Total Cost of Care/Year for Hospitals with and without Clinical Pharmacy Services Associated with Total Cost of Care

	No. (%)[a]	Mean Number of Occupied Beds/Hospital	Difference in Total Costs Occupied Bed ($)[b]	Mean Total Cost of Care Reduction/Increase/ Hospital/ Offering this Service ($)	Total Cost of Care Reduction/Increase for All Hospitals Offering this Service ($)[c]
Services associated with reduced total cost of care					
DUE	898 (88.4)	147.11 ± 138.53	7,612.74 ± 3521.72	1,119,810.18 ± 656,301.45	1,005,589,541.64
Drug information	232 (22.8)	221.82 ± 197.81	23,559.68 ± 15,432.83	5,226,128.22 ± 3,218,326.04	1,212,461,747.04
ADR monitoring	684 (67.3)	155.69 ± 145.32	10,346.40 ± 3,451.69	1,610,841.02 ± 899.891.09	1,101,815,257.68
Drug protocol management	355 (34.9)	161.06 ± 139.99	10,738.87 ± 4,622.08	1,729,608.41 ± 986,451.49	614,010,985.55
Medical rounds participation	152 (15)	273.40 ± 181.44	28,967.75 ± 31,273.51	7,979,720.45 ± 4,234,830.37	1,212,917,508.41
Admission drug histories	30 (3)	268.51 ± 194.90	25,936.26 ± 21,563.85	6,964,145.17 ± 4,567,921.61	208,924,355.10
Services associated with increased total cost of care					
Clinical research	106 (10.4)	338.80 ± 188.96	28,213.66 ± 19,610.32	9,558,788.01 ± 6,548,100.73	1,013,231,529.06
TPN team participation	320 (31.5)	201.31 ± 174.49	15,952.30 ± 9,520.37	3,211,355.12 ± 2,012,896.33	1,027,633,638.43

[a]Hospitals offering the service.
[b]Mean ± SD of total cost of care differences/occupied bed/year for hospitals offering the service.
[c]Mean total cost of care differences/hospital offering this service x the number of hospitals offering the service.

with pharmacist-conducted clinical research (p=0.0001) and TPN team participation (p=0.001) and higher total cost of care. As staffing increased for hospital pharmacy administrators (p=0.0001) and clinical pharmacists (p=0.007), the total cost of care decreased. As staffing increased for dispensing pharmacists (p=0.006) the total cost of care increased. These variables provided the best regression equation (fit) to explain total cost of care. This regression model accounted for 48.92% of the total explainable variance associated with total cost of care in the 1016 hospitals.

Figure 1 shows the graphic relationship between hospital pharmacy administrator staffing and total cost of care. Figure 2 shows the graphic relationship between dispensing pharmacist staffing and total cost of care. Figure 3 shows the graphic relationship between clinical pharmacist staffing and total cost of care. Data points represent staffing quintiles (20%, 40%, 60%, 80%, 100%). Staffing was calculated as staff/occupied bed, but graphed as staff/100 occupied beds.[31, 41]

Table 4 shows the mean number of occupied beds, total cost of care reduction/increase/ occupied bed/year, total cost of care reduction/

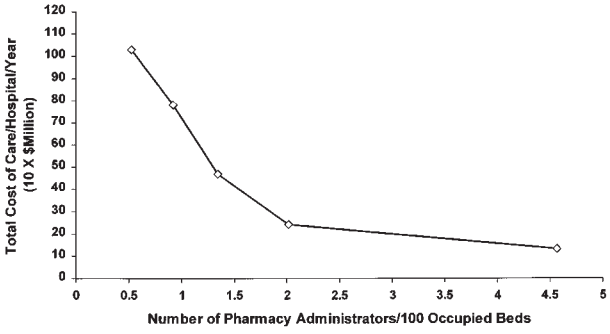

Figure 1. Hospital pharmacy administrator staffing and total cost of care.

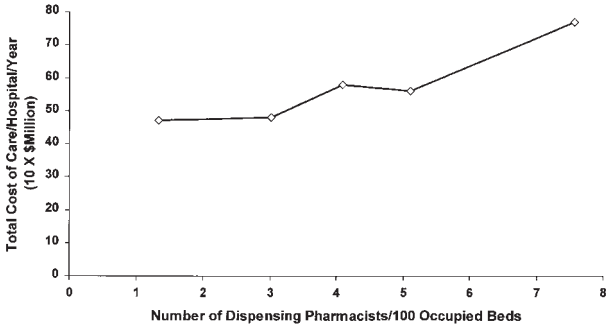

Figure 2. Dispensing pharmacist staffing and total cost of care.

increase/hospital/year, and total cost of care reduction/increase/year for all hospitals having one of the eight clinical pharmacy services that had a statistically significant association with total cost of care (multiple regression analysis). Cost differences are actual dollar amounts (per occupied bed, per hospital, and for the population of hospitals offering each clinical pharmacy service). Dollar figures for reduction/increase in total cost of care are not extrapolations. Differences in total cost of care for hospitals that provided the six services that were associated with lower total cost of care were DUE $1,119,810.18 (total $1,005,589,541.64 for the 898 hospitals offering the service), drug information $5,226,128.22 (total $1,212,461,747.04 for the 232 hospitals offering the service), ADR monitoring $1,610,841.02 (total $1,101,815,257.68 for the 684 hospitals offering the service), drug protocol management $1,729,608.41 (total $614,010,985.55 for the 355 hospitals offering the service), medical rounds participation $7,979,720.45 (total $1,212,917,508.41 for the 152 hospitals offering the service), and admission drug histories $6,964,145.17 (total $208,924,355.10 for the 30 hospitals offering the service). Clinical research $9,558,788.01 (total $1,013,231,529.06 for the 106 hospitals offering the service) and TPN team participation $3,211,355.12 (total $1,027,633,638.43 for the 320 hospitals offering the service) were associated with higher total cost of care.

Discussion

This study determined direct relationships and associations among 14 clinical pharmacy services, pharmacist staffing, and severity of illness adjusted total cost of care. Nine services were associated with lower hospital total cost of care in the multiple regression analysis, however, these differences were statistically significant for only DUE, drug information services, ADR monitoring, drug protocol management, medical rounds participation, and admission drug histories. Two services, clinical research and TPN team participation, were associated with statistically significant increases in total cost of care. As the number of pharmacy administrators and clinical pharmacists increased/occupied bed, the total cost of care decreased. As the number of dispensing pharmacists increased/occupied bed, the total cost of care increased. Study design limitations did not allow us to determine reasons why these variables were associated with the total cost of care.

Pharmacist-Provided DUE

It is worth noting that DUE studies are among the most frequently associated with drug cost reductions.[2, 28] Whereas cost savings from DUEs are relatively modest compared with total cost of care in a hospital, the presence of this service may indicate an institutional philosophy to implement audit systems that are intended to promote better patient care and save money. A reduction of $1,119,810.18 in total cost/hospital was associated with the presence of DUE ($1,005,589,541.64 decrease in total cost of care for the 898 hospitals having the service). If extrapolated to all 1016 hospitals, a potential reduction of $1,137,727,142.88 in total cost of care (2.1% of total cost of care for all 1016 hospitals) could be realized if all hospitals had this service. The median salary cost/hospital for providing DUE was $35,085, or $238.50/occupied bed/year.[31] Each dollar of pharmacist salary cost was associated with $31.92 reduction in total cost of care.

Pharmacist-Provided Drug Information

An unbiased source of drug information may promote better patient care and thus reduce total cost of care. This service may contribute to lower total cost of care, as up to 28% of all hospital admissions were attributed to drug-related morbidity and mortality.[49] Having trained personnel to provide information could reduce these costs. In addition, ADRs in hospitals are often preventable if detected early,[50] and could be reduced with better information systems.[51] The presence of this service may also indicate medical staff open to input from pharmacists and likely to accept recommendations on drug therapy, which may result in lower costs. Since the drug information service is often the process for formulary management coordination in the hospital, it is important in controlling drug costs that are a component of the total cost of care. A reduction of $5,226,128.22 in total cost of care/hospital was associated with the presence of this service ($1,212,461,747.04 decrease in total cost of care for the 232 hospitals having the service). If extrapolated to all 1016 hospitals, a potential reduction of $5,309,746,271.52 in total cost of care (9.9% of total cost of care for all 1016 hospitals) could be realized if all hospitals had this service. The median pharmacist salary costs/hospital for providing drug information

services was $8679, or $39.13/occupied bed/year.[41] Each dollar of pharmacist salary cost was associated with $602.16 reduction in total cost of care. Pharmacist-provided drug information should be considered one of the foundation clinical pharmacy services for hospitals. It also was associated with 10,463 fewer deaths and $90,852,346.24 reduction in drug costs in the same population of hospitals as reported in this study.[29, 34]

Pharmacist-Provided ADR Monitoring

Adverse drug reactions are the most common untoward events occurring in hospitals[52] and significantly increase the cost of care.[53] The presence of this service indicates a hospital that has an active program to detect and prevent ADRs, and thus may reduce the cost of care associated with these problems. A reduction of $1,610,841.02 in total cost of care/hospital was associated with the presence of the service ($1,101,815,257.68 decrease in total cost of care for the 684 hospitals having the service). If extrapolated to all 1016 hospitals, a potential reduction of $1,636,614,476.32 in total cost of care (3.1% of total cost of care for all 1016 hospitals) could be realized if all of hospitals had this service. The median pharmacist salary costs/hospital for pharmacist provided the service was $539, or $3.48/occupied bed/year.[31] Each dollar of pharmacist salary cost was associated with $2988.57 reduction in total cost of care.

Pharmacist-Provided Drug Protocol Management

The presence of a pharmacist-provided drug protocol management service indicates a fairly high level of trust by medical staff, perhaps indicating greater reception of pharmacists' input and management of patients, thus reducing total cost of care. This service may also indicate a hospitalwide system that allows health care professionals to expand provision of services, thus improving health care and reducing costs. A reduction of $1,729,608.41 in total cost of care reduction/hospital was associated with the presence of drug protocol management ($614,010,985.55 decrease in total cost of care for the 355 hospitals having the service). If extrapolated to all 1016 hospitals, a potential reduction of $1,757,282,144.56 in total cost of care (3.3% of total cost of care for all 1016 hospitals) could be realized if all hospitals had the service. The median pharmacist salary costs/hospital for providing drug protocol management was $1650, or $10.25/occupied/per year.[31] Each dollar of pharmacist salary cost was associated with $1048.25 reduction of total cost of care. This should be considered a core service if cost reduction is a primary focus of the hospital, since its presence also was associated with a reduction of $45,045,443.76 in drug costs in the same population of hospitals reported in this study.[29]

Pharmacists' Participation on Medical Rounds

Since medical rounds is where key decisions are made regarding patient care, pharmacists' participation may prospectively ensure optimum drug therapy, thus improving patient care and reducing health care costs. Some of the best single-site studies of clinical pharmacy services employed pharmacists participating in medical rounds.[16, 17, 54, 55] Perhaps this indicates that medical staff is more receptive to pharmacists' input and management of patients, thus reducing total costs by having a team approach to care. It may also indicate a hospitalwide system that allows many health care professionals to have direct input into decision making, thus improving health care and reducing costs. A reduction of $7,979,720.45 in total cost of care/hospital was associated with pharmacists' participation on medical rounds ($1,212,917,508.41 decrease in total cost of care for the 152 hospitals having the service). If extrapolated to all 1016 hospitals, a potential reduction of $8,107,395,977.20 in total cost of care (15.2% of total cost of care for all 1016 hospitals) could be realized if all hospitals had this service. The median pharmacist salary cost/hospital for the service was $31,652 or $115.94/occupied bed/year.[31] Each dollar of pharmacist salary cost was associated with $252.11 reduction in total cost of care. Although this was one of the more expensive clinical pharmacy services (total salary),[31] it was associated with the greatest reduction in total cost of care/hospital.

Pharmacist-Provided Drug Histories

As up to 28% of hospital admissions were attributed to drug-related morbidity and mortality,[49] perhaps pharmacists are better able to detect these problems than other health care professionals. In addition, admission drug histories may identify unnecessary or high-cost drug therapy very early in hospitalization, thus reducing total cost of care. A reduction of $6,964,145.17 in total cost of care/hospital was

associated with pharmacist-provided admission drug histories ($208,924,355.10 decrease in total cost of care for the 30 hospitals having the service). If extrapolated to all 1016 hospitals, a potential reduction of $7,075,571,492.74 in total cost of care (13.2% of total cost of care for all 1016 hospitals) could be realized. The median pharmacist salary cost/hospital for the service was $8967, or $33.40/occupied bed/year.[31] Each dollar of pharmacist salary cost was associated with $776.64 reduction in total cost of care. Pharmacist-provided admission drug histories should be considered one of the foundation clinical pharmacy services for most hospitals, since it was associated with 3843 fewer deaths and a reduction of $5,548,093.46 in drug costs in the same population of hospitals reported in this study.[29, 34]

Pharmacist-Conducted Clinical Research

Most likely the presence of this service is an indicator of specific types of patients who may cost more to care for, patients in clinical trials. Fifty of the 106 hospitals that had pharmacist conducted clinical research were members of the Council of Teaching Hospitals. Generally, teaching hospitals are more costly than nonteaching hospitals, even though they have lower mortality rates and shorter lengths of stays.[56–58] Unfortunately, there is no way to account for grant and contract funds that staff at the hospitals receive to conduct clinical trials in total cost of care figures from the AHA database.[30] Increases of $9,558,788.01 in total costs of care/hospital were associated with the presence of pharmacist-provided clinical research ($1,013,231,529.06 increase in total cost of care for the 106 hospitals having the service). If extrapolated to all 1016 hospitals, a potential increase of $9,711,728,618.16 in total cost of care (18.2% of total cost of care for all 1016 hospitals) could be seen. The median pharmacist salary cost/hospital for the service was $5656, or $16.69/occupied bed/year.[31] Each dollar of pharmacist salary cost was associated with $1690.03 increase in total cost of care. The mean pharmacist-obtained grant funding was $79,765 ± 128,641/year/hospital.[31] These funds are not accounted for in total cost of care figures from the AHA database.[30] Although pharmacist-conducted clinical research was associated with higher total cost of care, it was associated with 21,125 fewer deaths in the same population of hospitals reported in this study.[34]

Pharmacist Participation on the TPN Team

Most likely the presence of this service is an indicator of specific types of patients who may cost more to care for, those receiving TPN. The presence of the service may indicate a large number of patients in that hospital receiving TPN. These patients are by definition more expensive to care for because of their underlying illness, TPN costs, laboratory costs, nursing care costs, and drug therapy. Among the types of patients who commonly require TPN are those undergoing bone marrow transplantation, those with cancer, and patients in hospitals that have high levels of gastrointestinal surgery. An increase of $3,211,355.12 in total cost of care/hospital was associated with the presence of pharmacist participation on the TPN team ($1,027,633,638.43 increase in total cost of care for the 320 hospitals having the service). If extrapolated to all 1016 hospitals, a potential increase of $3,262,736,801.92 in total cost of care (6.1% of total cost of care for all 1016 hospitals) could be seen. The median pharmacist salary cost/hospital for pharmacist participation on the TPN team was $12,349, or $61.34/occupied bed/year.[31] Each dollar of pharmacist salary cost was associated with $260.05 increase in total cost of care.

Staffing

In addition to linear relationships between the pharmacy staffing variables and the total cost of care, the figures show the graphic relationship among staffing variables. In Figure 1, there is a fairly straight decrease in total cost of care from 0.53 pharmacy administrators/100 occupied beds (20% of staffing) to 2.01 pharmacy administrators/100 occupied beds (80%). Very little decrease in total cost of care is seen between the 2.01 (80%) and 4.56 pharmacy administrators/100 occupied beds (100%). Based on this finding, it appears that optimal staffing is about 2.01 hospital pharmacy administrators/100 occupied beds.

Figure 2 shows only a modest increase in total cost of care between 1.33 dispensing pharmacist/100 occupied bed (20%) and 5.11 dispensing pharmacists/100 occupied beds (80%). The total cost of care/hospital goes from $47 million to $56 million between these staffing levels. The greatest increases in total cost of care (from $56 to $77 million/hospital) is seen as staffing goes from 5.11 (80%) to 7.58 dispensing pharmacists/100 occupied beds (100%). This last twentieth percentile accounts for 70% of the increase in the

total cost of care. Based on this finding, dispensing pharmacist staffing should be kept as low as possible and definitely fewer than 5.11/100 occupied beds.

In Figure 3, there appears to be a steady decline in the total cost of care from 0.34 clinical pharmacists/100 occupied beds (20%) to 1.11 clinical pharmacists/100 occupied beds (80%). The greatest decrease in total cost of care is seen between 1.11 (80%) and 3.23 clinical pharmacists/100 occupied beds (100%). The last twentieth percentile accounts for 48% of the decrease in total cost of care. Based on this finding, clinical pharmacist staffing should be as high as possible but definitely more than 1.11/100 occupied beds.

This is the first study to demonstrate that pharmacy staffing is associated with total cost of care in hospitals. Similarly, it is the first to show that increased staffing levels of clinical pharmacists and pharmacy administrators are associated with lower total cost of care in a large number of our nation's hospitals (30% of hospitals and 34% of all hospital admissions).

Interpretation of Results

Some caution is advised in interpreting the total cost of care differences associated with these clinical pharmacy services. This study was designed to show direct relationships and associations, not cause and effect. In addition, we obtained only information about clinical pharmacy services. Information about services of other health care professionals, hospital structure, process, or other variables that could affect total cost of care were not obtained or evaluated.

Despite this caution, the value of these clinical pharmacy services and pharmacy staffing information should not be underestimated. The R^2 for the multiple regression model was 48.92%, which indicates that these variables are good predictors of the total cost of care in our nation's hospitals. Given the size of the dollar differences in this model, it is likely that these pharmacy variables probably predict other hospital variables (which we were unable to obtain) that also were associated with total cost of care (clinical services of other health care professionals, staffing, hospital structure, process, etc.). Our findings suggest that the best way to achieve reductions in total costs of care is through optimal pharmacy administrator staffing, increased clinical pharmacist staffing, decreased dispensing pharmacist staffing, and provision of some clinical pharmacy services.

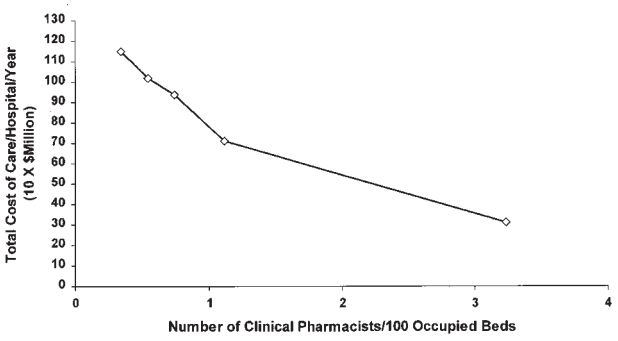

Figure 3. Clinical pharmacist staffing and total cost of care.

Most studies that supported the development of clinical pharmacy services in hospitals[2, 28] focused on the part of the hospital budget that accounts for less than 5.1% of total expenditures (drug costs, pharmacy personnel).[29–31] One of the more important findings of the current study is that pharmacists and clinical pharmacy services are associated with much larger total cost of care. Drug information, drug protocol management, and admission drug histories were also associated with drug cost savings in the same population of hospitals.[29] For the presence of drug information services, the dollar cost reduction was 12.14 times greater for total cost of care compared with what was seen with drug cost reduction/hospital ($5,226,128.22 for total cost of care vs $430,579.84 for drug costs).[29] For drug protocol management, the dollar cost reduction was 12.59 times greater for total cost of care compared with what was seen with drug cost reduction/hospital ($1,729,608.41 for total cost of care vs $137,333.67 for drug costs).[29] For admission drug histories, the dollar cost reduction was 32.64 times greater for total cost of care compared with what was seen with drug cost reduction/hospital ($6,964,145.17 for total cost of care vs $213,388.21 for drug costs).[29] Future outcome studies that evaluate the impact of clinical pharmacy services on total health care cost rather than on drug and pharmacy personnel are essential. Just as with the tip of the proverbial iceberg, where we can see only a small portion of mass above water, pharmacy must focus on total cost of care models where the true worth of our professional services can be seen and appreciated across the health care system.

Limitations

Given the size of the total cost differences seen

with the variables, it is likely that these variables were indicators of other hospital characteristics that affect the total cost of care. Cost information provided was for 1992 and does not reflect data for year 2000. Annual inflation rates and annual drug cost inflation rates of 20% would have to be considered to interpret these dollar figures in terms of current costs.[59] Similarly, cost data presented here do not reflect changes that have occurred in the health care delivery and reimbursement system since 1992. It is possible that information provided to the AHA by hospitals and to us for the national clinical pharmacy services database was inaccurate; we did not attempt to verify it. Since this is one of the first studies comparing clinical pharmacy services, pharmacist staffing, and total cost of care within a large number of hospitals, the findings will have to be replicated in future studies. The design did allow us to determine direct relationships among variables, but not to determine causality. Therefore, the findings should not be construed as cause and effect. Caution is advised in applying our findings to individual hospitals.

Summary

The preponderance of evidence from this study suggests that some clinical pharmacy services, hospital pharmacy administrators, and clinical pharmacists may be able reduce the total cost of care in United States hospitals. The results also suggest that allocating more personnel resources to the drug delivery system (distribution) may be counterproductive in reducing the total cost of care. Given the significant benefits of these clinical pharmacy services and low associated salary costs, clinical pharmacists and directors of pharmacy should use the findings to develop, justify, and expand the services. Much greater cost savings may be obtained when evaluating the impact of pharmacy services on total cost of care, rather than some minor components. It is hoped that our findings will help guide chief executive officers, hospital pharmacy administrators, and clinical coordinators in hiring and allocating personnel in hospitals, and in determining what clinical pharmacy services to provide.

Appendix 1. Definitions

Central Clinical Pharmacy Services

Drug-use evaluation: check if at minimum drug use patterns are analyzed and results are reported to hospital committee.
In-service education: pharmacist presents continuing education to fellow employees (M.D., R.N., R.Ph., etc.) on a scheduled basis at least 4 times a year.
Drug information: provided only if a formal drug information service with specifically assigned pharmacist is available for questions. Does not require a physical location called drug information center.
Poison information: provided only if a pharmacist is available to answer toxicity and overdose questions on a routine basis with appropriate resources.
Clinical research: is performed by pharmacist either as principal investigator or coinvestigator. Pharmacist is likely to be (co-) author of a published paper. Do not check if activity is limited to investigational drug distribution or record keeping.

Patient-Specific Clinical Pharmacy Services

ADR management: pharmacist evaluates potential ADR while patient is hospitalized and appropriately follows through with physicians.
Pharmacokinetic consultation: provided only if at a minimum drug regimen, serum levels, and patient's medical record are reviewed and verbal or written follow-up is provided when necessary.
Drug therapy monitoring: provided only if a patient's medical record is reviewed and verbal or written follow-up is provided when necessary. Monitoring is continuing and repeated, often on daily basis. Do not check if only drug orders are reviewed. Does not include pharmacokinetic consults, TPN team, rounds, ADR management, or drug therapy protocol management.
Drug protocol management: pharmacist, under the order of a prescriber, requests laboratory tests if necessary and begins drug therapy or adjusts dosage to obtain desired outcome (e.g., aminoglycoside or heparin dosing per pharmacy).
TPN team participation: pharmacist at a minimum reviews patient's medical record and/or provides written or verbal follow-up if necessary.
Drug counseling: pharmacist provides counseling either during hospitalization or at time of discharge. Do not check if counseling involves solely review of label directions.
CPR team participation: pharmacist is active member of the team attending most arrests when the pharmacist is present in the hospital.
Medical rounds participation: pharmacist attends rounds with medical team at least 3 days/week, actively providing specific input.
Admission drug histories: pharmacist provides admission histories.

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