Implementation and pharmacoeconomic analysis of a clinical staff pharmacist practice model

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Abstract: The implementation and pharmacoeconomic analysis of a clinical staff pharmacist (CSP) practice model are described.

Staff pharmacists at a large, tertiary care, academic medical center were selected and trained to perform clinical pharmacy services under the direction of clinical pharmacy specialist mentors. Clinical interventions by these CSP practitioners were evaluated in terms of direct cost savings (the difference in actual acquisition costs between therapies) and cost avoidance (the dollar value of adverse drug events [ADEs] avoided). The CSPs performed a total of 4959 interventions during a 12-month period. The interventions provided direct cost savings of $92,076 and an estimated cost avoidance of $488,436. Comparing cost savings and cost avoidance with the expenses of providing these services indicated a net economic benefit of $392,660.

A new model of pharmacy practice that integrates staff pharmacists into existing clinical practice has the potential to minimize the risks, decrease the costs, and improve the outcomes associated with drug therapy.

Drug-related morbidity and mortality have been estimated to cost more than $136 billion per year in the United States. Much of this cost is due to adverse drug events (ADEs). ADEs are associated with significantly prolonged hospital stays and a nearly twofold increase in the risk of death in hospitalized patients. Bates et al. conducted a study in 1993 at two large teaching hospitals and estimated the cost of a preventable ADE to be $4700, resulting in a total cost of $2.8 million annually at the institutions for preventable ADEs. The

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Institute of Medicine report calling for fundamental changes in health care delivery to reduce medical errors is evidence that ADEs are important to U.S. policymakers. In 1998, national expenditures for pharmaceuticals increased 15.4%—the largest increase in three years—to a total of $90.6 billion. Spending is expected to rise another 43% by 2002. Drug and total inpatient health care costs are growing more rapidly than reimbursement.7

Pharmacists can work with other health care practitioners to reduce costs, optimize patient outcomes, and decrease the frequency of preventable ADEs. At The Cleveland Clinic Foundation, a 1000-bed tertiary care academic medical center, clinical pharmacy services have resulted in significant economic benefits to the institution and improvements in the quality of care. These services were provided exclusively by 10 acute care clinical pharmacy specialists working with selected interdisciplinary patient care teams. However, the services were not available to all inpatients. We believed that selected staff pharmacists could provide clinical pharmacy services under the direction of clinical pharmacy specialists. Therefore, we implemented a new model of practice at our institution to expand clinical pharmacy services and further capitalize on their benefits. This model facilitates continued integration of pharmacists into drug selection, administration, and monitoring. Pharmacists practicing under this model are called clinical staff pharmacists (CSPs).

We describe here the interventions and activities performed by the CSPs, their potential to improve clinical outcomes, and their potential economic benefit.

The CSP practice model

The CSP practice model was implemented in February 1999 in the areas of hematology–oncology, medical–surgical intensive care, and general medicine. Services are provided by three full-time-equivalent (FTE) pharmacists to approximately 200 patients per day. In this model, clinical pharmacy specialists function as mentors to CSPs, working closely with them to provide clinical pharmacy services to hospitalized patients. Routine order processing, drug allergy and interaction screening, formulary support, and drug distribution services continue to be provided by satellite pharmacy-based and central pharmacy-based pharmacists.

The CSPs are strategically positioned to extend the significant operational role of the staff pharmacists and the specialized clinical and educational roles of the clinical pharmacy specialists. Within a given service area, CSPs are involved in patient care rounds for one or two interdisciplinary teams that were previously not covered by clinical pharmacy specialists. For the remaining patients not directly supported through patient care rounds, CSPs provide similar services (e.g., general monitoring of drug therapy, pharmacokinetic evaluation, assessment and reporting of ADEs, assessment of drug interactions, drug information, in-service education, patient education, dosage adjustment for renal function, i.v.–to–oral conversion, and support of restricted–drug policies). Two pharmacists rotate at one-month intervals between CSP and satellite staff pharmacist positions within each service area.

A departmental committee selected pharmacists for participation in the new practice model. Selection was based on assessments of candidates' motivation, knowledge base, interpersonal skills, and oral communication skills. Once selected, each CSP received a minimum of 80 hours of formalized education and training from the clinical specialists (appendix). In addition, they received up to two weeks of one-on-one training from the clinical pharmacy specialist mentor for the respective practice area. Clinical competencies were demonstrated and verified before program initiation through case-based examinations.

Interventions, recommendations, and activities of the CSPs were documented concurrently with commercially available hardware (Libretto 70CT notebook computer, Toshiba America Information Systems, Irvine, CA 92618) and software (Clinitrend, version 4.2, American Society of Health-System Pharmacists, Bethesda, MD 20814) customized to meet institution-specific needs. A case-based training program was used to develop consistent methods of documenting interventions by the CSPs. Training occurred until interrater agreement for category assignment of interventions was greater than 85%. Drug costs were customized to reflect actual institutional acquisition costs.

Economic analysis

Economic analysis was performed to estimate the value of the CSP practice model to the institution. Clinitrend supported report generation for use as the primary source of data for the analysis. Each intervention was assessed for drug acquisition-related cost savings and cost avoidance related to averted ADEs. Cost savings and cost avoidance were compared with the cost of the CSP practice model to determine the net economic impact on the institution.

Interventions that resulted in drug treatment with a lower acquisition cost were evaluated in terms of cost savings. Cost savings were calculated as the difference in actual acquisition costs between the previous therapy and the new therapy that was recommended by the pharmacist. The intervention documentation software could account for increases and decreases in the cost of drug therapy. The saving resulting from the change in drug therapy was generally assumed to extend to the end of therapy with the new agent. In the case of conversions from i.v. to oral dosage forms, the cost difference between the dosage forms was calculated for...
Interventions with potential to improve the efficacy of drug therapy but no evaluable cost impact (cost savings or cost avoidance) were assigned a zero dollar value.

Interventions with potential to avoid an ADE were assessed for cost avoidance by a seven-member panel of clinical specialists using a consensus approach. The panel included three members with specialized training in the three CSP practice model service areas. Six of the seven members had completed an accredited specialized pharmacy residency, and five of the seven were board-certified in pharmacotherapy.

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, 0.01, 0.1, 0.4, or 0.6. These categories roughly coincide with zero, very low, low, medium, or high likelihood of an ADE. Literature was used to assign probability estimates when available (e.g., for aminoglycoside-associated nephrotoxicity). In such cases—approximately 20% of the interventions evaluated—the intervention was assigned to the probability category that most closely corresponded to the literature value. When no literature estimate was available, judgment based on clinical data for the patient was used to assign the intervention to a probability category. We assumed that no intervention would increase the likelihood of a preventable ADE. The cost of each adverse event was set at $5006 on the basis of the average cost of a preventable ADE occurring on the basis of the average cost of a preventable adverse event taken from a prospective trial, adjusted to year 2000 dollars with the medical care services component of the Consumer Price Index. Cost avoidance was calculated for each intervention by multiplying the estimated probability of an ADE in the absence of the intervention by the cost of an ADE.

The cost of the practice model to the pharmacy department was calculated as the salaries plus the benefits of the practitioners and the cost of the equipment used to record interventions. Training and mentoring the CSPs were considered part of the clinical specialists’ usual educational responsibilities. Since no additional specialist FTEs were required to implement the CSP practice model, there was no added cost to the institution for training and mentoring CSP practitioners. Cost savings and cost avoidance were summed and compared with pharmacy expenses to calculate the net economic impact to the institution and the benefit:cost ratio.

A sensitivity analysis was performed for the cost and probability estimates in the cost avoidance calculation to determine the effect of varying these estimates on the net economic impact of the program. The cost of an ADE was halved and doubled, and all probability estimates were halved and doubled (up to a maximum of 1.0). A two-way sensitivity analysis was performed to determine the effect of varying the cost and probability estimates simultaneously. One- and two-way sensitivity analyses were performed to determine the break-even point—the cost and probability values necessary for cost avoidance plus cost savings to equal pharmacy expenses (the point at which the benefit:cost ratio is 1:1).

Outcomes

A total of 4959 interventions and activities were documented by the CSPs during the 12-month period (Table 1). The most common types of interventions involved therapeutic consultation (1062 interventions), dosage adjustment for renal function (1003), pharmacokinetic consultation (678), and drug information (635). Examples of the outcomes of the interventions appear in Table 2. On average, a total of 413 interventions were made per month among the three practice areas. Medical–surgical intensive care had the largest number of interventions (2187), followed by general medicine (1681) and hematology–oncology (1091) (Table 3).

Interventions resulted in direct cost savings of $92,076 during the 12 months (Table 3). Medical–surgical intensive care achieved the highest cost savings. The mean cost savings for interventions associated with direct cost savings was $34.31 per intervention (range, $0.48–$705).

Interventions during the first 12 months resulted in an estimated cost avoidance of $488,436 (Table 3). Cost avoidance was highest for medical–surgical intensive care. The number of interventions that potentially avoided ADEs were as follows: for a probability of an ADE of 0, 119 interventions (12% of all interventions); for a probability of 0.01, 326 (33%); for a probability of 0.1, 524 (53%); for a probability of 0.4, 14 (1%); and for a probability of 0.6, 9 (1%).

The cost of the CSP program totaled $187,852 for the 12-month period. Cost savings and cost avoidance resulting from interventions by the

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**Table 1. Interventions by Clinical Staff Pharmacists**

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<td>1003 (20.2)</td>
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CSPs during the year totaled $580,511. Comparison of benefits ($580,511) and costs ($187,852) indicates a net economic benefit to the institution of $392,660 and a benefit:cost ratio of 3.1:1 (Table 3). The CSP practice model yielded a net economic benefit of $392,660 in cost savings and cost avoidance.

Varying the probability and cost estimates within the established limits did not push the benefit:cost ratio below 3.1:1. When the cost of an ADE was reduced from $5006 to $2503, the benefit:cost ratio became 1.4:1. The same ratio was calculated when all probability estimates were reduced by 50%. When cost and probability estimates were simultaneously reduced by 50%, the ratio became 1.1:1. The benefit:cost ratio became 1:1 (the break-even point) if the cost of an ADE was reduced to $981 or if all probability estimates were set to 19.6% of their initial value.

The break-even line for the two-way sensitivity analysis is shown in Figure 2.

### Discussion

Our analysis suggests that interventions by CSPs under the new practice model resulted in net value to the institution. For the 12-month period, the estimated net benefit of pharmacist provision of clinical services in the three clinical areas was $392,660 in cost savings and cost avoidance.

These results are consistent with those reported in a 1999 prospective study in which the value of a single pharmacist's interventions, in terms of reducing ADEs in an intensive care unit (ICU), was estimated at $270,000 annually. The cost avoidance estimate for our ICU pharmacist in the 12-month period was $195,835. The direct cost saving per pharmacist intervention in another recent prospective study ($30.35) is comparable to the value we calculated for CSP interventions ($34.31).

We believe that our estimate of net economic benefit is conservative. Our analysis did not account for value added by interventions that resulted in the dissemination of drug information or that increased efficacy of therapeutic regimens; it is likely that these activities add significant value to patient care. Kinky et al. estimated the value of a drug information service in a 700-bed university-based teaching hospital to be $1.7 million annually. A nationwide study of 1029 hospitals found drug information to be one of four pharmaceutical services associated with lower mortality rates. With respect to therapeutic efficacy, Gattis et al. demonstrated that all-cause mortality and heart failure events were significantly less frequent among heart failure patients randomized to treatment that included the services of a clinical pharmacist than to treatment that did not. While it is reasonable to speculate that CSP interventions increase the efficacy of therapeutic regimens and thereby improve patient outcomes, this cannot be proven from our analysis. Other factors contributing to the conservatism of our analysis include
Figure 1. Cost savings and cost avoidance versus pharmacy expenses.

Figure 2. Results of two-way sensitivity analysis of adverse-drug-event (ADE) cost and probability.

the probability categories used in the cost-avoidance calculation. The maximum probability of an ADE in the absence of an intervention was set at 0.6. This was done to maintain a conservative bias, although the panel believed that the probability could have been higher than 0.6 for certain interventions. Finally, the left skew in the distribution of probability estimates indicates that the probabilities were probably not grossly overstated.

The CSP practice model incorporates many practice elements that have been previously shown to be beneficial. Patient-specific clinical pharmacy services, such as drug therapy monitoring, pharmacokinetic monitoring, ADE assessment and reporting, patient education, and participation in medical rounds, have been associated with decreased hospital mortality rates. The significant reductions in mortality associated with cardiopulmonary resuscitation team participation and admission drug histories identified by Bond et al. suggest additional opportunities for pharmacists under such a practice model. Drug information and in-service education have been associated with significant decreases in drug costs. Finally, the overall expansion of clinical pharmacy services through increased hospital mortality rates and drug costs. We believe that many of the benefits of the CSP practice model are consistent with these previous observations.

Because they are integrated into the patient care team, pharmacists practicing under this model are in a better position to influence drug therapy and prevent untoward events. Therefore, this model presents an opportunity for pharmacy to contribute to the Institute of Medicine’s goal of reducing medical errors by 50% in five years. To take advantage of the opportunities presented, pharmacy departments need to change their model of practice. The need for such a change was described recently by Manasse.

The CSP model is also consistent with ongoing changes that directly influence the pharmacy profession. Entry-level doctor of pharmacy programs will produce increasing numbers of practitioners with basic clinical skills. While many of these practitioners will further their training through formalized residency and fellowship programs, not all will pursue the additional training generally required for clinical pharmacy specialist positions. These individuals, including those with pharmacy practice residencies, should be ideally suited for the roles and re-
sponsibilities of the CSP. Clinical pharmacy specialists will continue to play a vital role as mentors to these practitioners. Furthermore, as automation is increasingly used to facilitate distribution services and improve quality control and patient safety, fewer pharmacists should be needed to support these services. Thus, it should be possible to reallocate resources to clinical services that result in known qualitative and economic benefits. We believe that our program provides a template for change for pharmacy directors, who are increasingly expected to meet patient care needs through the services provided by their staff while effectively managing pharmaceutical costs within their institutions.

We reported our experience with the CSP practice model to administrative and clinical decision-makers at our institution in advance of the annual budgetary process. Additional funds for CSPs were requested for the 2000 budget. The request was approved, and five additional FTEs for CSPs were budgeted for the next two years.

This was a nonexperimental evaluation. We did not make comparisons with a control group of patients that did not receive the CSPs’ interventions. Nevertheless, we believe that there is convincing evidence of the value of the interventions. Almost 5000 interventions were performed by the CSPs, and many of them had clear potential for cost savings or cost avoidance.

Intervention data were self-reported by the CSPs. While this may represent a potential source of bias toward overreporting of intervention activity, specific clinical details surrounding each intervention were also recorded. This intensive method of data collection could serve to decrease bias.

The cost-avoidance calculation in our analysis is based on the published value of the cost of an ADE and an estimate of the probability of an ADE in the absence of the intervention. The true cost of an ADE at our institution is unknown. We used the average cost of an ADE determined in a prospective study at a similar institution, adjusted to year 2000 dollars ($5006). This study has been widely cited in articles on the economic impact of ADEs and arguably provides the best published estimate of the cost of an ADE to date. We believe this estimate to be reasonable for us to use for our institution.

The original study was conducted at two institutions that were very similar to ours and that had similar patient populations.

Our results were relatively insensitive to variation in the cost of an ADE. The net economic benefit calculated was robust up to an 80% reduction in the cost of an ADE ($981).

The probability values used to calculate cost avoidance were estimates by a consensus panel. The consensus panel’s probability estimates may have been too high. An argument against this inflation, however, is that the distribution of probability scores assigned by the panel was skewed toward the low end of the scale. The panel was composed of highly trained clinicians who had advanced pharmacotherapeutic knowledge and were well qualified to assess the interventions.

Finally, our estimate of cost avoidance was not sensitive to reductions in the probability estimates. The net economic benefit calculated in our analysis remained positive as the probabilities were lowered to 19% of their initial value (Figure 2).

Conclusion

A new model of pharmacy practice that integrates staff pharmacists into existing clinical practice has the potential to minimize the risks, decrease the costs, and improve the outcomes associated with drug therapy.

References


Appendix—Content of didactic education and training

- Introduction to patient monitoring, 1 hr
- Drug-related problems, 1 hr
- Pharmaceutical care documentation, 1 hr
- Introduction to patient communication, 1 hr
- Physical assessment and medical terminology, 3 hr
- Clearing-organ function assessment, 2 hr
- Drug interactions, 2 hr
- Oral communication skills, 5 hr
- Patient education, 2 hr
- Pharmacokinetic principles, 10 hr
- Drug information skills, 12 hr
- Microbiology review, 4 hr
- Infectious diseases pharmacotherapy, 8 hr
- Fluids, electrolytes, and nutrition support, 5 hr
- Pain management principles, 2 hr
- Adverse-drug-reaction reporting, 1 hr
- Clinical programs review, 8 hr
- Computerized intervention documentation, 8 hr
- Practice model simulation, 4 hr