ACCP

Economic Evaluations of Clinical Pharmacy Services—1988–1995

Glen T. Schumock, Pharm.D., M.B.A., Patrick D. Meek, Pharm.D., Pamela A. Ploetz, B.S., Lee C. Vermeulen, M.S., and
the Publications Committee of the American College of Clinical Pharmacy

The objectives of this effort were to summarize and critique original economic assessments of clinical pharmacy services published from 1988–1995, and to make recommendations for future work in this area. A literature search was conducted to identify articles that were then blinded and randomly assigned to reviewers to confirm inclusion, abstract information, and assess the quality of study design. The 104 articles fell into four main categories based on type of service described: disease state management (4%), general pharmacotherapeutic monitoring (36%), pharmacokinetic monitoring services (13%), and targeted drug programs (47%). Articles were categorized by type of evaluation; 35% were considered outcome analyses, 32% outcome descriptions, and 18% full economic analyses. A majority (89%) of the studies reviewed described positive financial benefits from the clinical services evaluated; however, many (68%) did not include the input costs of providing the clinical service as part of the evaluation. Studies that were well conducted were most likely to demonstrate positive results. Commonly, results were expressed as net savings or costs avoided for a given time period or per patient. Seven studies expressed results as a benefit:cost ratio (these ranged from 1.08:1 to 75.84:1, mean 16.70:1). Overall this body of literature contains a wealth of information pertinent to the value of the clinical practice of pharmacy. Future economic evaluations of clinical pharmacy services should incorporate sound study design and evaluate practice in alternative settings.

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From the Department of Pharmacy, Wausau Hospital, Wausau, Wisconsin (Dr. Schumock); and the Center for Drug Policy and Clinical Economics (Dr. Meek and Mr. Vermeulen) and the Department of Pharmacy (Ms. Ploetz), University of Wisconsin Hospital and Clinics, Madison, Wisconsin. Members of the 1995 and 1996 Publications Committee of the American College of Clinical Pharmacy were Brian Alldredge, Guy Amsden, Douglas Anderson, Edward Bednarczyk (Chair, 1995), S. Diane Goodwin (Chair, 1996), Linda Jaber, David Knoppert, Bruce Mueller, Michael Otto, Therese Poirier, Jay Rho, Richard Scheife, Glen Schumock, Maureen Smythe, Wilkinson Thomas, Dennis Thompson, Donald Uden, and Eva Vasquez.

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Address reprint requests to the American College of Clinical Pharmacy, 3101 Broadway, Suite 380, Kansas City, MO 64111.

In 1989 the American College of Clinical Pharmacy (ACCP) published a position statement entitled "Prospectus on the Economic Value of Clinical Pharmacy Services."[1] The purpose of that document was to summarize literature published prior to 1988 that supported the economic value of clinical pharmacy services and as such provide a resource to the profession in efforts to advance the clinical practice of pharmacy. A similar review was published in 1986.[2] These papers have proved to be valuable indexes of the literature and have been referred to by many in the profession on points pertinent to the economic value of clinical pharmacy.

In the time that has passed since the original

Table 1. Criteria for Assessing Type of Analysis

		Were Both Cost and Outcomes Considered?	
		No	Yes
Were two or more alternatives considered?	No	Cost description or outcome description	Cost and outcome description
	Yes	Cost analysis or outcome analysis	True clinical economic analysis Subcategories Cost-minimization analysis Cost-benefit analysis Cost-effectiveness analysis Cost-utility analysis

Adapted from reference 6.

ACCP prospectus, the literature has continued to grow in both depth and breadth of evidence supportive of the financial justification of clinical pharmacy services. New service models and philosophies of practice have developed in the past 6 years, the most notable being that of pharmaceutical care.[3] In addition, our ability to evaluate scientifically and measure the impact of clinical services on costs and outcomes has matured with the increased understanding and use of analytical techniques in health economics and pharmacoeconomics.[4, 5] The effect of these advances on the quality and quantity of literature is unknown. The ACCP Board of Regents thus asked the ACCP Publications Committee to update this prospectus.

The committee reviewed, summarized, and critiqued the literature published between January 1988 and December 1995 that included original economic assessment of clinical pharmacy services or programs, thereby serving to update the original position statement of ACCP. Further intentions were to provide a barometer of the degree to which accepted techniques of economic analysis have been incorporated into this literature, and to make recommendations for future work in this area.

Methods

A search of two major data bases (MEDLINE, International Pharmaceutical Abstracts) was conducted to identify articles published between January 1988 and December 1995. The beginning date of January 1988 was selected because the original ACCP prospectus was inclusive through December 1987. Both MeSH and free text search terms were used to identify English-language articles assessing the value of clinical pharmacy services. Search terms were clinical pharmacy services, pharmacy services, program, economic evaluation, cost justification, cost, cost-effectiveness, cost-benefit, cost analysis, cost-consequence analysis, and cost-utility analysis. Review articles, editorials, and other unoriginal reports were excluded from the search. All citations identified were screened for inclusion by review of titles and abstracts. Those articles for which abstracts were not available from the computerized data bases were collected manually and screened for inclusion.

Inclusion criteria were English language, original evaluation, publication between January 1988 and December 1995 inclusive, assessment of a clinical pharmacy service (defined as patient-level interaction, and not including policy-type interventions unless accompanied by a patient-level interaction), and some economic assessment. Exclusion criteria were reviews, editorials, and letters, and studies published in abstract form only. All papers suspected of meeting the inclusion criteria were submitted to full review. In addition, the authors examined personal files, and a secondary search of the titles of articles cited in papers meeting the inclusion criteria was conducted. Papers identified through this search were again collected and screened for inclusion, and added to the set of papers subjected to full review.

In the full review process, a modified block randomization scheme was used to confirm inclusion and to abstract information and assess the quality of each article. Each paper was randomly assigned to two of four reviewers. Reviewers were blinded to original authors' names, affiliations, and journal of publication. Reviews were recorded on a standard case report form and entered into a data base for analysis. Discrepancies between reviewers were arbitrated by group consensus. Reviewers first made a final check of inclusion and exclusion criteria to exclude further any nonapplicable articles. Reviewers recorded the study setting, objectives,

methods, results, and any additional comments.

Each article was assessed for the type of evaluation and categorized (Table 1). Two factors were considered in determining the type of evaluation: the presence of two or more alternatives, and the consideration of both input (costs) and outcomes. Evaluations that included two or more alternatives (i.e., concurrent control group, historical control, preintervention and postintervention design) were considered true analyses, whereas those that did not include a comparison were labeled descriptions. A description of the type of analysis was assigned to the evaluation and included the options of cost or outcome description, cost or outcome analysis, cost and outcome description, and true clinical economic evaluation. Those articles considered true clinical economic evaluations were subcategorized by type, options including cost-minimization analysis, cost-benefit analysis, cost-effectiveness analysis, and cost-utility analysis.[6]

Descriptive statistics were used to profile and characterize the articles within each data field abstracted by the reviewers, including the type of clinical service performed, the site of the study or evaluation, and the type of analysis performed.

Results

The results of the search and screen process used are illustrated in Figure 1. A total of 575 articles were found through the original search. A preliminary review of the abstracts of these articles identified 444 that did not involve the justification of clinical pharmacy services, and these were deleted from the set. Seven articles were added from the files of the authors, and 46 were identified through the secondary search of the articles found. Thus, 184 articles were subjected to full review. During full review, an additional 80 articles were found that did not meet the inclusion criteria: 44 did not review a clinical pharmacy service, 20 did not describe original work, and 16 failed on both points. An analysis of the final set of 104 articles is shown in Appendix 1.[7–110]

Articles are sorted in Appendix 1 by the type of clinical pharmacy service described in the evaluation. Four major categories were used in grouping articles by type of clinical pharmacy service: (1) disease state management, defined as clinical pharmacy services primarily directed at patients with a specific disease state or diagnosis; for example, a renal dosing program; (2) general pharmacotherapeutic monitoring, defined as clinical pharmacy services that encompass a broad range of activities based primarily on the needs of a geographically assigned group of patients; services provided may include patient drug regimen review, adverse drug reaction monitoring, drug interaction assessment, formulary compliance, or rounding with physicians; (3) pharmacokinetic monitoring services, defined as clinical pharmacy services that primarily involve evaluation of anticipated or actual serum drug concentrations and provision of subsequent dosing recommendations; and (4) targeted drug programs, defined as clinical pharmacy services that are primarily focused on a single drug or class of drugs and include predefined guidelines for provision of alternative therapy or dosing recommendations; for example, recommended switch from intravenous to oral administration of histamine$_2$-receptor antagonists (H_2RAs). Because of the number of articles describing targeted drug programs, those articles are further subcategorized in Appendix 1 based on the class of drug involved.

Provided in Appendix 1 are the following data for each article: (1) reference number, (2) the setting in which the evaluation was conducted, (3) a summary of the primary intent or objective, (4) a description of the analytical method of the evaluation, (5) number and type of alternatives

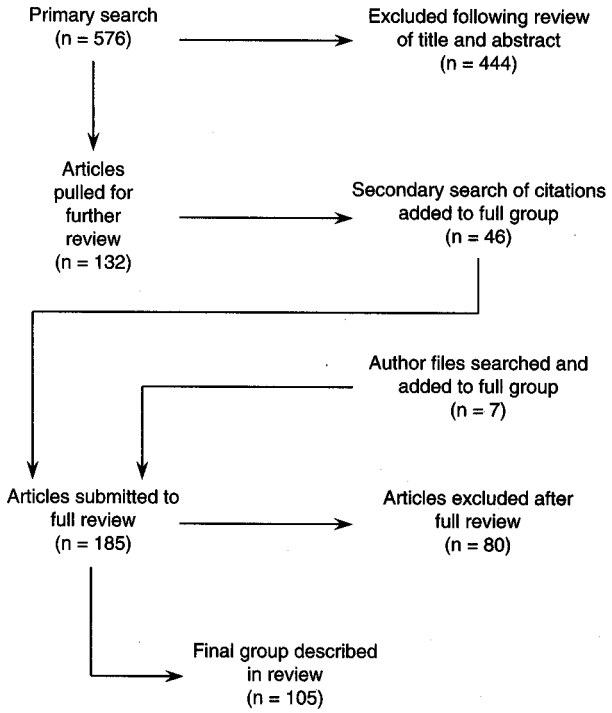

Figure 1. Literature search method and results.

Table 2. Settings of Cost-Justification Studies

Setting	Number of Studies
University hospital	33
Community hospital	25
University-affiliated teaching community hospital	12
Government hospital	10
University-affiliated ambulatory clinic	8
Government-affiliated ambulatory clinic	5
Health maintenance organization clinic	4
Multicenter, multisite	3
Community pharmacy	2
University-affiliated government hospital	2

Table 3. Analytic Methods of Cost-Justification Studies[a]

Method	Number of Studies
Outcome analysis	37
Outcome description	33
Economic analysis	19
Cost and outcome description	13
Cost analysis	1
Cost description	1

[a]Refer to Table 1 for classification analysis.

included in the evaluation, (6) input cost components included in the evaluation, (7) outcomes evaluated, (8) a summary of the main results of the evaluation, and (9) miscellaneous comments about the evaluation made by the reviewer.

Articles from pharmacy-based journals dominated the set of articles. The most common journal source was the *American Journal of Health-System Pharmacy* (n=32, 30%). *DICP/Annals of Pharmacotherapy*, *Hospital Pharmacy*, and *Hospital Formulary* were also common (n=19, n=15, and n=7, respectively). Several foreign journals also provided articles.

The most common type of pharmacy service was targeted drug programs (n=49, 47%). The specific drug classes described in targeted drug programs were most likely to be antimicrobials (n=27) or H_2RAs (n=17). Articles classified as general pharmacotherapeutic monitoring made up 36% (n=38), pharmacokinetic monitoring services 13% (n=13), and disease state management 4% (n=4).

Table 2 summarizes the settings of the studies included in this evaluation. The settings of most studies were university or community hospitals (n=33 and n=25, respectively). University-affiliated community hospitals and government hospitals were also common (n=12 and n=10, respectively). Less common settings were ambulatory clinics of various affiliations, health maintenance organizations, and community pharmacies.

Table 3 summarizes the analytic methods used in the included articles. Although 19 (18%) articles were considered full economic analyses (by definition, considering two or more alternatives and measurement of both input costs and outcomes), most were less rigorous. The most common types of studies were outcome analyses (n=37, 35%), which considered two or more alternatives but excluded consideration of the costs of providing the service, and outcome descriptions (n=33, 32%), which failed to consider two or more alternatives and did not consider the cost of providing the service.

The study design of the included articles was further analyzed by individually considering the use of a comparison group (alternative) and by the types of input costs and outcomes measured. Sixty-one (59%) studies included a comparison group, whereas 43 (41%) did not and were therefore considered to be descriptive. The study designs used in papers that had a comparison group were a concurrent control group (n=21), a historical control group (n=10), and preintervention and postintervention groups (n=30). Precontrols and postcontrols were differentiated from historical control designs in the temporal relationship to the intervention. If a study compared measurements taken immediately prior to an intervention and immediately after, it was coded as a pre/post design. If a longer period of time elapsed between comparison groups (e.g., comparing data from the study period to the same month 1 year earlier), it was defined as a historical control.

Seventy-one studies (68%) did not evaluate the cost of providing the clinical service as part of the economic evaluation of that service. Most commonly, costs were considered as an outcome or consequence of the service (i.e., as in drug costs avoided) rather than as an input (i.e., as in the investment required to establish and maintain the program under study). Of the 33 (32%) studies that did consider some input costs, the most common cost assessed was personnel (n=25). In these cases, the costs of the program under study were quantified in terms of salary and/or benefits associated with providing the program or service. Some studies used charges (i.e., hospital room, emergency room) rather than true costs.

Outcomes or consequences of the services described were considered in all of the articles.

The most common (n=80, 77%) outcome measured was drug costs avoided (i.e., the impact of the program on reducing use or cost of a particular drug). Other nonfinancial outcomes were also measured, including length of hospital stay (n=14, 13%), use of nonpharmaceutical resources, rates of adverse drug reactions, frequency of pharmacist-driven therapeutic interventions, and qualitative changes in prescribing patterns. True clinical patient outcomes were considered in few studies.

Ninety-three (89%) of the articles described beneficial financial impact of the clinical pharmacy service described. Many provided either gross cost savings or, in those that did consider input costs, net savings. Of the 33 studies that considered input costs, 31 (94%) demonstrated positive findings. Results of these were presented a number of different ways (Table 4).

Commonly these articles expressed net savings on an annual basis or for the time period of the study. For example, a study in 1992 described annual net cost savings of $221,056 for clinical pharmacy services provided in an ambulatory care clinic.[25] It did not, however, include a control group. In other cases savings were expressed per patient admission or per patient-day. In 1993, a well-conducted and controlled evaluation described an average net savings of $377 per patient admission as a result of clinical pharmacists assigned to selected inpatient medical services.[14]

In seven articles, results were expressed as benefit:cost ratios. They differed in type of clinical pharmacy service, site of provision of service, and resources invested in the service (Table 5). Nevertheless, the results were impressively positive, with calculated benefits to cost ranging from 1.08:1 to 75.84:1 (mean 16.70:1).

Table 4. Studies that Considered Input Costs of Providing Service

Method of Expressing Results	References[a]
Net savings annualized or for time period of study	8, 9, 11, 18, 20, 24, 25, 31, 36, 45, 51, 53, 55, 68, 79, 82, 91, 94, 98, 104, 110
Net savings/patient-day or patient admission	13, 14, 15, 20, 38, 52, 60, 71
Benefit:cost ratio	11, 14, 15, 41, 51, 60, 98
Other	10, 29

[a]References may be listed more than once if results were expressed in different formats.

Discussion

Assessment of the Literature

The conclusions drawn from our review and evaluation of literature assessing the economic value of clinical pharmacy services published from 1988–1995 are multifocal. The total number of articles published on this topic has grown, as demonstrated by the number in this review (104, average 13/yr) versus the original prospectus (58, average 4/yr), which included articles published from 1974–1987. Although the number of published articles on this topic appears sufficient, an opportunity does exist for improvement in the quality of study design.

A large percentage (41%) of the articles we reviewed did not include a comparison group. They did not incorporate a study design that would allow one to control variance, which therefore makes it difficult for the reader to confirm the validity or extrapolate the results to other practice settings. This is not to say that these articles are without value, however. Many are excellent descriptive reports that provide insight and experience from which others may learn.

Sixty-eight percent of studies did not consider the costs associated with providing clinical pharmacy services as a factor in the economic evaluation or justification of that service, thus making it difficult to demonstrate true economic justification of the service. For those studies that did consider some input costs, personnel costs were often singularly included, with nonlabor costs (i.e., overhead) being omitted. Furthermore, when charges were used, they were often misinterpreted as costs.

The outcomes measured tended to focus on financial consequences and not to include clinical or patient consequences. Without consideration of clinical outcomes, or without being able to make an assumption that clinical outcomes are unchanged, the true economic impact of the services studied could not be proved.

Despite the limitations of many of the articles as true economic evaluations, this literature contains a wealth of information pertinent to the clinical practice of pharmacy that serves to document innovative and successful experiences and programs. Of importance, we did find that when studies were well conducted (considered true economic evaluations), the results were likely to be favorable; that is, the studies were able to demonstrate net savings or positive benefit:cost ratios. Because of lack of standardization in reporting of results and variability in study design, it is difficult to make a general statement as to the degree of benefit derived from

Table 5. Studies Allowing Calculation of Benefit:Cost Ratio

Setting	Clinical Service	Objective	Benefit:Cost Ratio
University hospital[11]	Pharmacotherapeutic monitoring	To examine cost benefit of clinical pharmacy intervention and documentation system	1.98:1
Government hospital[14]	Pharmacotherapeutic monitoring	To study effect of clinical RPh on health care outcomes	6.03:1
HMO clinic[15]	Pharmacotherapeutic monitoring	To measure impact of pharmaceutical services on overall health care costs, and to estimate RPh productivity	3.2:1
University hospital[41]	Pharmacotherapeutic monitoring	To evaluate impact of clinical pharmacy service on hospital costs using cost-benefit analysis	1.08:1 & 1.59:1
University-affiliated[51] community hospital	Pharmacokinetic monitoring	To determine cost benefit of pharmacokinetic services for patients receiving aminoglycosides	75.84:1 & 52.25:1
University hospital[60]	Pharmacokinetic monitoring	To evaluate impact of computer-assisted aminoglycoside dosing	4.09:1
HMO clinic[98]	Target drug program	To evaluate impact of clinical RPh intervention program on cost of H_2RA therapy	4.3:1

HMO = health maintenance organization; H_2RA = histamine$_2$-receptor antagonist.

clinical pharmacy services. However, we were able to abstract calculated benefit:cost ratios from the seven applicable studies and describe a range of value from 1.08:1 to 75.84:1 (mean 16.70:1). In other words, for every dollar invested in clinical services, on average $16.70 was saved.

These seven studies were conducted in a variety of practice environments—university hospitals (3), university-affiliated community hospital (1), governmental hospital (1), and health maintenance organization clinics (2). They evaluated a spectrum of pharmacist-delivered services including pharmacotherapeutic monitoring (4), pharmacokinetic monitoring (2), and targeted drug programs (1). Both of these considerations speak to what we believe to be the broad applicability of the studies' results.

Limitations

We undertook this review and evaluation with the intent of providing the reader a resource to access original literature published assessing the economic value of clinical pharmacy services, and to evaluate the quality of that literature. The articles included in this review represent only those published in standard literature. We did not consider unpublished studies and therefore our results may be subject to inherent publication bias (so-called "file drawer" effect). We included only articles that contained some consideration of the financial impact of clinical pharmacy services. Certainly, many useful articles describe and evaluate clinical pharmacy services, but focus on nonfinancial outcomes and impact, and are worthy of review. Finally, our review of the literature, although intended to be systematic and thorough, may not have captured all of the published literature on this topic.

Recommendations

Having reviewed and evaluated the published literature on the economic value of clinical pharmacy services, we make the following recommendations to clinicians, investigators, authors, reviewers, and journal editors.

1. Future economic evaluations should incorporate sound methodology and study designs. Study designs should control for variance by using a comparison group such as a historical control, concurrent control, or pre- and postintervention measurement.
2. Consideration should be given to the input costs, that is, the costs of providing the service, as part of the economic evaluation. These costs should include direct and indirect costs if possible. Where charges are used they should be appropriately labeled and interpreted as such.
3. Outcome measurements should include more than just drug costs avoided. Nonfinancial outcomes such as clinical patient outcomes are important and should be part of the evaluation of any service that affects patient care. Using a disease state management approach rather than the

targeted drug approach to cost justification may help identify important outcome measurements that should be considered.

4. The concept of opportunity costs (i.e., money spent on one resource that cannot be spent for other purposes) should be explored. The value of any given service should be weighed against the possible services that might be provided. The concept of opportunity costs becomes even more important as health care downsizing and restructuring occur.
5. Clinical pharmacy services provided in settings outside the traditional hospital should be included in future economic evaluations.

Conclusion

It is hoped that the data summarized in this paper will assist individual pharmacists, departmental managers, and health system administrators to document and recognize the cost effectiveness of pharmacists' clinical services. Pharmacy practitioners should take pride in both the quantity and strength of this literature, and feel empowered to use it to justify further expansion or refinement of their care-giving responsibilities. Attention to our recommendations regarding the design and performance of future economic evaluations of clinical pharmacy services will further add to the strength of this literature and the conclusions that may be drawn from it.

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Appendix 1. Evaluations of Economic Value of Clinical Pharmacy Services—1988–1995

Setting	Objective (as stated by authors)	Analytic Method	Comparison Group	Input Costs	Outcomes Included	Results Measured	Comments
Disease State Management							
CH[7]	To evaluate impact of benzodiazepine guidelines on cost and quality of care of patients hospitalized for alcohol withdrawal	OA	Control group	None	DCA, LOS	Mean drug cost decreased from $1008/day to $59/day/patient; mean ICU LOS decreased from 4.1 to 1.1 days	Input costs not considered
UH[8]	To evaluate impact of clinical RPh on cost savings and patient outcome in asthma clinic	CBA	Historical control	Cost of clinic visit offset other savings	Cost of emergency room visits for asthma exacerbation	Cost savings $30,693 and $68,393 between study period and each of 2 control periods; savings derived from reduction in ER visits	Drug costs not considered; economic value of clinical outcomes (beyond ER visits) not assessed; no ratio calculated
CH[9]	To evaluate impact of renal function monitoring program, focusing on appropriate dosages of renally eliminated agents	COD	None	Personnel costs	DCA	Cost savings $5040 noted, with program cost $2700 for labor	No control group; clinical outcomes not considered; measured only what the cost of therapy would have been without intervention
UACH[10]	To conduct time and motion analysis of PCA vs i.m. analgesia and evaluate impact on cost and quality of pain control	CBA	Historical control	Costs of drug, RPh, and nursing labor	LOS, cost of ADRs, quality of analgesia	Quality of analgesia increased with PCA, but so did cost and time required	Evaluated both RPh and nursing time; did not provide ratio
General Pharmacotherapeutic Monitoring							
UH[11]	To examine cost benefit of clinical pharmacy intervention and documentation system	COD	None	Personnel costs	DCA, type of intervention	Cost savings of $1.98/$1 invested, with total annual savings $7100	Missing relevant costs and outcomes
CH[12]	To assess the quality and cost avoidance of RPh interventions using physician assessors	OD	None	None	DCA, LOS	Positive impact on patient care, estimated reduced LOS by 3.7 days	Physician reviewers estimated reduction in LOS resulting from interventions
UH[13]	To cost justify clinical pharmacy service on general surgery team	COD	None	Personnel costs	DCA, type of intervention, clinical impact of intervention	Positive impact on outcomes; net cost avoidance of $441.46/patient	Small sample
GH[14] (Army)	To study effect of clinical RPh on health care outcomes	CBA	Control group	Personnel costs	LOS, drug costs/ admission	Average net savings $377/patient admission; cost:benefit ratio 6.03:1	Control group included

Appendix 1. Evaluations of Economic Value of Clinical Pharmacy Services—1988–1995 (continued)

Setting	Objective (as stated by authors)	Analytic Method	Comparison Group	Input Costs	Outcomes Included	Results Measured	Comments
HMOC[15]	To measure impact of pharmaceutical services on overall health care costs, and to estimate RPh productivity	COD	None	Personnel costs, direct costs, overhead	Percentage of problematic drugs, use of service, DCA	Average total cost savings $644/patient; cost:benefit ratio 3.2:1	
GH[16] (VA)	To evaluate clinical RPh recommendations on number and costs of drugs	OD	Control group	None	DCA	Decreased average monthly drug cost/patient	Input costs not considered
UACH[17]	To describe program and determine cost savings from clinical pharmacy services provided in rehabilitation clinic	OD	None	None	DCA	Reduced hospital drug costs by $2700 during 6-mo study	Input costs not considered
CH[18]	To evaluate clinical pharmacy services and determine cost savings and justification for additional pharmacy staff	COD	None	Personnel costs	DCA	Annual net savings $25,862	
CH[19]	To evaluate impact of a clinical coordinator on costs avoided by the institution from clinical intervention program	OA	Pre/post	None	DCA, NOI	Average monthly net savings $3739 and $4644 before and after clinical coordinator	
UH[20]	To describe interventions made by clinical RPh and evaluate cost savings and cost avoidance impact	COD	None	Personnel costs	DCA, NOI	Cost savings of $69.11/ patient-day; annual net savings $300,079	
UH[21]	To compare cost and quality of decentralized vs centralized pharmaceutical services	OA	Pre/post	None	LOS, total cost/ admission	Decreased average total cost/admission by $1293; decreased average pharmacy cost/admission by $155 for decentralized	
CP[22]	To examine value of clinical pharmacy intervention program in a community pharmacy setting and determine economic value	OD	None	None	DCA, NOI	Cost avoided of $3.47/ prescription processed	

Appendix 1. Evaluations of Economic Value of Clinical Pharmacy Services—1988–1995 (continued)

Setting	Objective (as stated by authors)	Analytic Method	Comparison Group	Input Costs	Outcomes Included	Results Measured	Comments
UACH[23]	To describe program to develop clinical pharmacy staff and determine cost avoidance to hospital resulting from the service	OD	None	None	DCA	Average estimated cost avoidance $9306/mo over 5 yrs	Input costs not considered
UH[24]	To evaluate and document impact of clinical RPh on costs avoided at tertiary care teaching hospital	COD	None	Personnel costs	DCA	Net annualized cost avoidance $897,350	
UAAC[25]	To evaluate impact of clinical RPh on cost and quality of patient care in ambulatory care clinics	COD	None	Personnel costs	DCA	Net annualized cost avoidance $221,056	Emphasized need for documenting interventions
UH[26]	To evaluate impact of clinical RPh on medical team	OD	None	None	Interventions documented	27% of interventions prevented serious effects	Input costs not considered
MC, CH, MHF, SNF[27]	To evaluate impact of reactive clinical pharmacy interventions on cost and quality of patient care	OD	None	None	Cost impact of interventions documented	2.9% of pharmacy interventions prevented potential medical harm; limited cost impact	Input costs not considered; physicians assessed RPh service, introducing potential bias
GH[28] (VA)	To evaluate daily data collection of decentralized clinical pharmacy services	OD	None	None	DCA	Total savings $126,504 due to 2506 interventions provided	Input costs not considered; clinical outcomes not considered; no comparative group used to assess cost and outcome difference
GAAC[29]	To evaluate impact of clinical RPh's interventions on physician prescribing and costs in an ambulatory clinic	CBA	Control group	Personnel costs	Cost avoidance due to reduced number of prescriptions	Cost avoidance $4.63 for intervention group vs $1.10 in control group; savings in prescription filling labor noted; labor costs associated with program offset by DCA	Clinical outcomes not considered; no ratio presented
UAAC[30]	To evaluate impact of ambulatory clinical pharmacy program and to cost justify personnel for the program	OD	None	None	Cost avoidance in drug and laboratory use	$19,000 in cost reduction for interventions, 184 patients; documented clinical outcomes after interventions	Discussed cost of personnel required for program, but did not factor cost into analysis; no comparison group for analysis
GAAC[31] (VA)	To evaluate impact of clinical RPh on cost and quality of patient care	CBA	Pre/post	Costs associated with program and dispensing prescriptions generated in the clinic	DCA	Total cost decrease of $22,241 during study period	Charts assessed for quality based on the rate of suggestion implementation, but actual patient outcomes not assessed

Appendix 1. Evaluations of Economic Value of Clinical Pharmacy Services—1988–1995 (continued)

Setting	Objective (as stated by authors)	Analytic Method	Comparison Group	Input Costs	Outcomes Included	Results Measured	Comments
UACH[32]	To evaluate cost impact of clinical RPh in intensive care unit	COD	None	Personnel costs	DCA	Cost savings $10,010 (Canadian) documented over 3-mo study period; cost:benefit ratio 4:1	No control group; measured only what the cost of therapy would have been without intervention
UH[33]	To evaluate impact of pharmacy faculty providing clinical pharmacy interventions on drug costs and pharmacy department revenue	OD	None	None	DCA and service revenue generated	Impact of 278 interventions evaluated, demonstrating drug cost avoidance $1661, generation of $6000 in revenue from pharmacokinetic consultations	No control group; measured only what the cost of therapy would have been without intervention
GAAC[34] (VA)	To evaluate impact of clinical RPh on drug prescribing and cost savings	CBA	Control group	Personnel costs	DCA	Decreased total number of prescriptions and associated ADRs; total cost of prescriptions filled in study period $3872 less than during control period; total cost to administer program $2250	No ratio presented; mentioned but did not quantify value of prevented ADRs
CH[35]	To evaluate impact of documentation system for clinical pharmacy services	OD	None	None	DCA	Cost avoidance ranged $2341–7762/quarter during study	Input costs not considered; no control group; clinical outcomes not considered
CH[36]	To evaluate cost impact of implementing clinical pharmacy services in intensive care unit	COD	None	Personnel costs	DCA	During 32 days, cost avoidance $1651, labor cost associated with program was $2599	No control group; clinical outcomes not considered; small sample size (number of pilot days assessed, and short period of time/day)
MC, UH[37]	To evaluate acceptance and cost savings resulting from 2-yr postbaccalaureate Pharm.D. student interventions	OD	None	None	NOI, DCA, laboratory cost avoidance	Estimated annual drug savings $3891	Input costs not considered
CH[38]	To determine cost savings of clinical pharmacy service in a community hospital	CD	None	Personnel costs	DCA	Savings of $1.49/patient/day for clinical pharmacy services	Brief description of daily documentation activity to demonstrate cost savings
CH[39]	To describe impact of general clinical pharmacy interventions on hospital costs	OD	None	None	Physician acceptance, NOI, DCA	Total savings $15,525.81	Input costs not considered
CH[40]	To evaluate impact of comprehensive clinical pharmacy services on hospital costs	OA	Pre/post	None	DCA	Net cost savings $34.10/RPh-day	Input costs not considered; clinical outcomes not considered

Appendix 1. Evaluations of Economic Value of Clinical Pharmacy Services—1988–1995 (continued)

Setting	Objective (as stated by authors)	Analytic Method	Comparison Group	Input Costs	Outcomes Included	Results Measured	Comments
UH[41]	To evaluate impact of clinical pharmacy service on hospital costs using cost-benefit analysis	CBA	Historical control	Cost of providing service	DCA	Cost:benefit ratios 1.08 and 1.59 for 2 ward-based groups	Clinical outcomes not considered
CH[42]	To determine impact of clinical interventions on cost and quality of patient care	OD	None	None	Number of inappropriate laboratory tests, DCA	Annual drug cost avoidance of $26,580	
UH[43]	To evaluate impact of Pharm.D. student interventions	OD	None	None	NOI, physician acceptance	Decreased drug costs by 50.7%	
UH[44]	To document interventions of clinical RPh in emergency department	OA	Pre/post	None	DCA	Description of clinical and cost-saving interventions	Input costs not considered; clinical outcomes not considered
UAAC[45]	To evaluate impact of clinical pharmacy interventions on cost and quality of patient care	COD	None	Personnel costs	Physician acceptance, DCA, various quality indicators	Annual extrapolated cost savings $19,076	Documented cost and quality using daily patient data-collection forms
UAAC[46]	To determine impact of clinical RPh on cost savings to the hospital and quality of patient care	OA	Control group	None	NOI, DCA	RPhs saved $176,724 annually	Extrapolated savings from 2-wk pilot
CP[47]	To evaluate cost savings to pharmacy from interventions of community RPh	OD	None	None	Assessment of value of RPh interventions, cost of medical care avoided	Value of avoided care was $122.98/intervention; $2.32 savings/prescription screened	
UAAC[48]	To evaluate impact of clinical RPh on cost and quality of patient care	OD	None	None	Physician acceptance, patient outcome indicators, DCA	205 interventions made during 6-mo study; 80.9% made to increase quality; 18.1% to increase quality and decrease cost	
Pharmacokinetic Monitoring Service							
CH[49]	To determine effect of TDM program on inappropriate sampling times	OD	None	None	Unnecessary samples, patient charges	Charge avoidance $500,000 annually	Input costs not considered; charges vs costs
UH[50]	To evaluate impact of educational efforts on use of SDCs	OA	Pre/post	None	DCA, number of drug assays	Increased number of drug levels ordered; decrease of $599 in hospital costs	Increased rational ordering of serum drug concentrations

Appendix 1. Evaluations of Economic Value of Clinical Pharmacy Services—1988–1995 (continued)

Setting	Objective (as stated by authors)	Analytic Method	Comparison Group	Input Costs	Outcomes Included	Results Measured	Comments
UACH[51]	To determine cost benefit of pharmacokinetic services for patients receiving aminoglycosides	CBA	Control group	Variable costs, personnel costs, fixed costs	LOS, clinical response	Decreased LOS; decreased duration of febrile period; benefit:cost ratio 75.84:1 and 52.25:1	
CH[52]	To determine physician acceptance and impact of clinical pharmacokinetic recommendations on cost and quality of patient care	CBA	Control group	Variable costs, personnel costs, fixed costs	Acceptance by physicians, LOS, DCA, clinical response	Decreased LOS; decreased febrile period; decreased direct costs; cost of service $85/patient	
CH[53]	To evaluate impact of clinical pharmacokinetic service on cost and quality of patient care	CBA	Control group	Variable costs, fixed costs	LOS, clinical response, patient charges	Decreased length of treatment; decreased LOS; annual cost savings $113,934	Used charges rather than costs
CH[54]	To evaluate costs associated with clinical pharmacokinetic dosing service	OA	Pre/post	None	LOS, DCA	Cost reduction $107,000 associated with decrease in LOS; reduction of $14,000 in drug costs associated with program	Mentioned but did not value cost of system
UH[55]	To evaluate impact of clinical RPh on appropriate serum drug concentration ordering	CBA	Historical control	Personnel costs	Cost of laboratory testing avoided	Increased appropriateness of serum drug concentration determination; cost of $1000 with savings of $3000	Clinical outcomes not considered; no ratio presented
UH[56]	To evaluate impact of pediatric pharmacokinetic service using guidelines as basis for appropriate monitoring	CA	Control group	None	Costs avoided through decrease in inappropriate monitoring	Annual cost avoidance $12,325 based on fewer inappropriate laboratory assays	Input costs not considered
CH[57]	To evaluate effectiveness of serum digoxin concentration monitoring, and determine cost impact of service	OD	None	None	NOI, timing of digoxin serum concentrations, laboratory costs avoided	Decreased number of digoxin serum drug concentrations ordered	Input costs not considered
UH[58]	To analyze need for therapeutic drug monitoring program for phenytoin	OA	Control group	None	Number and cost of drug assays, LOS and readmission rate	Overall cost savings after 1 yr of program $100.00	Charges vs costs
UH[59]	To evaluate impact of therapeutic drug monitoring program for theophylline	OA	Control group	None	Number and cost of drug assays, LOS	Equal cost of RPh monitoring and savings after 1 yr	Charges vs costs

Appendix 1. Evaluations of Economic Value of Clinical Pharmacy Services—1988–1995 (continued)

Setting	Objective (as stated by authors)	Analytic Method	Comparison Group	Input Costs	Outcomes Included	Results Measured	Comments
UH[60]	To evaluate impact of computer-assisted aminoglycoside dosing	CBA	Control group	Service cost	LOS, room charge, DCA	$1311 savings/patient in study group; CBA ratio of 4.09:1 in favor of study group	Used charges rather than costs
CH[61]	To compare RPh vs physician dosing of aminophylline	OA	Control group	None	LOS, room charges, cost of concomitant drugs	Decreased LOS of 1.96 days; $490 savings/patient in study group	Used charges rather than costs
Target Drug Programs: Antiemetic Agents							
UH[62]	To evaluate impact of prescribing guidelines for use of ondansetron on drug costs	OA	Pre/Post	None	DCA	15% reduction in amount of ondansetron dispensed from period before guideline implementation	Input costs not considered; clinical outcomes not considered
Target Drug Programs: Antihypertensives							
HMOC[63]	To evaluate impact of clinical RPh consultation on cost of antihypertensive therapy in HMO family practice clinic	OA	Control group	None	Average daily drug costs	Decreased drug costs of $20.61/patient-year	Input costs not considered
Target Drug Programs: Antimicrobials							
UAAC[64]	To assess impact of fluconazole guidelines and concurrent RPh intervention	OA	Historical control	None	Appropriate use, ADRs, DCA	Annual cost avoidance $65,520	Input costs not considered
UACH[65]	To describe experience with program for modifying dosing regimens of mezlocillin	OD	None	None	DCA	Annual cost savings $33,000 or $49.47/patient	Input costs not considered
UH[66]	To document cost containment of RPh antibiotic streamlining program	OD	None	None	DCA	Annual cost savings $47,700	Input costs not considered
UH[67]	To evaluate educational and intervention program promoting use of metronidazole for antibiotic-associated colitis	OD	Historical control	None	DCA	Estimated annual savings $38, 829 based on decreased drug costs	Input costs not considered; clinical outcomes not considered
CH[68]	To evaluate impact of therapeutic intervention to alter metronidazole dosing	COD	Pre/post	Personnel costs	DCA	Annual savings $28,000	Input costs not considered

Appendix 1. Evaluations of Economic Value of Clinical Pharmacy Services—1988–1995 (continued)

Setting	Objective (as stated by authors)	Analytic Method	Comparison Group	Input Costs	Outcomes Included	Results Measured	Comments
GH[69] (VA)	To describe antibiotic monitoring program and determine costs avoided to hospital from rational antibiotic use	OD	None	None	DCA, appropriateness	Total cost avoidance $42,512 during study period	Input costs not considered
UH[70]	To evaluate impact of target drug monitoring program for clindamycin on hospital costs	OA	Historical control	None	DCA	Cost avoidance $16,000 annually	Input costs not considered
GH[71] (VA)	To evaluate impact of clinical RPh monitoring on i.v. ceftriaxone use (conversion to oral cefpodoxime)	CBA	Control group	Cost of treatment	Cost of treatment outcome	Cost savings $46.05/patient achieved, 1-day decrease in LOS	Input costs not considered; small sample
UH[72]	To evaluate antimicrobial management program and evaluate impact on cost and quality of patient care	OA	Historical control	None	DCA	Gross savings in antibiotic acquisition costs $483,032/yr	Cost associated with service considered, but not quantified
GH[73]	To evaluate cost impact of 2 DUE activities performed by undergraduate pharmacy students	OD	Historical control	None	DCA	Cefazolin dosing modification (q6h to q8h) resulted in savings of $18,000; substitution of metronidazole for clindamycin saved $21,000	Input costs not considered; clinical outcomes not considered
UH[74]	To evaluate cost impact of pharmacy-based antibiotic optimization program	OA	Pre/post	None	DCA	Savings of $12,640 realized after program implementation	Input costs not considered; clinical outcomes not considered
GH[75] (State)	To evaluate impact of RPh participating in patient care rounds on costs associated with antimicrobial drug use	OA	Pre/post	None	DCA	Cost reduction of $29,800 greater in study period vs prestudy period	Input costs not considered
UACH[76]	To evaluate impact of clinical RPh-based antibiotic management program	OA	Control group	None	Drug and ancillary cost avoidance	Estimated cost savings $40,000 associated with drug cost avoidance and appropriate use of laboratory data	Input costs not considered; clinical outcomes not considered
UACH[77]	To evaluate impact of renal function monitoring program, focusing on appropriate dosages of imipenem	OD	None	None	DCA	Potential to save $11,500 annually by adjusting imipenem dosages on basis of renal function	Input costs not considered; no control group; clinical outcomes not considered

Appendix 1. Evaluations of Economic Value of Clinical Pharmacy Services—1988–1995 (continued)

Setting	Objective (as stated by authors)	Analytic Method	Comparison Group	Input Costs	Outcomes Included	Results Measured	Comments
UACH[78]	To evaluate cost impact of computerized antibiotic monitoring program	OA	Historical control	None	DCA	Predicted cost avoidance approximately $80,000 in control vs study periods, but actual cost reduction attributed to program >$200,000	Cost associated with providing program mentioned but not quantified
UH[79]	To evaluate impact on hospital costs of antibiotic program using education and antimicrobial restriction	CBA	Pre/post	Costs of drug, labor, and program monitoring and implementation	LOS, infection frequency	Cost savings $14,250 annually with quality of care remaining constant	No ratio presented
MC, UH[80]	To conduct retrospective DUE to determine potential cost savings of ceftazidime dosage adjustment	OD	None	None	DCA	Ceftazidime dosing in elderly found to be in excess of labeled dosing because renal function not considered	Input costs not considered; clinical outcomes not considered
UH[81]	To evaluate impact of clinical RPh's intervention on antibiotic costs	OA	Pre/post	None	LOS, DCA	Audit results 3 mo before and after intervention revealed $3498.40 reduction in drug costs	
UH[82]	To determine impact of antibiotic monitoring program	CBA	Pre/post	Cost of printing intervention form	DCA	Net savings $17,000 annually	Clinical outcomes not considered; personnel costs not considered; no ratio presented
UAGH[83]	To evaluate impact of compliance with guidelines for third-generation cephalosporins	OA	Pre/post	None	Clinical and microbiologic indicators; DCA	Documented reduction of $27,000 over 6 mo in pharmacy expenditure for antibiotics	Input costs not considered
UACH[84]	To evaluate impact of antimicrobial intervention program	OD	None	None	Clinical and microbiologic indicators, laboratory costs, DCA	Savings $38,920 over 7 mo; projected annual savings $107,000	Input costs not considered; assumed quality and clinical outcome to be equal
GH[85] (VA)	To evaluate impact of antibiotic policy on hospital costs and quality of patient care	OA	Pre/post	None	DCA, duration of antibiotics, LOS, mortality	Decreased monthly antibiotic costs by $7600; average savings $91,200 annually; fewer deaths; decreased LOS	
CH[86]	To describe cost savings to hospital resulting from clinical RPh and nursing antibiotic prescribing interventions	OD	None	None	DCA, NOI	Cost avoidance $23,993 during study period	Input costs not considered

Appendix 1. Evaluations of Economic Value of Clinical Pharmacy Services—1988–1995 (continued)

Setting	Objective (as stated by authors)	Analytic Method	Comparison Group	Input Costs	Outcomes Included	Results Measured	Comments
UH[87]	To describe and evaluate dosing intervention program for imipenem	OA	Pre/post	None	ADRs, DCA	Decreased number of seizure episodes; cost savings due to dosage change	Retrospective chart review
GH[88] (VA)	To evaluate impact of concurrent antibiotic use program	OA	Pre/post	None	Length of antibiotic therapy, mortality, DCA, pharmacy cost, nursing cost	Decreased number of antibiotic doses/patient by 24%; 32% reduction in drug costs	Input costs not considered
UH[89]	To conduct DUE of prophylactic antibiotic therapy and determine cost savings to hospital	OA	Pre/post	None	DCA, number of inappropriate orders	Projected annual cost savings $25,000	Input costs not considered
UACH[90]	To evaluate impact of antibiotic therapeutic interchange program	OA	Pre/post	None	Efficacy indicators, ADRs, DCA	Decreased cost of daily antibiotic therapy in study group	Input costs not considered
Target Drug Programs: Acid-Reduction Therapy							
CH[91]	To document inappropriate use of i.v. H_2RAs and calculate cost avoided with oral conversion	COD	None	Personnel costs, direct costs	DCA	Cost avoidance range $606–8668 annually	No control group
CH[92]	To describe and evaluate the development of renal dosing intervention strategy for intermittent i.v. H_2RAs	OA	Pre/post	None	DCA	Decreased hospital cost/patient treatment day by 33% equal to $8053/yr	
CH[93]	To evaluate cost savings to hospital resulting from clinical RPh recommendations for dosing i.v. H_2RAs	OA	Pre/post	None	DCA	Treatment cost decreased by $1.27/day; annual savings $838	Input costs not considered; clinical outcomes not considered
GH[94] (VA)	To evaluate impact of educational intervention with guideline implementation	CBA	Pre/post	Personnel costs	DCA	Annual cost avoidance of $25,000 associated with decreased use of acid-reducing therapy; estimated cost of program $3000	Clinical outcomes not considered; no ratio presented
GAAC[95] (State)	To evaluate impact of concurrent DUE program on costs associated with acid-reducing therapy	OA	Pre/post	None	DCA; clinical outcomes including antacid use and ordering of gastrointestinal tests	Cost avoidance of $327,273 attributed to program, with no significant increase in antacid use or number of upper gastrointestinal studies	Input costs not considered

Appendix 1. Evaluations of Economic Value of Clinical Pharmacy Services—1988–1995 (continued)

Setting	Objective (as stated by authors)	Analytic Method	Comparison Group	Input Costs	Outcomes Included	Results Measured	Comments
UH[96]	To evaluate cost impact of program authorizing clinical RPh conversion of drugs from parenteral to oral route	OA	Control group	None	DCA	Cost avoidance $53,950 with decrease in length of parenteral therapy	Clinical outcomes not considered; mentioned but did not quantify labor cost associated with program; mentioned but did not calculate ratio
UAAC[97]	To evaluate impact of guideline-based intervention program on cost of H_2RA therapy	OD	None	None	DCA	Total cost avoidance $47,672 during 1st 6 mo	Input costs not considered; no control group; clinical outcomes not considered
HMOC[98]	To evaluate impact of clinical RPh intervention program on cost of H_2RA therapy	CBA	Pre/post	Personnel costs	DCA	Annual savings $14,600, with labor costs of $3400; calculated cost:benefit ratio 4.3:1	Clinical outcomes not considered; useful model for justification of program provided outcomes considered
CH[99]	To evaluate cost impact of therapeutic interchange program for H_2RA therapy	OD	None	None	Drug and ancillary cost avoidance	Estimated cost avoidance $37,565/yr	Input costs not considered; no control group; clinical outcomes not considered; included sunk costs (nursing costs associated with additional doses of drug) as costs avoided
CH[100]	To evaluate impact of therapeutic interchange program for H_2RA therapy	OD	None	None	DCA	Total $145,557 in cost avoidance in 1st yr of program	Input costs not considered; no control group; clinical outcomes not considered
HMOC[101]	To evaluate cost impact of educational interventions in improving use of H_2RA therapy	OA	Pre/post	None	DCA	Study group had fewer prescriptions, less expensive prescriptions, and more appropriate prescriptions after educational interventions than control group	Input costs not considered; clinical outcomes not considered; small sample (number of prescribers involved in intervention)
UACH[102]	To describe impact of therapeutic interchange program for H_2RAs on cost and quality of patient care	OD	None	None	DCA, ADRs, assessment of treatment failure	Estimated annual cost savings $16,000; reduced parenteral H_2RA use	Retrospective analysis; no evidence of increased treatment failure or adverse patient outcome
UH[103]	To evaluate impact of ranitidine i.v. to oral conversion project on cost savings to hospital	OD	None	None	DCA	Decreased number of days of i.v. acid-reducing agents; annual savings $23,425	

Appendix 1. Evaluations of Economic Value of Clinical Pharmacy Services—1988–1995 (continued)

Setting	Objective (as stated by authors)	Analytic Method	Comparison Group	Input Costs	Outcomes Included	Results Measured	Comments
UH[104]	To evaluate impact of clinical RPh monitoring and intervention program on i.v. H_2RA therapy	CBA	Control group	Personnel costs	Number of i.v. doses and days of i.v. drug, DCA	Lower mean number of inappropriate doses in study group; projected net annual savings $15,766.37	No ratio presented
UH[105]	To conduct prospective cost analysis of educational efforts to change inappropriate prescribing of H_2RAs	OA	Pre/post	None	Physician prescribing pattern, DCA, number of drug interactions	Savings of $250,000 estimated for 1st yr of program	Input costs not considered
UAGH[106]	To evaluate impact of i.v. to oral switch program for ranitidine	OA	Pre/post	None	DCA, pharmacy preparation costs	Cost avoidance $4214	Input costs not considered
UH[107]	To evaluate impact of H_2RA program on cost and quality of patient care	OA	Pre/post	None	Patient outcome, ADRs, drug interactions, DCA	Decreased cost but preserved quality	Input costs not considered
Target Drug Programs: NSAIDs							
GAAC[108] (VA)	To evaluate impact of clinical RPh activities in an ambulatory clinic	OA	Control group	None	DCA	Greater reduction in NSAID use in clinic staffed by RPh, resulted in cost savings of $38,776 more than control group	Input costs not considered; clinical outcomes not considered; data collected in 1985–1986, report not published until 1991
CH[109]	To describe target DUE program and determine impact on drug and labor costs	OA	Pre/post	None	DCA, NOI	Net annual savings $18,756	Considered personnel costs
UAAC[110]	To evaluate effect of pharmacist-managed anticoagulation clinical on therapeutic outcomes and costs	CMA	Control group	Charge for service	Hemorrhagic events, thromboembolic events, frequency and charge for clinic visits, ER visits, hospital admissions	Improved clinical outcomes, charge avoidance $4073/person-year	Included clinical outcomes, used charges rather than costs

CA = cost analysis; CBA = cost-benefit analysis; CD = cost description; COD = cost/outcome description; cost-minimization analysis; OA = outcome analysis; OD = outcome description; CH = community hospital; CP = community pharmacy; ER = emergency room; GAAC = government-affiliated ambulatory clinic; GH = government hospital; HMOC = health maintenance organization clinic; MC = multicenter; MHF = mental health facility; SNF = skilled nursing facility; UAAC = university-affiliated ambulatory clinic; UACH = university-affiliated community hospital; UAGH = university-affiliated government hospital; UH = university hospital; DCA = drug costs avoided; DUE = drug use evaluation; NOI = number of interventions or recommendations; ADRs = adverse drug reactions; H_2RA - histamine$_2$-receptor antagonist; ICU = intensive care unit; LOS = length of hospital stay; NSAID = nonsteroidal antiinflammatory drugs; RPh = pharmacist; SDC = serum drug concentration; TDM = therapeutic drug monitoring.