Workload and Cost-Benefit of Hospital Pharmacy Residents

Eileen Yoshida

ABSTRACT

The workload performed by three hospital pharmacy residents during typical clinical rotations was quantified then subjected to cost-benefit analysis. Daily activities and interventions were recorded on standardized forms for a four-week period. The cost of a resident to provide direct patient care services was compared to that of a staff pharmacist. In addition, the balance of the residents' salary and partial salaries of any pharmacists spending time with the residents were included in the cost analysis. The interventions were analyzed for their impact on patient care and potential cost avoidance by an external review committee.

Collectively, more than 660 hours were recorded. Fifty-two percent of hospital time was spent on education-related activities and 32 percent on the provision of clinical services. Thirty interventions were submitted to a review panel of three physicians. Of the 90 evaluations, 76 percent were considered to have a positive impact on patient care, 22 percent no effect, and two percent a potentially detrimental effect. In one case, reviewers thought that hospitalization could have been prolonged had the intervention not occurred. Cost-benefit analysis yielded a ratio of 1.4 to 1 in favour of the residents. While the major benefit of a residency program is the perceived long-term benefit to the profession and patients, this study suggests that even during their residency year, hospital pharmacy residents provide cost-beneficial clinical services.

Key Words: *cost-benefit, interventions, residency, workload measurement*

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RÉSUMÉ

On a mesuré la charge de travail de trois résidents en pharmacie hospitalière lors d'une rotation clinique, puis on a procédé à une analyse de rentabilité. Les activités et les interventions quotidiennes ont été notées sur un formulaire normalisé pendant quatre semaines. On a ensuite comparé le coût des soins directs offerts par le résident au patient au coût de ceux prodigués par un pharmacien de l'hôpital. L'analyse des coûts comprend le solde du salaire du résident et une fraction du salaire des pharmaciens consacrant une partie de leur temps aux résidents. Un comité d'examen externe a déterminé l'incidence des interventions sur le traitement du patient et les économies potentielles.

En tout, les relevés portaient sur plus de 660 heures. Cinquante-deux pour cent du temps passé à l'hôpital touche des activités associées à l'enseignement et 32 p. 100 à la prestation de services cliniques. Trente interventions ont été soumises à un comité d'examen composé de trois médecins. On estime que 76 p. 100 des 90 évaluations ont eu une incidence bénéfique sur les soins apportés au patient; 22 p. 100 n'ont eu aucun effet et 2 p. 100 auraient pu avoir des conséquences indésirables. Dans un cas, les examinateurs ont indiqué que l'hospitalisation aurait pu se prolonger sans l'intervention. L'analyse de rentabilité donne un ratio de 1,4: 1 en faveur des résidents. Bien que le principal intérêt du programme de résidence se situe au niveau des avantages à long terme pour la profession et les patients, l'étude suggère que les résidents en pharmacie hospitalière procurent des services cliniques rentables durant leur année de stage à l'hôpital.

Mots clés: *interventions, mesure de la charge de travail, rentabilité, résidence*

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INTRODUCTION

Hospital pharmacy residency programs have been recognized to provide leaders in the profession of hospital pharmacy through experiences gained during the programs.[1] It is a one year postgraduate program, providing an opportunity to improve the skills required to become clinical practitioners.

At present there are 32 hospital pharmacy residency positions available in Ontario. Little chance of expanding such opportunities exists as containment of health care costs has become a major societal concern. In this time of financial constraint, it would seem prudent to document the benefits relative to the costs of all current and proposed programs. Thus, this project was

undertaken to examine the cost-benefit of hospital pharmacy residents during typical clinical rotations. Specifically, the objectives of this project were to identify the various activities performed by residents during typical clinical rotations, and to perform a cost-benefit analysis of the residents during the same time period.

Cost-benefit analysis is an itemization of the costs and benefits (in terms of cost) of a program and in its simplest form, can be expressed as a ratio.[2] A benefit to cost ratio greater than one indicates that a program is cost-beneficial, whereas a ratio equal to or less than one, suggests that it is not. Cost-benefit analysis is one way to cost-justify new or existing programs.

METHODS

Workload Measurement

A pharmacy resident log was developed (Appendix A). Following an orientation meeting to ensure uniform completion and consistent use of the forms, three residents recorded their daily activities for a period of four weeks, the length of a typical clinical rotation at Victoria Hospital. In addition to the log, the residents also completed an intervention form each time an intervention was attempted.

At the end of the study period (March-June 1990), the data were collected and analyzed. The data from each resident were analyzed separately then pooled to calculate a mean and range for the three residents. The mean time taken to perform an activity and the percentage of total hospital time spent on that activity were determined. For cost-benefit analysis purposes, the mean time taken by the residents to complete direct patient care activities was compared to the time identified by the National Hospital Productivity Improvement Program: Pharmacy Workload Measurement System (WMS).[3] The latter was assumed to be indicative of the time required for a staff pharmacist to perform a given duty. Direct patient care-related activities included medication counselling, pharmacotherapy and pharmacokinetic monitoring, provision of drug information, medication history taking, adverse drug reaction reporting, and rounding with the medical team. WMS values were not available for the drug information component, therefore, the reference value was based on a six-month average of our institution's drug information centre statistics. The mean time taken by a resident to complete an activity could not be less than the time identified by WMS nor the alternative value. If this occurred, the mean time to perform the activity by a pharmacist and resident were considered to be the same. Time spent on patient care rounds with the medical team was assumed to be the same for both a pharmacist and the residents.

Cost-Benefit Analysis

The time values from the workload measurement analysis were multiplied by the respective hourly wages of the person performing the activity, and the mean number of times that activity was performed by the residents during the study period. The cost for one resident (based on the mean) to provide these direct patient care activities was compared to the cost for a pharmacist to provide the same service.

Each intervention attempted while the residents were on clinical time (i.e., not in the distribution system) was reviewed and assessed for its clinical and economic impact using the method described by Bayliff and Einarson.[4] Briefly, all interventions were documented and submitted to an external review committee of three physicians (one clinical pharmacologist, two chief residents in medicine). The physicians assessed the interventions for their impact on patient care and estimated indirect cost avoidance by determining the number of hospital days saved as a result of the interventions (Appendix B). Each additional day of hospitalization was estimated at $700.00.

The interventions were assessed by consensus. For interventions where there was agreement that hospitalization would have been prolonged, the cost was calculated on the mean number of days of prolonged stay. The same procedure was used if one or two of the assessors indicated that the hospital stay would have been extended and the other(s) indicated "did not know". A "did not know" response was equivalent to zero days of prolonged stay in the calculations. If any assessor did not feel that hospitalization would have been extended, then the intervention was excluded from indirect cost avoidance analysis.

Direct drug cost avoidance for drugs discontinued was estimated by using the acquisition cost of the drug and multiplying it by three days for acute therapy or 14 days for chronic therapy. Acute therapy was defined as a drug initiated while in hospital with an identifiable endpoint. Chronic therapy was defined as a drug the patient was taking on admission. If a drug was prescribed to replace an agent, the cost of the recommended alternative was subtracted from the cost avoidance. For non-formulary drugs, $50.00 per non-formulary request for purchase orders was added. The calculated cost avoidance could be positive or negative reflecting that an intervention could either increase or decrease costs.

Costs for residents included their entire salary for the study period and partial salaries of the clinical coordinator and the pharmacists of the involved clinical rotations who spent time with the residents. The approximate hourly salaries (based

on a 37.5 hour work week) used were $3.78, $30.00, and $21.49, respectively. The total cost avoidance was then compared to the costs to get a benefit to cost ratio.

RESULTS

Workload Measurement

Three residents collected data for a period of four weeks each. Their clinical rotations included Cardiology, Nephrology, and General Medicine. Over 660 hours were collectively recorded, of which 519 hours occurred during time spent in hospital. The activities completed, number of times they were performed, time taken, and percent of total hospital time are presented in Table I. Approximately 52 % of institution time was spent on education-related activities. This included a total of 25 hours or a mean of 25 minutes per day with the pharmacist rotation coordinators, a value consistent among the residents. In addition, a mean of 49.2 hours of personal time per four-week period was spent on education.

Almost 32 % of institution time was spent on direct patient care services. This did not include time spent in the distribution system. The residents participated in daily rounds with the medical team (17.6%), pharmacotherapy (10.1%) and pharmacokinetic (0.4%) monitoring, provision of drug information (2.4%), and medication counselling (1.3%). The time spent providing each of these services remained relatively constant among the residents.

Cost-Benefit Analysis

Fifty interventions were recorded, 36 of which occurred while the resi-

Table I: Residents' Workload Statistics

ACTIVITY	NUMBER OF TIMES PERFORMED mean (range)	TIME TAKEN mean (range)	PERCENTAGE OF TOTAL HOSPITAL TIME mean (range)
DIRECT PATIENT CARE SERVICES:			
counselling (# of pts)	7.3 (3-13)	17.7 (10-21.5) min/pt	1.3 (0.3-2.6)
pharmacotherapy monitoring			10.1 (7.9-12.1)
profile review (#)	44 (0-80)		
chart review (#)	167 (144-192)	6.3 (4.5-8.1) min/chart	
pharmacokinetic calculation (#)	6.7 (5-9)	5.5 (4.4-6.7) min/calculation	0.4 (0.3-0.4)
drug information response			2.4 (1.5-4.3)
no search (#)	19.7 (8-35)		
with search (#)	16 (12-22)	15.8 (11.4-19.5) min/question	
medication history (#)	0		
adverse drug reaction reporting (#)	0		
patient care rounds (h)	30.5 (24.5-37) h		17.6 (14.8-20.3)
interventions attempted while on clinical time (#)	12 (4-20)		
SUBTOTAL			**31.8%**
EDUCATION-RELATED ACTIVITIES:			
teaching/education output (h)	4.5 (3-5.5) h		2.6 (1.6-3.3)
preparation for teaching output (h)	14.5 (4-22.5) h [own time 22.8 (5-38) h]		8.4 (2.4-12.3)
education input (h)	62.7 (46.5-72) h [own time 26.3 (7-46.5) h]		36.2 (25.4-42)
time spent with pharmacist (h)	8.3 (7-9.7) h	25 (21-29) min/day	4.8 (4.2-5.3)
SUBTOTAL			**52.0%**
OTHER:			
administration (h)	4.3 (3-5) h		2.5 (1.8-2.7)
distribution support (h)	28.3 (11-43) h		16.4 (6-23.5)
SUBTOTAL			**18.9%**
TOTAL			**102.7%**

dents were on clinical time. The remaining 14 were documented while the residents were in the distribution system. The number of interventions per resident varied widely (range 4-20). The types of interventions included duplication of therapy, non-formulary drug requests, drug regimen adjustments (dose, alternative dosage form, alternative drug), potential avoidance of adverse drug reactions, drug monitoring-related recommendations, and discontinuation of medications no longer required.

All 36 interventions occurred upon discussion with physicians and in 97% (35/36) of the cases, the information was unsolicited. In 92% (33/36) of the cases, the pharmacy residents' recommendations were accepted, and in 86% (31/36) orders were written based on the interventions. Of the three interventions that were rejected, in one case the medical team decided to await culture and sensitivity results before discontinuing an antibiotic; in the second case, the team was reluctant to discontinue one or two calcium channel blockers for a patient on triple calcium channel blocker therapy as the patient was scheduled for a coronary artery bypass graft within the next few days; and finally, the team was reluctant to discontinue nitropaste for a patient already on nitroglycerin sublingual tablets and an increasing dose of diltiazem.

Thirty of the 36 interventions were analyzed by the external review committee as six of the intervention forms were considered incomplete by the investigator. Of the 90 evaluations rendered by the three physician reviewers: 76% (68/90) were considered to have a positive impact on patient care; 22% (20/90) no effect; and 2% (2/90) a potentially detrimental effect. This last judgement concerned one intervention, and was considered to be detrimental in terms of a failure to provide information to the medical team. Of the interventions considered to have a positive impact on patient care: 51% percent of the evaluations (35/68) were considered to have a minor effect on patient care; 37% (25/68) were considered to have a modest effect; and 12% (8/68) a marked effect.

In 74% of cases (67/90) it was felt that hospitalization would not have been prolonged had the intervention not occurred; in an additional 12% (11/90), the reviewers were undecided. In the remaining 13% of judgements (12/90), it was felt that hospitalization could have been prolonged had the intervention not taken place. By consensus, a mean of one day stay in hospital was avoided. No deaths occurred in any patient evaluated. The one "detrimental" intervention did not prolong hospitalization.

The estimated cost avoidance, when direct patient care activities were performed by residents instead of a pharmacist, was found to be $924.62 per resident for a four-week period (Table II). The 30 interventions submitted to the physicians, resulted in an estimated savings of $60.00 per resident in direct drug costs, and $233.33 per resident in indirect drug costs. The costs of the residents were determined and compared to the cost-avoidance. The average ratio of benefits to costs was found to be 1.4 to 1 (Table III).

DISCUSSION

Workload Measurement

The mandate of a hospital pharmacy residency program is to provide specialized training in hospital practice, and to nurture the potential for developing innovative and exemplary pharmaceutical services. The training hospital should consider the educational benefits to the resident to be of paramount importance in relation to the service benefits which it may obtain in return.[5] Workload measurement statistics

Table II: Cost comparison between Pharmacist and Resident in providing direct patient care-related activities over a four-week period

	Cost of Pharmacist[1] ($)	Cost of Resident[2] ($)	Difference ($)
medication counselling (13.2; 17.7 min/pt)[3]	34.59	8.14	26.45
pharmacotherapy monitoring (5.6; 6.3 min/chart)	333.16	66.28	266.88
pharmacokinetic calculation (8.93; 5.5 min/PCK)	21.43	3.77	17.66
drug information response (15.6;[4] 15.8 min/question)	89.40	15.93	73.47
medication history	0	0	0
adverse drug reaction reporting	0	0	0
patient care rounds (30.5 h)[5]	655.45	115.29	540.16
TOTAL	1,134.03	209.41	924.62

[1] based on pharmacist's average hourly wage $21.49
[2] based on resident's hourly wage $3.78
[3] expressed as (workload measurement or literature value; mean time taken by resident)
[4] based on a six-month average of our institution's drug information centre statistics
[5] assume same time for both residents and pharmacist; multiply by respective (average) hourly wages only

Table III: Cost-benefit analysis for one resident over a four-week period

Benefit	($)	Cost:	($)
estimated cost avoidance (direct plus indirect)	293.33	pharmacist's time with resident	178.00
Cost of pharmacist to perform direct patient care-related activities	1,134.03[1]	cost of resident to perform direct patient care-related activities	209.41[1]
		clinical coordinator's time[2] with resident	240.00
		balance of resident's salary	357.59
TOTAL:	1,427.36		985.00
RATIO:	1.4		1

[1] see Table II for calculations
[2] based on calculation of 2 h/resident/week and estimated hourly wage $30.00

revealed that at our institution, education and practical experience were emphasized. Approximately half of the residents' time in hospital was spent on education-related activities. Residents attended weekly journal club, pharmacists' clinical hour, clinical pharmacology rounds (case presentation and discussion), breakfast club (residents' meeting with clinical coordinator where they presented a case and discussed pharmacotherapy), medical grand rounds, and drug lunch presentations (includes pharmacist or resident presentation of drug, including its role in hospital, to medical staff). They also used this time to broaden their knowledge by researching unfamiliar disease states and pharmacotherapy, and to discuss the same with their pharmacist rotation coordinators.

At our institution, the residents had a number of teaching and presentation responsibilities both within and outside the department. They were key presenters for clinical pharmacology rounds, and they participated routinely in journal club, pharmacists' clinical hour and drug lunch presentations to the medical staff. Each resident also lectured bi-annually to nursing students at the local college, presented a poster at a national hospital pharmacy meeting, and participated in the practical training of pharmacy students.

To accomplish these tasks, the residents also devoted personal time in addition to the hours spent at the hospital. Our analysis estimated a mean of 49.2 hours personal time over a four-week period.

Another one-third of the residents' time was spent in direct patient care services. Emphasis was on attendance at daily patient care rounds with the medical team, and on pharmacotherapy monitoring. As undergraduates, minimal exposure to these clinical activities existed.

Approximately 16% of their time was spent in the distribution system: residents were required to work one in every six or seven weekends as the charge pharmacist for a particular area. Minimal time was spent performing administrative duties.

Cost-Benefit Analysis

In providing a "teaching laboratory" for pharmacy residents, a pharmacy department may, in turn, benefit from its residents. Educational services have not undergone rigorous cost-analysis to evaluate their financial and clinical impact,[6] however; its documentation has become important as health care costs continue to climb, and programs must be justified to hospital administrators. Our analysis revealed that the benefits exceeded the costs of the residents by a ratio of 1.4 to 1.

A number of clinical activities have been shown in the literature to improve patient care and reduce hospital stay.[7] Attempts have also been made to cost-justify these activities. Numerous reports have been published demonstrating the cost-savings or cost-avoidance of pharmacokinetic services.[8-11] Others have documented the cost-effectiveness of pharmacist-conducted patient training programs,[12,13] and pharmacotherapy monitoring.[14] However, reports of cost-benefit analyses are not as plentiful. This may occur because it is often difficult to express the benefits in terms of a monetary value.[15] The true cost-benefit of direct patient care services such as medication counselling, provision of drug information and other activities is difficult to determine, thus our evaluation may only represent a fraction of the savings. However, the benefits can only be magnified when tasks normally performed by staff pharmacists are completed by residents. This cost avoidance exists, despite the fact that it may have taken the residents longer to complete an activity in comparison to a pharmacist. We estimated a cost avoidance of approximately $925.00 per resident over a four-week period.

Documentation of pharmacists' interventions has become commonplace in hospitals due to pressure

from administrators to justify personnel. This documentation also offers an opportunity to assign a dollar figure to the cost of inappropriate therapy.[6,16-19] We attempted to analyze the cost-benefit of the residents' interventions: direct drug cost savings of approximately $60.00 per resident were minimal. In addition, indirect savings of approximately $230.00 per resident were also modest. Although the savings may not have been dramatic, we were assured of the interventions' positive impact on patient care. This was reflected by the fact that, of the 83% of evaluations rendered by the physician reviewers, to have had a positive effect on patient care, and 44% were deemed to have had a modest or marked effect. We were further encouraged by the fact that in 92% of cases, the residents' recommendations were accepted, and orders were written or changed in 86%. Others have reported intervention implementation rates ranging from 83.0 to 94.4%.[18,21]

There were a number of limitations to our analysis, the first of which was the self-reporting method of data collection, and thus, introduction of bias into the study. No effort was made to verify the data collected; however, all residents and pharmacists at our institution were required to document their daily activities on a departmental clinical activity log, similar to the residents' log developed for this study. Therefore, it was unlikely that the Hawthorne effect (i.e., the awareness of being studied)[20] was a source of bias.

To minimize bias in the assessment of the interventions, an external physician review committee was used. Physician review of pharmacy interventions has been documented in the literature,[4] although, physician bias may still be a limitation.[20,22]

Thirdly, was the assumption that both staff pharmacists and residents would perform a given activity the same number of times. One could argue that a staff pharmacist, because of their expertise and experience, could accomplish more. However, it was difficult to directly compare residents and staff pharmacists because their respective time commitments differed. Residents had more clinical time than staff pharmacists. The latter spent approximately 50% of their time in the distribution system. However, in a previous examination of the impact of a drug information/intervention program, it was found that the number of drug information responses/interventions did not depend on whether the pharmacist was involved in distribution or clinical activities.[23]

The costs considered in our evaluation dealt only with direct operational costs of providing selected clinical services. The analysis did not include start-up or indirect operation costs. Furthermore, the salaries quoted did not include nonmonetary benefits such as medical or dental benefits.

A further limitation to our analysis was that only "typical" clinical rotations near the end of the residency year were examined; extrapolation to rotations which occurred earlier in the year may not have been appropriate.

Finally, the results reported here were based only on experiences at our institution, thus the findings cannot necessarily be extrapolated to other residency programs. Similar studies conducted at other hospitals with pharmacy residency programs are needed to confirm our results. We were only aware of one report in the literature which attempted to analyze the workload measurement of a pharmacy residency program.[24] The definitions and method of analysis were not identical to ours so it was difficult to make direct comparisons. However, the results showed similar trends: clinical education represented the greatest percentage of time commitment.

A randomized multicentre trial during the entire residency year, involving a large number of residents and concurrent control groups of pharmacists, would be least subject to bias, and would also overcome the institution-related and rotation-related limitations. While such a trial would be difficult to perform, it may be an issue that could be considered by the Canadian Hospital Pharmacy Residency Board.

While we recognize the limitations of this study, we believe that the benefit to cost ratio determined is fair, and in fact, an underestimation of the true value because of the methodology utilized. The analysis did not include the residents' impact on other rotations including drug information, drug utilization review, and administration, nor did it evaluate the potential service benefit of the completion of drug monographs, drug lunch presentations, and participation in the Drug Surveillance Network, which if considered, would likely strengthen the benefit to cost ratio.

In addition, we utilized the residents' entire four-week salary in the cost-benefit analysis. If the ratio was recalculated using only that portion of the residents' salary representing the provision of direct patient care services, the benefit to cost ratio increased to approximately 2.3 to 1.

In conclusion, workload performed by residents during typical clinical rotations was quantified. Cost-benefit analysis revealed that pharmacy residents, in addition to the educational benefit to themselves and the department, provide a number of valuable clinical services. Using a limited number of assessable parameters, and specifically excluding distribution-related activities, a favourable cost-benefit ratio for a resident during a clinical rotation was demonstrated. While

the major benefit of a residency program is the perceived long-term benefit to the profession and patients, this study suggests that even during their residency year, hospital pharmacy residents provide cost-beneficial patient-oriented services.

REFERENCES

1. Ontario Branch, Canadian Society of Hospital Pharmacists. Resolutions to the annual meeting of the Ontario Branch, Canadian Society of Hospital Pharmacists, November 1989.
2. McGhan WF, Rowland CR, Bootman JL. Cost-benefit and cost-effectiveness: methodologies for evaluating innovative pharmaceutical services. *Am J Hosp Pharm* 1978; 35:133-40.
3. Health and Welfare Canada. National Hospital Productivity Improvement Program: Pharmacy Workload Measurement System Prepublication Draft. Ottawa, ON. October 1985.
4. Bayliff CD, Einarson TR. Physician assessment of pharmacists' interventions — a method of estimating cost avoidance and determining quality assurance. *Can J Hosp Pharm* 1990; 43:167-71, 195.
5. Canadian Hospital Pharmacy Residency Board. Pharmacy residency in hospital practice minimum standards. Toronto, ON: *Canadian Society of Hospital Pharmacists*, 1987.
6. Mueller BA, Abel SR. Impact of college of pharmacy-based educational services within the hospital. *Drug Intell Clin Pharm* 1990; 24:422-5.
7. Hatoum HT, Catizone C, Hutchinson RA, et al. An eleven-year review of the pharmacy literature: documentation of the value and acceptance of clinical pharmacy. *Drug Intell Clin Pharm* 1986; 20:33-48.
8. Levin B, Cohen SB, Birmingham PH. Effect of pharmacist intervention on the use of serum drug assays. *Am J Hosp Pharm* 1981; 38:845-51.
9. Zaske DE, Copolle RJ, Rotschafer JC. Gentamicin pharmacokinetics in 1640 patients: method for control of serum concentrations. *Antimicrob Agents Chemother* 1982; 21:407-11.
10. Kimelblatt BJ, Bradbury K, Chodoff L, et al. Cost-benefit analysis of an aminoglycoside monitoring service. *Am J Hosp Pharm* 1986; 43:1205-9.
11. Mungall D, Marshall J, Penn D, et al. Individualizing theophylline therapy: the impact of clinical pharmacokinetics on patient outcomes. *Ther Drug Monit* 1983; 5:95-101.
12. Pathak DS, Nold EG. Cost-effectiveness of clinical pharmaceutical services: a follow up report. *Am J Hosp Pharm* 1979; 36:1527-9.
13. Nold EG, Pathak DS. Third-party reimbursement for clinical pharmacy services: philosophy and practice. *Am J Hosp Pharm* 1977; 34:823-6.
14. Gardner DM, Hardy BG. Cost-effectiveness of therapeutic drug monitoring. *Can J Hosp Pharm* 1990; 1:7-12, xii.
15. Vozeh S. Cost-effectiveness of therapeutic drug monitoring. *Clin Pharmacokinet* 1987; 13:131-40.
16. Ito S, Glaquinta D. Assessing the impact of clinical pharmacy with cefazolin dosing. Paper presented at 21st Annual Midyear Clinical Meeting. Las Vegas, NV; 1986, December 8.
17. Coderre PT, Williams JM. Cost assessment: pharmacists' clinical intervention with non formulary drug requests. Paper presented at 21st Annual Midyear Clinical Meeting. Las Vegas, NV; 1986; December 9.
18. Hatoum HT, Hutchinson RA, Witte KW, et al. Evaluation of the contribution of clinical pharmacists: inpatient care and cost reduction. *Drug Intell Clin Pharm* 1988; 22:252-9.
19. Warrian K, Irvine-Meek J. Cost-benefit of clinical services intergrated with a decentralized unit dose system. *Can J Hosp Pharm* 1988; 41:109-12.
20. Hatoum HT, Hutchinson RA, Elliott LR, et al. Physicians' review of significant interventions by clinical pharmacists in inpatient care. *Drug Intell Clin Pharm* 1988; 22:980-2.
21. Mutnick AH, Ziccarelli A, Derouin CG. Documenting pharmacists' services in a hospital pharmacy satellite. *Am J Hosp Pharm* 1985; 42:1988-9.
22. Bernstein LR, Klett EA, Jacoby KE. Physicians' attitudes toward the use of clinical pharmaceutical services in private medical practice. *Am J Hosp Pharm* 1978; 35:715-7.
23. Bayliff CD. Interventions of the pharmacist. Paper presented at CSHP 39th Annual General Meeting. Ottawa, ON; 1986.
24. Gray DR, Ho MI, Cavale KL, et al. Workload measurement of a clinical pharmacy residency program. *Am J Hosp Pharm* 1987; 44:557-61.

See appendices on the following page.

Appendix A: Pharmacy Resident Log

Name _____	Date _____
Medication Counselling (# patients):	12345678901234567890
Time spent counselling (10 min):	12345678901234567890
Intervention (#):	12345678901234567890
Pharmacotherapy monitoring:	
profile review (#):	12345678901234567890
chart review (#):	12345678901234567890
Total time spent (10 min):	12345678901234567890
Pharmacokinetic calculation (#):	12345678901234567890
Time spent performing calculation (10 min):	12345678901234567890
Drug information response:	
no search (#):	12345678901234567890
with search (#):	12345678901234567890
Time spent researching (10 min):	12345678901234567890
Medication history (#):	12345678901234567890
Time spent performing (10 min):	12345678901234567890
Adverse drug reaction (#):	12345678901234567890
Total time spent (10 min):	12345678901234567890
Teaching education output (30 min):	12345678901234567890
Preparation for teaching output (30 min):	12345678901234567890
Prepration for teaching output — own time (30 min):	12345678901234567890
Education input — total (30 min):	12345678901234567890
Education input — own time (30 min):	12345678901234567890
Rounds (30 min):	12345678901234567890
Time on unit (30 min):	12345678901234567890
Administration (30 min):	12345678901234567890
Distribution support (30 min):	12345678901234567890
Time spent with pharmacist (10 min):	12345678901234567890

Appendix B: Resident Intervention Evaluation Form

Problem identified _____

Intervention _____

EVALUATION

PART 1.

The intervention resulted in a:

( ) detrimental effect: recommendation (could have) led to adverse outcome

( ) no effect: impact on patient theoretical or undetectable

( ) positive effect: recommendation (could have) brought care to more acceptable level

- ( ) minor effect on patient therapy
- ( ) modest effect on patient therapy (thereby could have been compromised or side effects may have occurred if the intervention had not taken place)
- ( ) marked effect on patient therapy (had the intervention not taken place, severe, potentially life-threatening events may have occurred)

PART 2.

If the intervention had not occurred, would hospitalization have been prolonged?

( ) no ( ) yes ( ) don't know

If yes, hospital stay may have been prolonged:

( ) approximately one day

( ) approximately three days

( ) approximately five days

( ) a week or more