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PHARMACOECONOMICS

Economic impact of medication management by clinical pharmacists in a urology department

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Introduction The effectiveness of pharmaceutical care for urological inpatients has been shown, but this investigation aims to evaluate the economic benefit of clinical pharmacy services in a urology department. Return on investment (ROI) is to be determined.

Material and methods Medication management comprised pharmaceutical interventions (PIs) that were carried out by ward-based pharmacists following analysis of drug-related problems. Each pharmaceutical intervention was assigned a probability value indicating the likelihood of an adverse drug event (ADE) occurring without intervention. Assuming that each ADE results in a longer hospital stay, the average case costs for the urology department per day were used as the potential savings.

Results A total of 295 PIs were documented by the clinical pharmacists within 1,495 included patient days. The recorded acceptance rate by physicians was 77.97%. PIs prevented approximately 60 ADE and thus a potential extension of hospital stay of 132 days. Clinical pharmacy services resulted in avoided costs totaling €112,256, thus giving a ROI of 881%.

Conclusions The present investigation demonstrates the economic benefits of clinical pharmacy services for a surgical specialty, namely urology. PIs improve medication safety. Ward-based pharmacists have become a vital part of the urology care team.

Key Words: clinical pharmacy services ‹› medication management ‹› return on investment ‹› avoided costs ‹› ward-based pharmacists ‹› pharmaceutical intervention ‹› medication safety ‹› urology

INTRODUCTION

A high level of medication safety is still a challenging goal, especially for hospitalized patients because almost all of them have to take medication. Therefore, the supply of medicines is of crucial importance. It is characterized by high complexity in hospitals. This is particularly the case due to the processes at admission and discharge, as well as those related to perioperative medication management.

Upon admission, only a small number of patients have correct medication plans available. Around half to 80% of medication histories contain errors, and less than half of these errors are discovered during the inpatient stay [1, 2]. As many as three-quarters of all medication errors in hospital can be traced back to an incorrect medication history on admission [3]. Most drug-related problems (DRPs) during hospitalization are considered preventable and occur in 3.2 to 5.6% of patients [4, 5]. Multi-morbid patients with polypharmacy are particularly at risk [6]. In surgical patients, mortality is more strongly correlated with polypharmacy than with surgery [7].

DRPs have a significant negative impact on patient safety and contribute to rising healthcare costs worldwide [8–11].

The positive impact of pharmaceutical care and interprofessional collaboration on the improvement of medication safety is regarded as proven. For inpatients, the focus is on so-called closed-loop medication management, in which medication reconciliation in accordance with the World Health Organization (WHO) initiative "Action on Patient Safety – High 5s" is of particular importance, as it can ensure the correct transfer of medication data on admission, during the stay, in perioperative situations, and on discharge. Clinical pharmacists are playing an increasingly important role in this setting. Various measures for preventing DRPs are described, such as regular training of medical and nursing staff, the introduction and utilization of electronic prescription systems, the implementation of medication standards, and the establishment of continuous pharmaceutical care, which can include medication analyses, ward rounds, pharmacy consultations, and polypharmacy meetings.

Various recent studies have shown the effectiveness of pharmaceutical care for urological inpatients: adverse drug events (ADEs) and postoperative complications were reduced, medication errors were prevented or resolved, medication safety improved, and the outcome optimized [12–14].

Even though the financial benefit of pharmacy services for hospital inpatients could be shown [15], there are few data available specifically for the perioperative situation. Following an analysis of the impact of ward-based pharmacists in intensive care medicine [16], this investigation applies the same methodology in a perioperative setting, namely urology, to demonstrate the efficacy of medication management by clinical pharmacists. Additionally, the return on investment for the pharmacy services offered is to be determined.

MATERIAL AND METHODS

Pharmaceutical interventions

Medication management of this investigation comprised PIs, which were carried out as a result of medication analyses and the associated identification of DRPs for urological inpatients. Following a policy document of the Federal Union of German Associations of Pharmacists, medication analysis is a structured review of the current overall medication of a patient to assess whether there are any DRPs. Beyond that, the Pharmaceutical Care Network Europe (PCNE) defines as follows: "Medication review is an evaluation of all the patient's medicines with the aim of optimizing use of medicines and improving health outcomes. This entails detecting DRPs and recommending interventions. Medication review is part of the patient's medication management." Medication analysis or medication review are therefore the starting point for medication management, meaning continuous inpatient care, which requires interprofessional collaboration until discharge and beyond.

The medication analyses were performed in the pharmacy back office using the hospital medication software (ID Medics®), and subsequently the resulting optimization recommendations were provided during interprofessional meetings on the ward.

By definition, DRPs are events or circumstances in drug therapy that actually or potentially prevent the achievement of the intended therapeutic goals. In addition to adverse drug reactions (ADRs), these also include adverse drug events (ADEs) and medication errors, which can lead to avoidable harm to patients by deviating from the optimal medication process.

All PIs were documented by the clinical pharmacists in a table matrix, which is based on the established form of the ADKA-DokuPIK. DokuPIK stands for "Documentation of Pharmaceutical Interventions in Hospitals" and is an online database of the Federal Association of German Hospital Pharmacists (ADKA).

During the investigation period the Department of Urology was monitored, covering a total of 34 beds and 1,495 occupancy or patient days, respectively. The average case and bed costs amounted to €850 per day, calculated from the hospital cost center-based booking of all costs incurred per ward. To carry out comprehensive medication reviews, the clinical pharmacists worked with the prescription software ID Medics®, which is used by physicians and nursing staff to manage drug therapy.

Clinical pharmacists were engaged for a total of 12 hours per week for medication management. Subsequent case discussions with the participation of clinical pharmacists were held twice a week, during which the DRPs identified in the preceding medication analysis were discussed on an interprofessional basis. The DRPs were initially assessed by pharmacists, using the nine-level NCC MERP Index (National Coordinating Council for Medication Error Reporting and Prevention) for categorizing medication errors. The further investigation exclusively incorporated DRPs for which the PIs resulted in alterations to medication by the doctors.

Economic impact model

To analyze the primary PIs data economically, a model was developed based on the results of two publications. Bates et al. determined by paired regression analysis of 247 ADEs that the average length of stay (LOS) is extended by an average of 2.2 days due to an ADE [17]. Since DRPs, due to their different clinical relevance, do not necessarily lead to an ADE and thus an extension of the LOS, a consensus panel, consisting of a senior clinical pharmacist, certified specialist in medication management, and an experienced ward-based clinical pharmacist determined so-called "probability scores", as described by Nesbit et al. [18]. Each PI was assigned a probability that an ADE would have occurred without this intervention. The evaluation is based on the categorization that an ADE occurs with no (p = 0), very low (p = 0.01), low (p = 0.1), medium (p = 0.4), or high (p = 0.6) probability. The sum of the individual probabilities (N) is used as representative of the number of ADEs avoided in the following formula for calculating the avoidable costs (Kv):

$$Kv = N \times L \times Ku$$
$$N = \sum p \text{ (Nesbit) [ADE]}$$
$$L = \text{extension of LOS (Bates) [Day/ADE]}$$
$$Ku = \text{Bed Costs Urology [€/Day]}$$

Return on investment calculation

The costs for the pharmacy services offered in this project amount to the personnel costs for the clinical pharmacists. Two clinical pharmacists were involved with part of their total working time, equating to 0.3 full-time equivalents (FTE).
Direct savings effects from avoided drug costs due to deprescribing or modification of medication after the PIs were not taken into account in this study.
To determine the economic benefit of medication management by the clinical pharmacists, the ROI of the pharmacy services was determined. For this purpose, the pro rata personnel costs Kp (0.3 FTE) were deducted from the calculated avoided costs Kv. The resulting net savings led to the calculation of the ROI rate in relation to the annual investment in per cent:

$$ROI = (Kv-Kp)/Kp \times 100\%$$

Sensitivity analyses

A series of sensitivity analyses were conducted to evaluate the robustness of the method employed, to ascertain its limitations, and to critically assess its economic outcome.
The first analysis used decreased probabilities adapted from Pantanwala et al. [19] (0; 0.01; 0.05; 0.1; 0.25, and 0.5, respectively); the second analysis decreased the extension of LOS by half; the third analysis fixed the probabilities of occurrence to 0.05 (unlikely); while the fourth decreased the extension of LOS by half in addition. A final analysis used the extended LOS (2.9 days), based on Rottenkolber's work [11].

Bioethical standards

This investigation does not involve human participants. Therefore, ethical approval was not required.

RESULTS

Pharmaceutical interventions

During the 27-week investigation period, a total of 295 PIs were documented by the clinical pharmacists within 1,495 included patient days. Only PIs accepted by physicians (230) were taken into account for the evaluation to calculate the cost savings and ROI. The recorded acceptance rate by physicians was 77.97% (230/295 PIs). The rate of PIs is therefore 15.4 per 100 patient days, which is a slightly lower rate compared to other studies [20]. The most common reasons for PIs (Table 1) were indication/drug selection (90 PIs), dosage (83 PIs), and contraindication (17 PIs). The distribution by ATC classification (Table 2) shows that antibiotics for systemic use and antithrombotic agents account for around 40% of all PIs (26.5% and 16.1%, respectively). Together, these two groups contribute more than half of the total probability score.
The distribution of the probability scores of the 230 PIs can be summarized as follows: Almost half of the PIs have medium and high probabilities of an ADE (49 and 52 PI; 21.3% and 22.6%, respectively). The total number of all PIs multiplied by their associated probability is 60.03. It can be deduced from this that PIs prevented approximately 60 ADEs and thus a potential extension of hospital stay of 132 days (Table 3).
Medication management during the investigation period resulted in avoided costs totaling €112,256. Extrapolation of the data over a period of one year indicates a potential saving of €216,197.

Return on investment calculation

Two ward-based clinical pharmacists carried out medication reviews and PIs alternately within 27 weeks and spent around 12 hours of their weekly working time on this. The pro rata personnel costs (totaling 0.3 FTE) for this pharmacy service amounted to €11,447.40 during the project period, equaling €22,046.84 per year, thus giving a ROI of 881%.

Sensitivity analyses

The annual avoided costs and ROI were calculated using five sensitivity analyses, as presented in Table 4. The economic impact remains positive in the sensitivity analyses where probabilities and LOS are reduced and even in the analysis which fixes the probability of occurrence to a very low value (0.05). The fourth analysis falls below the break-even point of the economic impact model.

DISCUSSION

The presented project describes the introduction of a pharmacy service by clinical pharmacists in urology, including an economic impact analysis. A primary aim of the study was to demonstrate the effect of PIs in economic terms.

The method combines the results of two independently published studies, thus enabling determination of the economic impact of pharmacy services. The research shows that medication management performed by ward-based clinical pharmacists could reduce hospital costs by avoiding ADEs. The revealed ROI is 881%, corresponding to a cost savings ratio of €8.81 for each €1.00 invested in clinical pharmacy services. Thus, the result is comparable with those of more recent studies [21, 22]. In contrast to the latter, and to further studies on the economic impact of pharmacy services, the present investigation did not take into account direct cost savings in medication, such as the replacement of expensive drugs with generic or cheaper ones, the switch from intravenous to oral therapy, or the use of deprescribing strategies. If these direct or further savings, for instance increased adherence to guidelines for antibiotic therapy or the avoidance of litigation costs through the use of prefilled syringes, had been included, the savings would have been even greater.

In three different German studies from 2006, 2015, and 2024 [16, 23, 24], the annual direct sav-

Table 1. *Categorization of pharmaceutical interventions by reason*

Reason (category)	Number of pharmaceutical interventions (%)
Indication/choice of medication	90 (39.1)
Dose	83 (36.1)
Contraindication	17 (7.4)
Interaction	13 (5.7)
Application	8 (3.5)
Advice for medical staff	6 (2.6)
Documentation/transfer	5 (2.2)
Double prescription	4 (1.7)
Error in "placing" medicine	2 (0.9)
Procurement/costs	1 (0.4)
Side effect	1 (0.4)
∑	230

Table 2. *Categorization of pharmaceutical interventions according to ATC classification*

ATC-Code	Meaning ATC-Code	Pharmaceutical interventions	
		Number (%)	∑ Nesbit score
B01	Antithrombotic agents	61 (26.5)	23.08
J01	Antibiotics for systemic use	37 (16.1)	12.63
N02	Analgesics	24 (10.4)	3.21
A10	Antidiabetics	19 (8.3)	4.85
C09	Agents with an effect on the renin-angiotensin system	14 (6.1)	3.41
C10	Agents that influence the lipid metabolism	8 (3.5)	0.71
	Others	67 (29.1)	12.14
	∑	230	60.03

Table 3. *Number and distribution of probabilities*

Probability of ADE (Nesbit probability score)	Pharmaceutical interventions		
	Number (%)	∑ Nesbit score	Avoided costs [€]
Zero (0)	7 (3.0)	0	0.00
Very low (0.01)	33 (14.3)	0.33	617.10
Low (0.1)	89 (38.7)	8.90	16,643.00
Medium (0.4)	49 (21.3)	19.60	36,652.00
High (0.6)	52 (22.6)	31.20	58,344.00
∑	230	60.03	112,256.10

Kv = 60.03*2.2*€850 = €112.256

Table 4. *Sensitivity analyses: parameters, costs, and ROI*

Parameters	Kv avoided costs per year [€]	Pro rata personnel costs (0.3 FTE) per year [€]	ROI
Nesbit Score (original analysis)	216,197	22,046.84	8.81 (881%)
Decreased probabilities (Patanwala et al. [19])	175,752	22,046.84	6.97 (697%)
Decreased LOS (1.1 days)	108,585	22,046.84	3.93 (393%)
Probabilities fixed to 0.05 (unlikely)	41,417	22,046.84	0.88 (88%)
Probabilities fixed to 0.05 (unlikely) plus decreased LOS (1.1 days)	20,709	22,046.84	–0.06 (–6%)
Increased LOS (2.9 days) (Rottenkolber et al. [11])	284,987	22,046.84	11.93 (1,193%)

ings amount to approximately €30,000 (€33,600, €30,000, and €25,700, respectively). However, these studies used very different approaches. Assuming theoretical direct savings of €30,000 per year, this would account for approximately 12% of the total annual savings (€216,197 plus €30,000).

In general, both the earlier [25] and the more recent reviews of the economic impact of clinical pharmacy services [26] showed a wide range of ROI on the one hand and heterogeneity in study designs, definitions, interventions evaluated, and types of costs included on the other. Only a few studies quantified the cost savings (avoided costs) related to DRPs or ADEs. Jermini et al. [15] and Liebing et al. [16] used actual institutional costs derived from their internal hospital billing data rather than estimating costs from the literature. By using the same methodological approach, the findings of the latter are similar and comparable to our results. Two investigations from the Netherlands and Ireland also used a method to assign avoided costs to prevented ADEs [27, 28]. The cost-benefit ratios (cost benefit/costs of service) identified were around 3.3 and 8.64, resulting in ROI of 234% and 764%, respectively, in line with our calculated ROI of 880%.

Sensitivity analyses demonstrated that the robustness of our economic model is sound. The break-even point revealed that intervention in ADEs is financially viable, even when the probability of occurrence is very low.

In a study from 2012, which included patients from various medical specialties from 3 German hospitals, the economic consequences of ADEs were examined in particular [11]. The authors determined €970 increased treatment costs for patients with ADEs and found that the average length of hospitalization was extended by as much as 2.9 days. This so-called micro-costing method includes the sum of various costs associated with the treatment of ADEs of inpatients and thus enables a transparent cost calculation from a practical point of view.

PIs related to identified DRPs may not only avoid costs but may also improve medication safety and have a positive impact on the clinical outcome of hospitalized patients [29–32].

Only PIs accepted by the physicians were considered to calculate the cost savings and ROI, respectively. With a ratio of 15.4 per 100 patient days, the number of PIs included in this project (230) is slightly below those of other investigations [20]. This is because the clinical pharmacists' role encompassed a broader spectrum of services, such as collaborating on therapy guidelines projects. The PI acceptance rate of 77.97% (230 out of 295) is high but corresponds to recent findings from other working groups [32, 33].

Due to the continuous intervention of the clinical pharmacists throughout the entire project period, no data can be shown representing a control phase without pharmaceutical care. Therefore, further studies are necessary to verify the methodology.

The probability of an ADE occurring without intervention is assessed as a maximum of 60% (p = 0.6) in the present model, although the probability may be significantly higher in individual cases.

To focus more strongly on the clinical relevance of the PIs, the consensus panel, in contrast to Nesbit et al. [18], could be expanded to include medical staff. This measure appears to minimize potential confirmation bias, as the sum of the probability scores exclusively assessed by pharmacists may be up to one-third higher [16]. Naturally, there is an inherent conflict of interest for pharmacists as researchers, which has the potential to exaggerate the probabilities.

CONCLUSIONS

The introduction of clinical pharmacy services, namely PIs following medication reviews in urology, was associated with economic benefit. The involvement of clinical pharmacists in the urology care team provides support in the field of drug therapy. The high acceptance rate of the PIs clearly shows that this concept meets the need. A notable positive aspect is the continuous bedside teaching associated with the pharmacy services offered. Moreover, this approach has been demonstrated to promote medication safety and to avoid further treatment expenses, thereby ensuring cost-effectiveness in a surgically focused environment.

This ultimately results in enhancement of the quality of care for urological patients, particularly at the interfaces of the patient journey, during admission and discharge. Ward-based clinical pharmacists are now an integral part of the urology care team, playing a vital role in ensuring the best possible patient outcomes.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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ETHICS APPROVAL STATEMENT

This investigation does not involve human participants. Therefore, ethical approval was not required.

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