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ORIGINAL ARTICLE

A cost-minimisation analysis of inpatient versus day surgery for gynaecological laparoscopy

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Abstract The aim of this study was to investigate whether medium-term hospital resource use differed between ambulatory and inpatient laparoscopy surgery for benign gynaecological conditions. Patient-based costing data were collected through a randomised controlled trial involving 26 inpatients and 40 day-surgery patients. The perspective was that of the hospital gynaecological ward. Day surgery was significantly cheaper per patient than was inpatient surgery, mainly due to shorter operation times and lower hotel costs. Remedial surgery had a higher total cost than did evaluative surgery, but patient age, referral source and diagnosis, and surgeon seniority had no significant impact. Based on previous findings that ambulatory and inpatient surgery result in equivalent clinical outcomes, day surgery for benign gynaecological laparoscopy is cheaper and thus should be preferred to inpatient surgery.

Keywords Day surgery · Gynaecological laparoscopy · Costs

Introduction

Day surgery has become an accepted alternative to inpatient surgery for many operative procedures and is often introduced as a cost-saving strategy. No empirical studies have been found investigating the relative cost-effectiveness of gynaecological day surgery compared with inpatient surgery, although comparisons have been made of ambulatory versus inpatient laparoscopy in general surgery [1–3]. These studies reported that day surgery was associated with lower total costs.

Health economic evaluation comprises comparative studies in which the consequences of two alternative interventions are compared. These interventions may be different treatment procedures (e.g. open surgery versus laparoscopy) or the same treatment procedure applied in different organisational regimes (e.g. inpatient versus day surgery). Different types of health economic assessment are available depending on the way in which the consequences of the health interventions are expressed [4]. In cost-effectiveness analysis, relevant outcomes could be numbers of patients successfully treated without side effects or gain in lifetime without gynaecological problems, cost-utility analysis expresses outcome in terms of quality-adjusted life years, while cost-benefit analysis measures outcome in monetary terms. Cost-minimisation analysis is undertaken when the health interventions under comparison yield identical health outcomes but are expected to use different amounts of health care resources. The recommended intervention is that which can be provided at the lowest cost.

In the comparison of gynaecological laparoscopy conducted either in a day care or an inpatient regime, the relevant differences may be related to operative success rates, complication rates, resource use related to the operation and resource use after discharge. In a previous article [5], it was reported that health outcomes between these two regimes were similar in terms of operation success and complication rate. The aim of the current analysis was thus to investigate whether medium-term

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resource use differed between ambulatory and inpatient laparoscopy surgery for benign gynaecological conditions. Patient-based costing data were collected prospectively within the framework of a randomised controlled trial.

Method

Data collection

From 658 consecutive patients referred to a hospital gynaecological department for laparoscopy related to benign gynaecological conditions, 66 patients were randomised to either inpatient (n=26) or day (n=40) surgery. Just under half of the patients (n=280) fulfilled exclusion criteria (age<18 years; pregnancy; previous laparotomy; other, including acute (<2 weeks) illness; no relatives able to provide patient care after hospital discharge; history of alcohol or drug abuse), a further 201 declined to participate in the randomisation study, and 111 randomised patients were still on the surgical waiting list when the study was stopped before time due to the closure of the gynaecological day surgery unit as part of a hospital cost-cutting exercise. Further details of the randomisation and patient characteristics have been reported previously [5].

Day surgery was performed in a unit designated to gynaecological day surgery with its own reception, operating theatres, recovery areas and surgical and nursing staff. Day-surgery patients arrived in the morning and left after surgery the same day, while inpatients stayed at least 1 night in hospital after the operation.

Costing perspective

The changes in resource use that should be identified depend on a study's perspective [6]. The current study took the perspective of the hospital gynaecological department and focussed on the medium-term consequences of the two surgical approaches. In this case, only direct health care costs that related to inpatient or day-patient surgery were included:

- Hospital staff time (based on mean hourly salaries, length of operation and recovery period)
- Medicines and other consumables used in anaesthesia, surgery and recovery period
- Opportunity costs of using the operating room and instruments
- Hotel costs (dependent on length of hospital stay)
- Costs arising from surgical complications

Not included were costs related to time use by patients and informal caregivers (assumed to be similar in the two surgical approaches), costs related to referral and diagnosis (also assumed to be similar for the two groups) and costs related to postoperative medication and general practitioner visits (the study data showed no significant differences between the groups [5]). The focus on a medium-term comparison of two interventions meant that neither future costs as a consequence of the intervention nor fixed costs related to administration, electricity etc., were included.

Measurement of costs

An activity-based costing approach was taken in which the activities that resulted in resource use were identified. For each activity, the resource use was then specified and costed in order to generate the total cost associated with each patient. Operation data (including operation code, length of stay, subsequent hospital admission) obtained from the hospital administrative register were supplemented by information collected prospectively by surgical staff on the number and seniority of the surgical personnel involved in each operation, type of anaesthesia, instrument and drug use, duration of anaesthesia and operation, complications, use of pain relief and antiemetics in recovery, and patient time in the recovery room. These data and patient characteristics are shown in Table 1 for the two patient groups.

The costs incurred by each patient were calculated as resource use (Table 1) multiplied by the unit cost of the specific resource (Table 2; all costs are in 2004 Danish kroner, where 1 DKK=0.13 euro).

Staff costs were calculated separately for administrative, anaesthetic, surgical and recovery room personnel. Additional use of porter staff for inpatients was assumed to be incorporated in the hotel cost. Most staff time was calculated according to the duration of anaesthesia, operation or time in recovery; assumptions were made regarding secretarial and nursing staff time for patient reception and registration. The anaesthetist was present only at induction and cessation of anaesthesia and was thus allotted 20 min per patient; the anaesthesia nurse was present for the whole duration, with extra time allotted for documentation of a case and preparation for the next. Surgeons and theatre nurses were also allotted extra time for scrubbing, documentation and/or clearing up. The recovery room nurse was assumed to look after four patients at a time; the cost was thus based on a quarter of the patient's time in the recovery room.

A standard cost per patient was assumed for the use of anaesthetic drugs, operative consumables, opportunity costs of using the operating room and equipment, and overnight hospital stay. A small number of patients in each group had slight deviations from the standard anaesthetic protocol (e.g. additional use of atropine due to bradycardia or hypotension; no nonsteroidal anti-inflammatory agents due to gastric ulcer); there were no significant differences between inpatient and day surgery groups, however, so

Table 1 Characteristics and operative data for patients randomised to either inpatient or day surgery

	Inpatient (n=26)	Day surgery (n=40)	p value
Patient characteristics			
Age (mean, SD)	35.0 (9.9)	33.9 (6.9)	NS
BMI (mean, SD)	22.8 (2.5)	23.1 (3.3)	NS
Referred from GP	57.8%	55.0%	NS
Diagnostic/evaluative operation[a]	46.2%	70.0%	NS
Surgeon			
Consultant/registrar	84.6% (n=22)	35.0% (n=14)	p<0.001 (2×2 table)
House surgeon	15.4% (n=4)	65.0% (n=26)	
Supervisor/assistant present	57.7% (n=15)	75.0% (n=30)	NS
Median time in minutes (IQR)			
Anaesthesia	80.0 min (28.0)	62.5 min (29.2)	p<0.001
Operation	42.5 min (34.0)	32.5 min (19.8)	NS
Recovery	110.0 min (61.2)	250.0 min (70.0)	p<0.001
Operation			
Standard anaesthesia	80.8% (n=21)	85.0% (n=34)	NS
Instrument error[b]	3.8% (n=1)	22.5% (n=9)	p<0.05
Complications[c]	11.5% (n=3)	5.0% (n=2)	NS
Medication while in recovery			
Pain killers	73.1% (n=19)	77.5% (n=31)	NS
Antiemetics	19.2% (n=5)	10.0% (n=4)	NS
Length of stay (SD)	2.3 days (1.0)	0.0 days (0.1)	p<0.001

SD standard deviation, *NS* not significant, *BMI* body mass index, *GP* general practitioner. *IQR* interquartile range

[a] In both groups, the most frequent operative code was for diagnostic laparoscopy/biopsy (37% and 48% in inpatient and day surgery, respectively), followed by investigation/treatment of infertility (19% and 25%), cyst removal (14% and 11%), treatment of endometriosis (12% and 2%) and sterilisation procedures (5% and 3%). Each patient could have up to five operation codes; hence, there were more operative procedures (43 and 64, respectively) than patients in each group.

[b] Instrument error: defective light cable, scope or camera (five day patients), defective cauteriser (one inpatient and one day patient), defective Verres cannula (two day patients)

[c] Complications: one day patient admitted overnight for observation of syncope; one day patient discharged later same day after 6 hours' observation for bradycardia; one inpatient with intraoperative perforation of uterus was discharged as planned the day after operation; laparoscopy in two inpatients was altered to laparotomy due to a tumour and large ovarian cyst, respectively.

these deviations were not costed separately. Operative complications were few and were costed on an individual basis (Table 2). Instrument error occurred but did not influence anaesthetic or operative time and was thus not costed.

Statistical analysis

Sample size calculations showed that the inclusion of 24 patients in each of the inpatient and day surgery samples would allow a between-group cost difference of 3,000 DKK to be detected, while inclusion of 34 patients would allow a cost difference of 2,500 DKK to be detected. Descriptive statistics for inpatient and day-surgery groups are presented as average costs per patient. Costs are presented for the two randomised groups and according to aim of surgery (evaluative vs. remedial). Pearson's chi-square test was used in the analysis of categorical variables. Total costs were analysed for subgroups of patients defined in relation to age, referral source and diagnosis, aim of operation and surgeon seniority. Most cost data were non-normally distributed and were analysed using nonparametric statistics. Mann–Whitney tests were applied to test for differences in average costs and durations between the inpatient and day surgery groups and between patient subgroups. The level of significance was set at 0.05. Multiple regression analysis was used on log-transformed total cost data to test for multiple co-variation.

Results

The mean total cost of inpatient surgery was nearly double that of day surgery (Table 3). The main elements contributing to this higher cost were longer mean anaesthetic and operative times (resulting in higher salary costs for anaesthetic and surgical staff, plus greater opportunity costs for the use of the operating theatre and equipment) and a longer length of stay (resulting in higher hotel costs). Day-surgery patients were a longer time in the recovery room and had higher associated nursing costs, but these did not offset the other higher costs for inpatient surgery.

Table 2 Cost units related to laparoscopic surgery [costs are 2004 Danish kroner (DKK)]

	Cost per unit[a] (DKK)	Resource unit	
		Inpatient	Day surgery
Reception/administration			
Secretary	213 kr/h	10 min	10 min
Nurse	232 kr/h	15 min	15 min
Anaesthesia			
Anaesthetist	450 kr/h	20 min	20 min
Anaesthesia nurse	232 kr/h	AN time+15	AN time+15
Drugs & consumables	200 kr[b]	Per patient	Per patient
Operation			
Surgeon	294–503 kr/h	OP time+20 min	OP time+20 min
Supervisor	294–503 kr/h	OP time+20 min	OP time+20 min
Theatre nurse (scrubbed)	232 kr/h	AN time+20 min	AN time+20 min
Theatre nurse (not scrubbed)	232 kr/h	AN time+10 min	AN time+10 min
Consumables (sutures, swabs etc.)	1,000 kr[b]	Per patient	Per patient
Use of operating room & equipment	1,500 kr/h[b]	AN time	AN time
Recovery room			
Nurse	232 kr/h	0.25*REC time	0.25*REC time
Pain relief	See note[c]	As per patient data	As per patient data
Antiemetics	See note[c]	As per patient data	As per patient data
Hotel costs	2,000 kr/day[b]	Length of stay	Length of stay
Complications			
Extended hospital stay	Accounted for in length of hospital stay		
Extended observation after surgery	0.25*2000 (1 day patient stayed extra 6 hours)		
Later hospital admission	7,000 kr/day		
Laparotomy (two inpatients)	No extra costs assumed		

AN time minutes from induction of anaesthesia to delivery of patient to recovery room, *OP time* minutes from first incision to final stitch, *REC time* minutes spent by patient in recovery room

[a] Salary costs were based on gross salary per. August 2004 from national sources; unit cost is monthly salary/126.4 h based on assumption that a working year comprises 52 weeks, each of 37 h; after subtracting 8 weeks for public holidays and holidays (10 days and 6 weeks, respectively) and 15 days for absence due to illness, there are on average 1,517 effective working hours per person per year, or 126.4 working hours per month.

[b] Assumptions based on information from local financial officers

[c] Individual patient data were collected on use of Fentanyl (IV), Xefo (IV or tablet), Panodil (supp. or tablet), Vilan (IV or subcut.); Zofran (IV), Dehydrobenzperidol (DHB, IV) and Primperan (IV or supp.) all costed according to national prices, excluding any hospital discounts; disposable equipment and fluids associated with drug administration were assumed to be included in the overall cost per dose

As seen in Table 1, the day-surgery group had a higher number of operations that were undertaken for diagnostic or evaluative purposes, whereas there were more remedial operations among the inpatients. This difference nearly reached statistical significance ($p=0.053$) and may have contributed to the cost difference between the two patient groups, as it could be hypothesised that evaluative operations were less expensive than remedial operations. This was confirmed by further analysis (Table 3) that showed a lower mean total cost for evaluative operations. This was due to significantly shorter ($p<0.001$) mean durations of anaesthesia and operation (which resulted in lower salary and opportunity costs), shorter length of stay (mean 0.5 days versus 1.4 days; $p=0.012$) and lower cost of antiemetic medication when compared with remedial operations. For both appraisal and remedial operations, however, day surgery still had a significantly higher mean salary cost for the recovery nurse (both $p<0.001$), lower mean hotel cost (both $p<0.001$) and lower mean total cost (both $p<0.001$) when compared with inpatient surgery. Other trends were also seen for both appraisal and remedial operations where day surgery resulted in lower mean salary costs for anaesthetic staff ($p=0.058$ for appraisal; $p=0.046$ for remedial) and lower mean theatre opportunity cost ($p=0.058$ for appraisal, $p=0.046$ for remedial) compared with inpatient surgery.

Factors affecting total cost

Within the inpatient and day-surgery groups, there were no significant cost differences when patients were subgrouped according to age, referral source and surgeon seniority (data not presented). Although inpatient surgery was typically undertaken by more senior surgeons, an assistant was also often present, while the more junior surgeon typically performed day surgery in the presence of a more senior

Table 3 Mean patient costs [2004 Danish kroner (DKK)]±standard deviation (SD) according to surgical approach and aim of surgery

	Surgical approach		Aim of surgery	
	Inpatient (n=26)	Day case (n=40)	Evaluative (n=40)	Remedial (n=26)
Salary costs				
Administration	93±0	93±0	93±0	93±0
Anaesthesia	546±106	463±73*	464±63	540±117***
Operation	1,535±499	1,261±311**	1,251±292	1,540±505****
Recovery	117±42	239±42*	205±75	175±67
All salaries	2,301±614	2,057±377	2,014±349	2,358±601****
Drug costs				
Anaesthesia	200±0	200±0	200±0	200±0
Drug costs in recovery	27±49	11±30	10±24	29±53****
Pain relief	11±18	4±7	7±14	8±12
Antiemetics	16±43	7±29	3±20	21±49****
Costs due to complications	0	187±1,108	187±1,108	0
Other costs				
Consumables	1,000±0	1,000±0	1,000±0	1,000±0
Operating room/equipment	2,183±685	1,648±473*	1,658±409	2,147±757***
Hotel costs	4,667±2,014	50±316*	1,128±2,142	2,800±2,887****
Total cost per patient	10,348±2,340	5,142±1,327*	6,193±2,400	8,501±3,542****

*Significant difference (p<0.001) between inpatient and day surgery
**Significant difference (p<0.05) between inpatient and day surgery
***Significantly higher (p<0.001) than cost for evaluative surgery
****Significantly higher (p<0.05) than cost for evaluative surgery

supervisor, thus levelling out the cost differences. For inpatients only, surgery for pelvic pain was cheaper than for endometriosis or infertility (p<0.05), but patient numbers were small (four patients with infertility and five with pelvic pain). The significant differences between the inpatient and day-surgery groups remained in each subgroup (all p<0.001).

As hotel costs formed a substantial amount of the cost difference between the inpatient and day-surgery groups, the analysis was repeated with hotel costs set at 0. The mean total costs for inpatient and day surgery were reduced to 5,682 DKK and 5,092 DKK, respectively, but were still statistically different (p=0.02).

Regression analysis results (Table 4) confirmed that even when other key parameters were controlled for, surgical approach and aim of operation had a significant influence on the total cost per patient, where day surgery and evaluative surgery were associated with lower costs. Patient age, referral source and diagnosis, and sugeon seniority had no significant impact. Together with a constant term, all parameters together explained 76% of the variation in the total cost of laparoscopic surgery in these patients.

Discussion

Results confirmed the hypothesis that it was cheaper for the hospital gynaecological department to conduct laparoscopic surgery for the conditions under study as day surgery rather than with an inpatient approach. The cost difference was estimated at approximately 5,200 DKK per patient and was mainly due to the shorter operation times and savings in hotel costs associated with day surgery. A higher total cost was also associated with remedial surgery as opposed to evaluative surgery, but patient age, referral source and diagnosis, and surgeon seniority had no significant impact.

Hotel cost was the largest cost element for inpatient surgery (45%), followed by total salary cost (22%). Salary

Table 4 Association between variables: multiple regression analysis of log-transformed total costs (n=66)

Model parameters	Unstandardised coefficients		p value
	B	Standard error	
Patient age >35	−0.09	0.06	0.123
Day surgery	−0.71	0.06	0.000
Remedial operation	0.13	0.06	0.022
Referred from specialist/ department	0.07	0.06	0.244
Senior surgeon	0.11	0.06	0.073
Referral diagnosis: infertility	−0.04	0.08	0.672
Referral diagnosis: pelvic pain	−0.03	0.06	0.670
(Constant)	9.69	0.16	0.000
R squared	0.76		

costs formed 40% of the day surgery total costs, the same as that reported in a previous study [7]. Even when hotel costs were set at 0 DKK, day surgery was still cheaper than inpatient surgery. The shorter operation times may reflect a tighter planning with fewer delays, which is possible in an ambulatory regime, thus resulting in more efficient use of resources when compared with the traditional inpatient regime.

The current analysis was conducted using a medium-term perspective and thus did not include estimates of fixed costs (administration, lighting, depreciation of buildings and equipment etc.) or capital costs associated with setting up the day surgery facilities. Inclusion of fixed costs would be unlikely to alter the conclusion that day surgery can be conducted more cheaply than can inpatient surgery but would likely increase the cost savings of day surgery. The effects of adding capital costs would depend on the structure and organisation of the facilities provided. As the operations resulted in similar medium-term patient outcomes and would be unlikely to produce significant differences in long-term patient resource use, the effect of discounting the costs would also be negligible.

It should be noted that a change from inpatient to day surgery will not necessarily produce overall cost savings for the hospital department. These will only be realised if the number of patients remains constant and fewer resources are used [8]. It is likely, however, that shorter theatre time (and the associated reduced use of staff time) and shorter hospital stay will allow more patients to be treated in the same length of time. This would result in higher overall costs, but also higher productivity, more efficient use of resources and a better contribution to general population health.

The data on which this analysis was based were derived from a randomised controlled trial in which patients were highly selected both on clinical grounds and by self-selection. It is not known whether similar results would have emerged had the study included patients with more complex gynaecological conditions, greater comorbidity, no relatives available to help in the recuperative period, or stronger preferences for inpatient (or day) surgery. It could be argued that these factors would increase the costs associated with day surgery due to a higher complication rate, requirement for a senior surgeon and/or longer length of stay.

Limiting the analysis to the perspective of the hospital department meant that, although later complications involving the hospital were included, costs related to general practitioner consultations and other community services, costs to the patients and their families (transport costs, time off work, over-the-counter medication, etc.) were not. The relative cost-effectiveness of laparoscopic versus open surgery can differ according to whether or not these costs are included [9], but the consequences for different laparoscopic approaches is not clear. While the reports of postoperative days off work and general practitioner visits were similar in the inpatient and day surgery groups in the current study [5], it is not known whether there were any cost differences between the groups, for example, due to differing consumption of medications, dressings, or general practitioner and/or practice nurse time. Finally, the current analysis did not attempt to cost any loss of welfare from the patient's perspective. Both groups reported significantly less pain within the month after surgery, however, and there were no significant differences with respect to feeling confident to go home, reports of problems after discharge or the degree to which daily activities were affected by gynaecological symptoms in the month after operation [5]. Again, these similarities between inpatient and day-surgery groups may disappear with a patient sample with different case mix or attitudes to day surgery.

The conclusion from this study is that day surgery for gynaecological surgery is associated with cost savings from the hospital department's perspective. As it has previously been documented that day surgery can be undertaken with the same clinical quality and outcome as inpatient care, the results imply that day surgery for gynaecological laparoscopy should be preferred to inpatient surgery.

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