Implications of decreasing surgical lengths of stay

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Abstract

A recent study at the Prince of Wales Hospital (PoW) compared health outcomes and user satisfaction for conventional clinical pathways with a shortened pathway incorporating day of surgery admission (DOSA), early discharge and post acute care domiciliary visits for two high volume, elective surgical procedures (herniorrhaphy and laparoscopic cholecystectomy). This paper quantifies cost differences between the control and intervention groups for nursing salaries and wages, other ward costs, pathology and imaging.

The study verified and measured the lower resource use that accompanies a significant reduction in length of stay (LOS). Costs of pre- and post-operative domiciliary visits were calculated and offset against savings generated by the re-engineered clinical pathway. Average costs per separation were at least $239 (herniorrhaphy) and $265 (laparoscopic cholecystectomy) lower for those on the DOSA pathway with domiciliary post acute care.

Introduction

A study carried out at PoW in 1995–97 compared health outcomes (readmission rate, infection and complication rate), cost and patient satisfaction for a traditional (control) pathway and a re-engineered (intervention) pathway. The latter included pre-admission assessment by patient health questionnaire, admission on day of surgery, early discharge and enhanced patient education (Caplan *et al*, 1998).

This paper quantifies cost differences between nursing salaries and wages, pathology services, imaging, ward costs and overheads for control and intervention (re-engineered) groups of patients undergoing two common elective surgical procedures, laparoscopic cholecystectomy and inguinal or femoral herniorrhaphy. The cost components are consistent with those used in national and state level DRG costing studies.

In NSW hospitals, coding of separations and cost modelling are performed retrospectively. Many hospital costs are not attributable to individual patient-care episodes and are defined as "overheads", averaged out and then allocated over weighted separations. For this reason, it is rare that the nature of the relationship between LOS and cost per separation is made explicit.

Moreover, claims that savings are generated by shortening LOS are often rebutted by noting that the hospital overheads are not reduced in line with reduced inpatient bed days.

The drivers of cost for each of the four cost components referred to were identified and quantified. These were: nursing contact time as a marker for nursing wages and salaries; laboratory tests ordered; imaging investigations ordered, and nursing contact time again as a marker for ward costs and overheads. In addition, the real costs of pre-operative assessment and post-operative domiciliary visits are calculated.

Background

As surgical and anaesthetic technology evolve, together with operating theatre management, perioperative assessment and post acute care, it is reasonable to expect shorter LOS for surgical procedures (Maxwell 1994, Jolly 1993). It is generally accepted that reducing LOS will generate savings. However, if we are merely trimming off the low intensity in-hospital days and substituting outpatient and domiciliary care it is possible that no savings will result. Rather, the hospital might be shifting its costs onto others.

Australian and overseas literature generally attribute higher operating theatre costs to laparoscopic approaches that generate shorter LOS, because of longer theatre times and more expensive equipment (Rudkin & Maddern 1995, Tsaltas *et al* 1997, Barkun *et al* 1995, Goodwin & Traverso 1995, Moon *et al* 1993, Schurz *et al* 1995). However, methods used to quantify savings from shorter LOS vary (Sadler 1992, Hollingworth 1994), and are discussed further in this article.

If the main costs for elective surgery occur during the perioperative phase, does trimming time in hospital at the beginning and end of the stay actually save money? Where alternate facilities are required to coordinate the perioperative assessment as an outpatient and post acute care at home, are in-hospital savings meaningful? Is the hospital simply cost shifting onto the outpatient sector? Are the pre-operative assessment and post acute care facilities actually cheaper than inpatient care, especially given that LOS has fallen dramatically anyway?

Clinical pathway costs need to be accurately established in order to make the best use of finite hospital budgets (Hindle, 1999) and achieve safe “resource stewardship” (Dowling 1995). This paper explores the drivers of hospital costs for common separations in detail, in the context of a clinical trial which demonstrated the clinical safety of a re-engineered pathway (Caplan *et al* (a), 1998) without an increased cost to the community (Caplan *et al* (b), 1998).

Methods

We conducted a sequential controlled trial, studying patients prospectively before and after the introduction of a reengineered surgical service. Many surgical trials are not amenable to randomised controlled trials (RCT) (Solomon & McLeod, 1998). Where a multi-component service is being studied, treatment elements like pre-operative education and early discharge will easily leak across, making an RCT impossible.

In order to minimise variation and ensure adequate patient numbers, we selected two general surgical procedures: inguinal or femoral herniorrhaphy, and laparoscopic cholecystectomy. Patients were excluded from the trial if they lived out of area or were admitted as an emergency. All patients gave informed consent. The methods have been fully described in a previous paper (Caplan *et al*, 1998).

The control and re-engineered pathways were compared. Study variables were pre-operative nursing assessment coordinated by a Perioperative Clinic, admission on day of surgery, enhanced patient education, use of clinical pathways and early discharge with follow up by the Post Acute Care Service (PACS) multidisciplinary team (Caplan & Brown 1997) (see Table 1). Endpoints included LOS, cost, pain scales and use of analgesia, complications, working days lost and patient satisfaction. Table 2 shows the characteristics of the study groups.

Table 1: Features of clinical pathways studied

Conventional pathway (control)	Re-engineered pathway (intervention)
Admission day before surgery	Admission (DOSA) coordinated by Perioperative Unit which sends and reviews patient self-reported health questionnaires, and arranges pre-admission assessment if indicated. (30% of patients attended pre-admission anaesthetic clinic)
	Patient information specific for each operation distributed by surgeon. Nurses reinforce patient knowledge.
Anaesthetic consult evening before surgery	Pre-admission visit by Registered Nurse if social circumstances indicated
Surgery day 1	Clinical pathway followed. This provides a diagnosis-specific plan for the episode of care.
Routine recovery and discharge	Early discharge with dressings in situ
No post-acute domiciliary visits	Post-acute care at home after discharge
7 day phone check (study purposes only)	7 day phone check or visit

Table 2: Baseline characteristics

	Intervention n (%)	Control n (%)	p value
All patients	101 (100)	123 (100)	
Female: male ratio	46:55	54:69	0.81
Mean age [range]	54.4 [21–85]	54.0 [18–90]	0.86
Smokers	27 (26.7)	25 (20.3)	0.24
Ischaemic Heart Disease	8 (7.9)	9 (7.3)	0.87
Requires an interpreter	8 (7.9)	4 (3.3)	0.12
Lives alone	19 (18.8)	23 (18.7)	0.98
Lives up stairs (no lift)	37 (36.6)	39 (31.7)	0.46

Baseline characteristics were compared using t-tests for continuous variables and Chi-square for dichotomous variables.

DRGs are designed to be clinically coherent and reflect similar resource use. Significant drivers – and splitting attributes – of higher resource use within given diagnostic and procedural groups are age and co-morbidity. While there will be resource use variations between individual, uncomplicated herniorrhaphy and laparoscopic cholecystectomy cases over their hospital stay, coding and grouping of records into DRGs is an accepted measure of average resource use.

In order to analyse resource use for clinically comparable separations, the costing study was confined to the separations in AN-DRGs 320 (Inguinal & femoral hernia procedures age>9; n = 97) and 367 (Cholecystectomy without exploration of the common bile duct; n = 114). 94.6% of patients included in the study were coded into those AN-DRGs (version 3). Coding was performed by medical records staff blinded to study status.

Co-morbidities, complications and surgical findings (changing expected MDC) were responsible for a small number of separations being coded into other DRGs. Two laparoscopic cholecystectomies from the control and two from the intervention group each proceeded to open cholecystectomy with exploration of the common bile duct (AN-DRG 366). Other outliers included two AN-DRG 319 from the intervention group (Abdominal, Umbilical & Other Hernia Procedures Age>9) and one pre-existing condition coding to AN-DRG 19 (Non-Acute Quadriplegia/Paraplegia, with or without O.R. Procedure), a post-operative complication coding to AN-DRG 69 (TIA & Precerebral Occlusion Age<80 without CC), 313 (Appendicectomy with Complicated Principal Diag), 322 (Other Digestive System O.R. Procedures with CC or with Malignancy), 363 (Biliary Tract Procedures excluding only Cholecyst with or without C.D.E. with non-major CC) and 377 (Disorders of Liver Except Malignancy, Cirrhosis, Alcoholic Hepatitis without CC). The numbers of control and intervention patients whose eventual AN-DRG differed from the expected (320 or 367) were not significantly different (p= .26, Chi-square).

Costing method – hospital separation

In order to measure the cost difference between the treatment pathways with significantly shorter LOS and the control group, four major casemix cost components (Nursing salary & wages, Other ward costs, Pathology, and Imaging) were analysed.

Nursing contact time for clinical pathways was calculated in consultation with ward staff, and used to weight “Nursing salaries & wages” costs. Nursing contact time also served as a resource use intensity marker for “Other ward costs”.

For “Pathology Costs”, the unweighted number of tests ordered was considered the cost driver (in the absence of atypically costly laboratory investigations). Single measures such as plasma sodium or haemoglogin were grouped according to the hospital’s ordering practice (eg “full blood count”, “urea/electrolytes/creatinine”) and Medicare billing (Commonwealth Department of Health and Family Services, 1996). “Imaging Costs” were also analysed by volume of unweighted tests performed.

Operating theatre costs were held to be equal for the control and study groups, as the reengineered pathway did not alter theatre procedures. The t-test for independent samples showed there was no significant difference in operating theatre times (range 25 – 260 minutes) for DRG 320 (79.8 v 79.3, p = 0.93) or for DRG 367 (120.0 v 111.9, p = 0.265).

Steps in costing

The PoW Business Information Unit modelled costs retrospectively for DRGs 320 and 367 for the financial year 1995–96 (table 3). It used COSMOS software to allocate global overhead costs to PACS which provided the pre-operative nursing assessment and the post-operative visits for the financial year 1995–96.

Table 3: Cost groups for DRGs 320 & 367, Prince of Wales Hospital 1995/96

Component	AN-DRG 320: Inguinal & Femoral Hernia Procedures Age>9 in $	AN-DRG 367: Cholecystectomy without CDE* in $
Clinical depts		
Medical S & W**	204	256
Allied & Other	226	298
Theatre	1094	1540
Pathology	124	199
Imaging	23	88
Wards		
Nurse S & W**	385	705
Other ward costs	469	853
Emergency	27	70
Intensive Care	53	88
Prostheses	52	76
Depreciation	121	212
Super	137	224
TOTALS	**$2,915**	**$4,611**

* without CDE: without common bile duct exploration

** salaries and wages

Nursing contact time for typical separations was determined in consultation with the surgical ward's Nurse Unit Manager and clinical associate, by observation and by chart review. Times for each nursing intervention – by day of stay – were charted in minutes within the clinical pathway for DRG 320 (table 4) and DRG 367 (table 5) for control and intervention groups. These clinical pathways were based on the average LOS.

In the case of DRG 320, the hospital's average length of stay (ALOS) of 3.09 days for 1995–96 matched the study's control group (3.09 days). The hospital's cost modelling for DRG 320 was applied to the control group for nursing salaries & wages and "other ward costs" to the herniorrhaphy controls.

Table 4: Nursing and ward cost components weighted by measured ward nursing contact time for DRG 320 (inguinal & femoral hernia procedures age >9)

	Control	Intervention	Difference
ALOS days (CI95%)	3.09 (2.82 – 3.36)	1.73 (1.48 – 1.97)	
Day 0 (hours:minutes)	00:50	n/a	00:50
Day of surgery	02:40	3:10	(00:30)
Day 2	01:10		01:10
Final day	01:00	01:00	00:00
TOTAL	**05:40**	**04:10**	**01:30**
Reengineered pathway nursing time as a portion of control 73.4%			
	100%	73.4%	26.6%
Nursing S & W	$385	$283	$102
and Other Ward Costs	$469	$345	$124

ALOS: average length of stay

The match between ALOS for DRG 367 for the whole hospital (5.35 days) and for the control group (3.34) was poor, as the whole hospital's DRG 367 separations for 1995/96 included both open and laparoscopic cholecystectomies. Resource use for nursing salaries & wages and "other ward costs" were therefore modelled by observed nursing contact time for typical cholecystectomy separations and typical laparoscopic cholecystectomy separations (control group) to the shorter LOS for laparoscopic cholecystectomy.

Table 5: Nursing and ward cost components weighted by measured ward nursing contact time for DRG 367(cholecystectomy without common bile duct exploration)

DRG 367	**POWH* 1995/96**	**Control**	**Intervention**
ALOS in days (CI95%)	5.35 (n/a)	3.34 (3.01 – 3.67)	2.36 (2.02 – 2.70)
Day 0 (hours:minutes)	00:50	00:50	n/a
Day of surgery	02:40	02:40	03:10
Day 2	01:10	01:10	01:10
Day 3	01:00	01:00	
Day 4	01:00		
Day 5	01:00		
Final Day	01:00	01:00	01:00
TOTAL	**8:40**	**6:40**	**5:20**
laparoscopic pathways nursing time as % of all cholecystectomies	100%	76.9%	61.5%
Nursing S & W	$705	$542	$433 (saving $109)
Other Ward Costs	$853	$656	$524 (saving $132)

* ALOS for DRG 367 whole of Prince of Wales and Prince Henry Hospitals for the financial year 1995/96 (n = 304). All DRG 367 separations include open as well as laparoscopic cholecystectomy. The study's control and intervention separations were admitted for laparoscopic cholecystectomy only.

Non-contact and non patient-specific nursing activities include line and ward nursing management, checking scheduled drugs, rostering, annual and sick leave, in-service education and stocking. For the purposes of costing, this human resource use was allocated in proportion to nursing contact as a marker of intensity of care in the cost component Nursing salaries and wages. Similarly, ward overheads, non-nursing staff and consumables were calculated from Diagnosis Related Group cost modelling in proportion to nursing contact time as a more accurate marker of Other ward costs than LOS.

Costing method – pre-operative assessment and post acute care

In addition to inpatient costs measured through casemix cost modelling, pre-operative nursing assessment and post-operative domiciliary visits were performed by the hospital's PACS for all patients in the intervention group. The costs of PACS are not included in the hospital's inpatient DRG costs, and so were calculated separately for this study.

Whole-of-year (direct and indirect) costs for the Post Acute Care Service were calculated, and used to derive costs per productive nurse/day (and likewise for allied health professionals). Although each episode involves significant non-contact, patient-attributable time (travel time, GP and pathology follow up, for example), time per domiciliary contact correlated well (inversely) to visits per nurse day worked.

Cost per productive nurse (or allied health professional) day was divided by the number of patient contacts per productive day to calculate average cost per domiciliary contact. Observation and retrospective review of the number of visits achieved per day showed a pattern determined by service group. Visit types for the PACS (Hospital in the Home, Post Acute Care/elective surgery, Post Acute Care/orthogeriatrics, Respiratory Outreach Program) were given relative weights according to number of visits achieved per nurse per day worked.

For example, a higher rate of herniorrhaphy and laparoscopic cholecystectomy post acute domiciliary visits was achieved (8 per day) than the team's orthogeriatric post acute care (6/day) and Hospital in the Home program work (4 visits per day). On the other hand, ward assessment and follow up of patients by PACS – being onsite – was achieved at the rate of 15 contacts per productive day. The teams average cost per surgical domiciliary visit was weighted accordingly, giving a domiciliary visit cost of $42.43 for the study patients and $22.63 per ward assessment. Table 6 shows the additional cost per episode of providing these services to the intervention group.

Table 6 – Cost of ward assessment and pre-operative visits by post acute care nurses (intervention group only)

Cost per dom visit $42.43 Cost per ward visit $22.63	average domiciliary visits per separation	ward assessment	additional cost per separation
DRG 320	1.43 ($60.67)	1 ($22.63)	$83.30
DRG 367	1.77 ($75.10)	1 ($22.63)	$97.73

All direct and indirect costs for PACS for the financial year 1995–96 were used to calculate domiciliary visit and ward assessment costs. Hospital as well as team management and overhead costs were built in, as were travel time, superannuation, all types of leave and all departmental inputs. The service-weighted contact cost was most sensitive to service utilisation rate (average cost per visit rises if staff are underutilised) and staff seniority (higher hourly rates for more senior nurses).

Results

Health outcomes are described in the paper previously cited (Caplan *et al*, 1998). While achieving equivalent or better health outcomes, the study group for both surgical procedures showed significantly shorter ALOS.

For the herniorrhaphy group, ALOS was shorter for the intervention group in hours (43.6 vs 74.1 hours; $p<0.001$ – t-test for independent samples) and when calculated in whole days, which is current practice in the NSW Department of Health and for casemix generally in Australia (1.73 vs 3.09 days; $p < 0.001$).

For the laparoscopic cholecystectomy patients, the intervention group ALOS was also significantly shorter in hours (60.7 vs 80.6 hours; $p = 0.001$) and in whole days (2.36 vs 3.34 days; $p < 0.001$).

An analysis of modal and median LOS showed that the majority of the intervention herniorrhaphies stayed in hospital for one (18) or two (16) days, with a median stay of 2 in whole days. The control group clustered around two (16) and three (27) days, with a median LOS of 3 days.

For the laparoscopic cholecystectomy group, the difference by modes was even clearer. 38 of 53 laparoscopic cholecystectomies performed from the perioperative pathway stayed two days in hospital (median = 2), while 39 of 61 controls stayed three days in hospital (median = 3).

Nursing time and "other ward" costs

Timed nursing inputs for typical days of stay, including the pre-admission clinic, are shown in Tables 4 and 5. By breaking down "hospital days" into care processes with demonstrated levels of nursing time, the notion of "saved bed days" is translated into more meaningful resource drivers "Nursing salaries and wages" and "Other ward costs".

Mapping nursing contact time for the herniorrhaphy group (DRG 320) shows a total of 5 hours and 40 minutes for the average control group pathway (ALOS 3.09 days), and 4 hours 10 minutes for the intervention group (ALOS 1.73 days). Nursing salaries and wages and "Other ward costs" are allocated in proportion to nursing contact in tables 4 and 5.

The intervention group for herniorrhaphy had costs that were $226 lower in these two DRG cost components, while for laparoscopic cholecystectomy the intervention group the difference was $241.

Pathology

Pathology and imaging ordered in the pre-admission clinic as well as during the hospital separation were included in the intervention group cost data. Tests for each patient separation were counted and grouped into haematology, clinical chemistry, other serology and histology. For both the herniorrhaphy and laparoscopic cholecystectomy groups the number of pathology tests was significantly lower (p < 0.001) in the intervention group (Table 7).

Averages of "all tests" per separation were compared and used to calculate cost differences from the hospital's pathology cost modelling for each DRG (Table 7). 304 patient separations were coded into DRG 367 at the Prince of Wales Hospital for the period 1995/96. This group included open as well as laparoscopic cholecystectomy patients. Pathology costs of $199 per separation were attributed to this group. The cost of pathology calculated for laparoscopic cholecystectomy patients on the re-engineered pathway was $77. For the herniorrhaphy patients, pathology costs were $84 lower for the intervention group.

Table 7 – Mean laboratory tests ordered by DRG and pathway

Tests	Control (CI=95%)	Intervention (CI=95%)	p
DRG 320 Inguinal & Femoral Hernia Procedures Age>9			
Haematology	1.36 (1.03–1.69)	0.44 (0.18–0.69)	<0.001
Clinical chemistry	1.54 (1.01–2.06)	0.49 (0.25–0.72)	0.001
Other serology and histology	0.29 (0.11–0.46)	0.1 (0.003–0.19)	0.089
All laboratory tests	3.19 (2.23–4.06)	1.02 (0.56–1.46)	<0.001
Cost	$124	$40	
DRG 367 Cholecystectomy w/o CDE			
Haematology	2.33 (1.77–2.88)	0.51 (0.29–0.73)	<0.001
Clinical chemistry	3.38 (2.65–4.1)	1.08 (0.51–1.64)	<0.001
Other serology and histology	1.02 (0.72–1.31)	1.02 (0.92–1.12)	NS
All laboratory tests	6.72 (5.52–7.93)	2.6 (1.76–3.44)	
Cost	$199	$77	

* t-test for independent samples used – SPSS for Windows

Imaging

Significantly less imaging was ordered for herniorrhaphy (DRG 320) patients in the group on the reengineered pathway (0.7 v 0.32; p 0.002), most of which were chest X-rays. An averaged saving of $12 per patient using the reengineered pathway was calculated from the control group's imaging costs of $23 for 1995/96.

The difference between control and intervention imaging usage for the laparoscopic cholecystectomy group is not significant (1.46 v 1.32: p = 0.48). The bulk of imaging resource use comes from intra-operative cholangiograms. No significant savings for imaging on the re-engineered pathway can be imputed for DRG 367.

Table 8 – Use of imaging by DRG and pathway at Prince of Wales/Prince Henry Hospital

Tests	Control		Intervention
DRG 320			
Radiography – average items	0.7 ($23)		0.32 ($11)
1995/96 costs		**$23 (saving $12)**	
DRG 367			
Radiography – average items	1.46		1.32
1995/96 costs		**$88 (no saving)**	

Post acute care and pre-operative visits

Herniorrhaphy and laparoscopic cholecystectomy patients on the re-engineered pathway were visited by the post acute care team pre-operatively at home or on the ward, or were phoned pre-operatively to check their home situation.

Patients on the re-engineered pathway classified as DRG 320 averaged 1.43 domestic visits and all received one ward visit, giving a total additional cost of $83.30. For the study's DRG 367 (laparoscopic cholecystectomy) patients, there was an average of 1.77 home visits in addition to the ward visit, adding $97.73 to the cost per separation as shown in Table 6.

Table 6 – Cost of ward assessment and pre-operative visits by post acute care nurses (intervention group only)

Cost per dom visit $42.43 Cost per ward visit $22.63	average domiciliary visits per separation	ward assessment	additional cost per separation
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DRG 367	1.77 ($75.10)	1 ($22.63)	$97.73

The rate of post hospital-visits was artificially high due to the demands of the study. The pre-operative anaesthetic clinic is run by the perioperative unit which admitted intervention group patients on the day of surgery. Patients complete a general health questionnaire that is reviewed by the unit's director, an anaesthetist. On the basis of the questionnaire, 15% of the study group were asked to attend the pre-admission clinic. A further 15% attended the clinic because of anaesthetist preference. This patient contact time is built into the nursing contact plotted in this group's (reengineered) clinical pathway.

Final cost comparison

Real savings generated by using these re-engineered pathways are likely to be higher than the sum of the cost differences identified in this study, which were $239 for DRG 320 and $265 for DRG 367 (Table 9). For example, lower superannuation payments would correspond to lower timed nursing inputs, directly proportional to payment of salaries and wages. However, it was not feasible to separate the proportion of the superannuation payments allocated to DRGs 320 and 367 corresponding to the nursing division. Nor was it possible to analyse medical time ("Medical Salaries & Wages") or allied health.

Table 9 – pathway cost comparison

	Control	Intervention	Saving
DRG 320			
Nursing S & W	$385	$283	$102
"Other ward costs"	$469	$345	$124
Pathology	$124	$40	$84
Imaging	$23	$11	$12
Domiciliary and pre-operative assessments	($83)		
TOTAL DIFFERENCE			**$239**
DRG 367			
Nursing S & W	$542	$433	$109
"Other ward costs"	$656	$524	$132
Pathology	$199	$77	$122
Imaging	$88	$88	$0
Domiciliary and pre-operative assessments	($98)		
TOTAL DIFFERENCE			**$265**

Other cost components modelled and allocated by the casemix unit represent the averaging out of resource use generated by outliers. For example, neither Emergency Department nor prostheses (Table 3) were used by study participants, although a proportion of these costs was allocated across all DRGs.

Discussion

Comparison of resource use for short stay and conventional pathways for these DRGs is useful only if clinical outcomes and patient satisfaction are shown to be no worse for short stay patients. In fact, significantly lower wound infection rates, lower use of pathology services, and higher patient satisfaction were seen in the short stay group.

In this study, what was known about cost allocation and cost generation for the hospital was analysed with reference to patient separations coded blind into DRGs 320 and 367. More detailed information about the care pathway for patients undergoing herniorrhaphy and laparoscopic cholecystectomy was also sought, particularly with regard to nursing contact time, use of pathology and imaging, and delivering home-based care.

Study patients were grouped by DRGs to strengthen the validity of comparisons. In NSW, casemix data are used predominantly for management and review rather than as a formal basis for resource allocation, although casemix data quantify part of the Area Health Service performance agreements. This distinction is important, as cost modelling techniques are applied retrospectively by individual hospitals to large samples (whole years) of expenditure data. Although resource use variation by separation within DRGs is not explained by modelling, casemix data are likely to provide the most relevant, useful and accurate cost allocation in Australia. Basic cost-generation units (nursing time, ward overheads, laboratory and radiological investigations, visits) were identified and quantified within given clinical pathways, and offset against economies generated by shortened LOS.

The same costing techniques were then applied in a simpler way to the non-inpatient component of care on the re-engineered pathway. However, instead of describing costs per hospital separation, the weighted patient contact was identified as the basic unit of service delivery.

Other costing methods rejected included averaged per diem costs, "clinical costing" and marginal costs. Each costing technique has methodological limitations.

Calculating averaged costs per day is insensitive to different clinical imputs that are not uniformly spread across a surgical separation. However, it is common for authors to use averaged costs per diem (Sadler 1992) or per separation (Hollingworth 1994) for both cost projections and implied savings. However, removing one patient from a ward's throughput will not save the average cost of that separation, as most DRG cost components are either fixed or sensitive only to larger variations in workloads. In other words, the marginal saving is far lower than the average cost per separation.

Marginal costing can show how much will be saved or spent by removing or adding one patient separation to a hospital's budget. However, marginal costs have equally limited application to pathway costing. Measuring the extra cost to a ward or a hospital of one extra case in not generalisable to pathway re-engineering, which requires direct and indirect costs to be modelled for budget planning and day-to-day management of a unit's clinical throughput.

Clinical costing involves a labour-intensive audit of resource use for patients throughout their hospital stay. The current generation of computer costing/billing systems – *Transition* in Victoria and *Trendstar* in NSW – appear to offer comprehensive "bottom up" costing of each patient separation, while actually relying on a series of weighted and fractioned allocations of averaged major cost separation components like nursing to be built into DRG costs. Other overheads include utilities (water and electricity), line management (medical, nursing and non-clinical personnel administration), security and cleaning. Personnel costs must build in paid non-productive time including annual, maternity, Family and Community Service, and leave (study, long service and maternity). Moreover, at the time of this study Trendstar was not effectively in use in the Southeastern Sydney Area Health Service.

Hindle (1999) has argued that significant benefits in healthcare will accrue from analysing standard costs for clinical pathways as well as analysing averages and variances. The high-volume, low-variance nature of the pathways analysed in this paper are particularly suited to that approach.

The linking of casemix data with clinical pathways should encourage clinicians to analyse and make use of the comparisons casemix data provide. The emphasis some managers and systems put on outliers obscures the central fact that the biggest gains in efficiency are to be derived from the high-volume middle of the bell curve – the average separation. Other authors have referred to the need to concentrate on inliers as well as reviewing outliers and complications identified through the use of robust clinical indicators (Hammermeister 1994, Hindle 1999).

The rationale behind clinical pathway development and casemix cost modelling is to take control of the high volume, low variation separations in order to optimise a facility's ability to deal with major trauma and complex medical/surgicalcases. Responsible "resource stewardship" eliminates unnecessary bed occupation and reshapes pathways in ways that take full advantage of improved surgical and anaesthetic techniques and that focus on efficient use of existing resources. By monitoring accepted clinical indicators, the safety and effectiveness of given clinical pathways can be reviewed. Quality improvement, benchmarking and the use of performance indicators are valid tools for improving patient health and satisfaction and reviewing process (Cope 1992, Laffet & Blumenthal, 1989).

The application of epidemiological techniques – statistical analyses over large groups of similar patients – to surgical populations and the focus on quality in healthcare remind us that poor clinical outcomes and complications are frequently the result of process and practice inadequacies and are themselves strong contributors to cost inefficiency (Lasker *et al* 1992). Our previous findings on wound infection rates (Caplan *et al*, 1998) and this analysis of pathology services and costs show that LOS can and should be shortened. The correlation of LOS to adverse events has also been demonstrated by Wilson *et al* (1995).

Every health care item has an opportunity cost (Fuchs 1974). Resources have to be allocated and shifted in short time frames. We would argue that it is preferable to organise services more efficiently than to ration services. In such a context, cost modelling and cost control need to become part of the clinician's armamentarium. In other words, the drive for savings and efficiency is not incompatible with the goal of optimal clinical outcomes. A focus on process and outcomes will lead clinicians to lower complications rates. A shorter length of stay is not an end in itself, but an expression of better hospital utilisation, reduced opportunity for iatrogenesis, and an evolving patient perception of what hospitals are trying to do.

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