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GALLSTONE DISEASE: THE COST OF TREATMENT

Andrew Street
Research Fellow

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The Co-ordinator
Centre for Health Program Evaluation
PO Box 477
West Heidelberg Vic 3081, Australia
Telephone + 61 3 9496 4433/4434 **Facsimile** + 61 3 9496 4424
E-mail CHPE@BusEco.monash.edu.au

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ABSTRACT

This paper presents the methodology and results from the costing analysis of gallstone disease treatments. This was part of a larger cost utility analysis undertaken by the National Centre for Health Program Evaluation. Preliminary results from this are available in Cook, Richardson and Street (1993*a*). Issues relating to the assessment of the outcomes of treatment are discussed in Cook and Richardson (1993*a* and 1993*b*). The final report, which provides an overview of the economic evaluation, is forthcoming (Cook, Richardson and Street 1993*b*).

The present paper discusses the estimation of hospital, patient and indirect costs associated with the three treatment options, open cholecystectomy, laparoscopic cholecystectomy, and extra-corporeal shockwave lithotripsy (ESWL). Results are based on a clinical trial conducted over a three year period at St Vincent's Hospital, Melbourne beginning in 1989. The methodology and various issues arising in the estimation of costs are described in detail.

It was found that when only hospital costs were considered laparoscopic cholecystectomy was unambiguously the least expensive treatment. The inclusion of indirect and patient costs reduced the relative cost advantage of laparoscopic cholecystectomy over ESWL but did not negate it.

Open cholecystectomy had lower hospital costs than ESWL but the inclusion of costs incurred outside the hospital resulted in ESWL being less expensive than open cholecystectomy.

The cost of ESWL varied by stone size and number, the treatment for those with large stones (>20 mm diameter) costing approximately 50% more than for those with small stones (<10 mm diameter).

Gallstone Disease: The Cost Of Treatment

Summary

The paper describes the methodology used to calculate the cost of three treatments for gallstone disease. Although the theoretical underpinning of costing in economic evaluation is reasonably well established, in general there is a paucity of information about how to deal with the inevitable practical problems which arise. In this paper, where there is dispute about the basis for costing or where it has been possible to arrive at different cost estimates by changing the assumptions underlying the calculation, details have been provided of the alternative approaches and the costs derived. As a consequence, the paper is of length and level of detail unusual for costing reports. It is hoped that this will prove useful to those who have to undertake their own costing and who require a point of reference for translating theory into practice. However, other readers may value a brief description of the study and its findings without the distraction of fine detail. The following summary is intended to provide this overview and serve as a reference to the main text.

Introduction

A comparison of three treatments for gallstone disease was conducted at St. Vincent's Hospital, Melbourne, Australia over a three year period from 1989 to 1992. 100 patients who had the conventional treatment, open cholecystectomy, were compared to 99 patients treated with the new surgical technique, laparoscopic cholecystectomy, and 454 patients who received the non-invasive procedure, extra-corporeal shockwave lithotripsy (ESWL). The following summarises the methodology used in calculating the costs of the three treatments.

The economic cost of treatment includes the direct cost to the health system, the patient and their families, and the indirect cost arising from the loss of (paid or unpaid) productive activity. It is important to identify those costs arising as a result of treatment, rather than those which would have occurred anyway because the patient was ill. In other words, the objective is to evaluate the *consequences* of treatment, not the *costs* of illness.

There are two broad approaches to costing. First, global estimates may be made of the total cost of each cost component from aggregate data, and average patient costs derived by simple division. Alternatively, costs may be attributed to the individual patient, and average costs calculated after summation of individual patient costs. The latter approach has been used in this study as it permits analysis of cost differences by patient characteristics, and in particular for ESWL patients, stone size.

Hospital data was collected by the St Vincents' biliary lithotripsy unit which recorded patient specific treatment details. This allowed investigation of cost variation between patients as well as between treatments.

This information was supplemented by questionnaires sent to patients in March 1992. Among other things, patients were asked about the time lost, number of journeys made to hospital, and amount of additional care received because of their treatment and recovery.

Accordingly, estimates were made of the following:

1. Hospital costs; including medical, theatre, diagnostic tests, nursing, overheads, capital and pharmacy;

2 Patient costs; including transport and travel time, and costs borne by carers; and

3. Indirect costs; including the loss of paid and unpaid activity.

Where appropriate, two sets of figures are presented in the paper as estimates of the cost of these items, depending on the assumptions underlying the calculation. For example, staff costs might vary according to the grade of staff undertaking the duties. If resource use differs between procedures, changing the basis for calculation of their costs might alter the cost ranking of the treatments relative to one another. The two sets of estimates are used for the sensitivity analysis described in the overview paper. This summary reports only upper cost estimates, unless otherwise indicated. Figures in parentheses are standard deviations.

HOSPITAL COSTS: OPEN AND LAPAROSCOPIC CHOLECYSTECTOMY.

Introduction

Open and laparoscopic cholecystectomy costs were calculated using data specific to individual patients. The patient protocols recorded details including the number of diagnostic tests, the type and dosage of medication received, and the main indicators of resource use for these patients, operation time and length of stay. Laparoscopic cholecystectomy patients typically had a longer operation than those who had open surgery, the operation lasting 82 minutes (± 32) compared to 70 minutes (± 22). This difference was significant ($p<0.01$). Operating time was used to calculate the cost of the surgeon and theatre staff. Nursing costs, and ward and hospital overheads varied according to length of stay. On average, open cholecystectomy patients were in hospital for 8.8 days (± 2.2) compared to 5.6 days (± 2.8) for laparoscopic cholecystectomy patients. This difference was significant ($p<0.001$).

Medical and theatre costs

The cost of the surgeon and other staff was calculated assuming that all were public patients. Two figures are presented as estimates of surgeon costs, depending on the sessional salary scale the surgeon may have been on. Inter-patient variation primarily reflects differences in operating time, but is also a result of differences in length of stay. The average cost of the surgeon amounted to $191 (± 23) for open cholecystectomy and $187 (± 33) for laparoscopic cholecystectomy. Differences between

patients in the cost of theatre staff are fully explained by differences in the length of the operation. The average cost of theatre staff was $291 (± 52) and $318 (± 75) for open and laparoscopic cholecystectomy respectively.

The costs of anaesthetics, consumables and instruments were calculated for each procedure, amounting to $255 and $319 for open and laparoscopic cholecystectomy respectively. The capital cost of the theatre was estimated as $69 per operation.

The cost of diagnostic and laboratory tests

A variety of tests were conducted on patients undergoing the two procedures. Details were recorded in the protocols and costed using the benefit of 75% of the schedule fee in the Commonwealth Medical Benefits Schedule (CMBS) as an approximation. The average cost was estimated as $180 (± 75) and $182 (± 96) for open and laparoscopic cholecystectomy respectively.

Nursing costs

Two methods could be used to estimate the cost of nursing staff. The first would be to calculate a *per diem* cost, by dividing the nursing salary bill by the total number of bed days for a given period, and multiplying by the length of stay for each patient in the study. However, nursing costs vary both by length of stay and the *intensity* of care required. For any given day in hospital, cholecystectomy patients might require different amounts of nursing time than patients admitted with other conditions. To account for this, estimates of nursing costs were calculated using the hospital's patient dependency system. For each shift spent at a particular dependency level, the patient's time requirement of each category of nursing staff was multiplied by the hourly employment cost for that shift and nursing category. When the costing was conducted the actual dependencies of patients in the study were no longer available, so the shift specific dependency level costs were applied to more recently treated open and laparoscopic cholecystectomy patients to derive an average daily nursing cost. The estimates varied according to assumptions about the type of ward and the nursing salary scales, and two sets of figures are presented in the paper to demonstrate the effect of varying the basis for estimation. These average daily nursing costs were then applied to patients in the study, according to their lengths of stay.

For a given day in hospital cholecystectomy patients appeared to be less intense users of nursing time than patients in general. The difference in average daily nursing costs for open compared to laparoscopic patients was not marked. However, because open cholecystectomy patients spent longer in hospital, total nursing costs were greater for this procedure than for laparoscopic cholecystectomy. Depending on the underlying assumptions, total nursing costs amounted to $984 (± 241) for open cholecystectomy and $588 (± 290) for laparoscopic cholecystectomy.

Overheads

Ward overheads include nursing allowances, consumables, laundry, and floor space. As with nursing costs, the estimate of the cost of ward overheads varied according to type of ward, and figures for two wards are presented in the paper. The costs of catering, cleaning, electricity, and administration were included in the estimate of hospital overheads. Average total overhead costs were calculated as $1,286 (± 314) for open cholecystectomy and $814 (± 402) for laparoscopic cholecystectomy, the difference attributable to differences in average length of stay for the two procedures.

Pharmacy costs

The patient protocols recorded information on the type and amount of medication prescribed for each patient. Costs were estimated using the buying guide of the Victorian Hospital's Association (VHA). Pharmacy overheads were assigned according to length of stay.

Total hospital costs

Average total hospital costs amounted to $3,366 (± 603) for open cholecystectomy and $2,581 (± 820) for laparoscopic cholecystectomy. The cost difference between treatments was significant ($p<0.001$). The estimate of the cost of laparoscopic cholecystectomy does not include the cost associated with conversion to an open procedure during the operation.

HOSPITAL COSTS: EXTRA CORPOREAL SHOCKWAVE LITHOTRIPSY.

Introduction

ESWL patients were treated as out-patients. Following their initial consultation, patients received a number of treatments on the lithotripter. They returned to the biliary lithotripsy unit periodically for follow-up, where the size of the stone was monitored and further treatments may have been suggested. Patients were prescribed bile salts to facilitate the dissolution and removal of stone fragments. It is hypothesised that the cost of ESWL is influenced by the number and size of gallstones, those with smaller stones requiring fewer sessions on the lithotripter, fewer follow-up visits, and less litholytic therapy to dissolve stone fragments. Costs were compared for patients grouped on the basis of stone size into the following categories: small stones of less than 10 mm diameter, medium stones of between 10 mm and 20 mm diameter, large stones of greater than 20 mm diameter, and multiple stones.

Treatment costs

The costs of the physician, ultrasonographer and nurse were estimated according to the time each typically spent with the patient, and assuming treatment time on the lithotripter was the same for all patients. Staff costs were estimated as $185 per lithotripsy treatment.

The costs of diagnostic tests, medication and floor space were calculated as they were for the surgical treatments. The cost of hospital overheads was estimated as approximately 20% of the cost of per bed day, on the basis of the average time it takes to perform an episode of ESWL.

The lithotripter and colour doppler cost $2,056,538 when purchased in 1989. In calculating the equipment cost per operation it was assumed that the lithotripter had a useful life of five years, two electrodes were used per treatment, there was a throughput of 1000 treatments per year, and the discount rate was 7%. The equipment cost per treatment amounted to $1,284. If the machine lasted ten years and only one electrode was necessary, the cost per treatment would amount to $802.

The treatment cost per patient varied according to the number of treatments necessary. On average patients required 1.5 ESWL treatments. The average treatment cost amounted to $2,406 (± 1,074) for all ESWL patients. This average cost varied from $1,831 (± 596) for those with small stones (less than

10 mm in diameter) to $3,085 (± 1,140) for those with large stones (greater than 20 mm in diameter). Treatment costs were significantly different between stone categories ($p<0.001$).

Follow-up costs

ESWL patients returned for follow-up in the first two weeks after treatment, six weeks later, and thereafter at intervals of approximately three months. Follow-up continued until the patient was declared stone free or surgery was recommended. Patients had an average of five follow-up sessions. The cost of follow-up was calculated according to the number of sessions attended and the tests conducted during the examination, and amounted to an average $370 per patient. This ranged from $345 for those with small stones to $480 for those with large stones.

Litholytic therapy

Litholytic or bile salt therapy represents a significant proportion of the cost of ESWL. The medication was taken to dissolve the stone fragments which remain after ESWL treatment. Patients were prescribed chenodeoxycholic acid (Chendol) according to their body weight. Protocols recorded dosages and time spent on the medication. A number of patients (8.4%) did not return for follow-up and the time spent on medication for these is unknown. Chendol was costed using the VHA buying guide. On average, excluding those lost to follow-up, the cost of litholytic therapy amounted to $1,094 (± 769). The average ranged from $1,044 (± 790) for those with small stones to $1,359 (± 729) for those with large stones. However, no two groups had significantly different medication costs.

Total hospital costs

The average total hospital costs of ESWL was estimated as $4,007. The average amounted to $3,356, $3,896, $5,061, and $4,171 respectively for those with small, medium, large, and multiple stones.

PRIVATE PAYMENTS.

Although all those receiving ESWL were treated as public patients (irrespective of their insurance status), those having surgery were a mix of public and private patients. Private payments for the physician, assistant at the operation, and the anaesthetist were determined using Health Insurance Commission data from the fourth quarter of 1991 to calculate the average benefits paid and fees charged for services rendered. Average total charges were calculated as $829 for open cholecystectomy, $1050 for laparoscopic cholecystectomy, and $787 for ESWL. The patient co-payment was 37% of the total charge for cholecystectomy and 40% of the total charge for ESWL. However, these estimates have not been used in the calculation of the cost of the three procedures.

INDIRECT AND PATIENT COSTS.

Introduction

In March 1992, questionnaires were sent to patients in the trial. An overall response rate of 74% was achieved. Among other things, patients were asked about the lost time, travel, and additional care related to their treatment and recovery.

Indirect costs

Indirect costs are defined as the production losses resulting from treatment because the patient is unable to return to normal activity while recovering. On average, open cholecystectomy patients were unable to engage in normal activity for over four weeks after treatment, compared to two weeks for those who had laparoscopic cholecystectomy, and less than four days for those who had ESWL. Patients were categorised as being in the paid work force, occupied by home duties or retired/unemployed.

The cost of days lost to paid activity was estimated using average weekly earnings for those in the paid work force. A number of patients estimated that no time was lost to paid activity because they were financially compensated for their time off work. However, because the loss of production is borne somewhere in the economy, if not to the patients directly, cost estimates have been presented to account for this. The productive loss associated with time lost to home duties was estimated using both the replacement cost and opportunity cost methods. No *productive* value was attributed to those categorised as unemployed or retired, as the effects of treatment on non-productive time is subsumed in the outcome measure.

The proportion of patients in each occupation differed for open cholecystectomy from the other treatments, which introduces bias to the cost estimates. To overcome this, the same work force composition was assumed for each patient group, as would occur in a randomised control trial. On average, indirect costs amounted to $2,564 (± 3,869) for open cholecystectomy, $1,123 (± 1,338) for laparoscopic cholecystectomy, and $321 (± 503) for ESWL. These differences were significant for each treatment group ($p<0.001$).

Travel costs

Patients were asked about the number of trips made to hospital, and the mode of transportation used. Travel costs included the cost of transportation and time spent travelling. Transportation costs were estimated assuming journeys were undertaken by public transport or private car. The cost of travel time was estimated at 40% of average weekly earnings. Average travel costs amounted to $97 (± 74), $81 (± 55), and $175 (± 116) for open cholecystectomy, laparoscopic cholecystectomy, and ESWL respectively. ESWL mean costs were significantly higher than the mean costs of the two surgical procedures on account of the greater number of trips made ($p<0.001$).

Costs borne by carers

Patients were asked whether they had been assisted and cared for after discharge from hospital. Very few patients required additional professional care, and the cost of this care was minimal for each treatment. However, many patients indicated that they were cared for by relatives and friends. The cost of days lost by carers was calculated using the opportunity cost and replacement cost approaches. On average, the replacement cost of additional care amounted to $881 (± 2,066) for open cholecystectomy, $307 (± 662) for laparoscopic cholecystectomy, and $69 (± 145) for ESWL. Between group differences were significant ($p<0.001$), with the mean cost of care for open cholecystectomy significantly different to that for both laparoscopic cholecystectomy and ESWL.

Total indirect and patient costs

Average indirect and patient costs amounted to $3,556 for open cholecystectomy, $1,518 for laparoscopic cholecystectomy, and $575 for ESWL. For ESWL patients, the average amounted to $453, $599, $786, and $492 respectively for those with small, medium, large, and multiple stones.

CONVERSION TO OTHER PROCEDURES.

It was estimated that 10% of patients undergoing laparoscopic cholecystectomy would have to convert to open cholecystectomy during the course of the operation for technical reasons. After adjustment for the higher cost of converted patients, the average cost of laparoscopic cholecystectomy was estimated as $4,422.

Of the 454 patients who received ESWL, 20% were subsequently admitted for surgery. It has been assumed that patients having surgery had laparoscopic cholecystectomy with a 10% probability of conversion to the open procedure. The average cost of ESWL for all patients including those who have subsequent surgery was estimated as $5,536.

CONCLUSION.

The average hospital costs of open cholecystectomy, laparoscopic cholecystectomy, and ESWL amounted to $3,366, $2,699, and $4,617 respectively. With the inclusion of indirect and patient costs, the total cost of each treatment amounted to $6,922, $4,422, and $5,536 respectively. The average cost of ESWL varied considerably depending on stone size, those with large stones incurring total costs approximately 50% higher than those with small stones.

When only hospital costs are considered, laparoscopic cholecystectomy is unambiguously the least expensive procedure. The inclusion of indirect and patient costs reduces its cost advantage relative to ESWL, although it remains the cheaper option. ESWL has a cost advantage over open cholecystectomy for all patients except those with large stones. However, if only hospital costs are considered, open cholecystectomy is a cheaper option than ESWL for all stone categories. The inclusion of indirect and patient costs may reverse the choice of procedure if these were the only treatment options and the outcomes secured were similar. This demonstrates that an efficient allocation of resources within the hospital sector might be sub-optimal socially.

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1 Introduction

1.1. Gallstone Disease and its Treatment.

It has been estimated that 25% of women and 20% of men will have gallstones at some stage of their lives (Harding Rains, 1981). The conventional treatment for gallstone disease is open cholecystectomy, whereby the gallbladder is surgically removed. About 25,000 open cholecystectomies are performed annually in Australia (Hailey and Hirsch, 1991). Post-operative morbidity is high, and the recovery period is lengthy. The treatment of gallstone disease has changed rapidly in recent years with the advent of two new technologies.

Extracorporeal shockwave lithotripsy (ESWL) was first used to treat gallstones in (West) Germany in 1986 (Sackmann *et al*, 1991). Although originally used to treat kidney stones, several types of lithotripter have been developed to treat gallstones (National Health Technology Advisory Panel, 1988). The procedure is non-invasive, with shockwaves directed to fragment the gallstone. The shockwaves are transmitted from the lithotripter through a column of water to the patient's body. (Early lithotripters transmitted through a water bath in which the patient was suspended). Following ESWL, patients take litholytic therapy (bile salts) to dissolve and remove the fragments from the body.

Laparoscopic cholecystectomy is the most recent technology, and was first used in France in 1987 (Dubois *et al*, 1989). The procedure is minimally invasive, with four small incisions made to allow removal of the gallbladder. The operation is performed by viewing the abdominal cavity on video monitors, the image carried via an endoscope. Studies suggest that the technique has a shorter hospital stay and facilitates an earlier return to normal activity than does conventional surgery, resulting in a reduction in hospital, patient, and indirect costs (Gadacz and Talamini, 1991; Olsen, 1991; Cushieri *et al*, 1991) .

1.2. Literature Review.

The development of ESWL and laparoscopic cholecystectomy has created a recent explosion in the literature on gallstone treatment. Much of this focuses on the clinical and technical aspects of the treatments. A review of the literature relating to patient outcomes is presented in the companion paper by Cook and Richardson (1993*a*). A few studies consider the cost implications of treatment, and these are reviewed below. The studies fall into two groups: those which compare open cholecystectomy with ESWL; and those comparing open cholecystectomy with laparoscopic cholecystectomy. No studies were found which discussed all three treatments.

i) Open cholecystectomy versus ESWL.

In a study by Nicholl *et al* (1992) 163 patients were randomised to ESWL and open cholecystectomy. ESWL was performed as an in-patient procedure. Both treatments yielded positive health gains, but few differences between treatments were found. Health service and patient time costs were considered. ESWL appeared to be at least as cost-effective as open cholecystectomy for patients with small stones (less than $4cm^3$), but less cost-effective for those with large stones.

Rothschild *et al* (1990) compared 48 patients undergoing open cholecystectomy with 18 undergoing ESWL, all of whom were treated as in-patients. The average cost of hospitalisation was $6,240 (A$8,636, 1992 prices) for open cholecystectomy and $8,100 (A$11,211) for ESWL. However, ESWL was less costly when the difference in the time taken to return to work was considered. On average, open cholecystectomy patients took five weeks to return while ESWL patients took only three days. It was suggested that if ESWL were provided on an out-patient basis the hospital costs would be lower.

Bass *et al* (1991) reported a comparison of open cholecystectomy and ESWL in terms of their cost-effectiveness for patients with symptomatic gallstones. A computer simulation was used to examine the clinical and economic outcomes of each treatment. Probabilities for the possible outcomes of treatment were estimated from the literature, utility scores were provided by clinicians, and direct charges to insurers were used for costing. ESWL charges were estimated by enumerating professional and facility related services associated with provision of the treatment on an out-patient basis. It was concluded that ESWL was more cost-effective than open cholecystectomy for elderly than young patients, for patients with single than multiple stones, and for men than women.

ii) Open cholecystectomy and laparoscopic cholecystectomy.

Cushieri *et al* (1991) conducted a retrospective study in seven European centres where 1,236 laparoscopic cholecystectomies had been performed. The treatment was found to be an eminently safe procedure when performed by trained surgeons. Compared to open cholecystectomy, laparoscopic cholecystectomy drastically reduced the convalescence period. It was suggested that the cost saving per patient was £900 (A$2,012). It was unclear whether this was a saving to society or to the health system only.

Peters *et al* (1991) studied one hundred laparoscopic cholecystectomies, demonstrating that the procedure could be performed as safely as open cholecystectomy for patients with symptomatic gallstone disease. The mean hospital charge for these patients was $3,620 (A$4,731). This compares to a mean charge of $4,251 (A$5,555) for 58 patients who had open cholecystectomy.

1.3. The St Vincent's Trial.

A comparison of the three treatments for gallstone disease was undertaken at St Vincent's Hospital, Melbourne, Australia over a three year period from 1989 to 1992. Although initially planned as a to comparison of open cholecystectomy and ESWL, the study was broadened to include laparoscopic cholecystectomy, which was introduced at the hospital at the end of 1990.

A randomised controlled study was not undertaken because it was envisaged that there would be difficulty securing agreement to randomisation from patients and referring specialists, and that the randomisation criteria would not be consistently followed (Hailey and Hirsch, 1991). ESWL was given to all patients who satisfied the selection criteria and who were willing to accept the treatment. The St Vincent's study was based upon a `quasi trial' in which patients were selected for inclusion in the study according to certain criteria designed to make the comparisons valid. The inclusion and exclusion criteria are presented in Cook and Richardson (1993*a*). While these criteria may have achieved comparable samples to answer the clinical question about respective outcomes, other patient characteristics are relevant for the costing study, in particular, patient age, which effects work force participation, and body weight, which effects bile salt dosage.

Detailed hospital data was collected for each patient by the St Vincent's biliary lithotripsy unit. This information was supplemented by questionnaires which were sent to patients in March 1992. 454 patients who received ESWL, were compared with 100 patients who had open cholecystectomy, and 99 patients who had laparoscopic cholecystectomy. Of all patients 72.6% were female. All those undergoing ESWL were treated as public patients, whereas 32.8% of the patients having surgery were private patients. This discrepancy does not indicate bias because ESWL was only offered on a public basis irrespective of the patient's insurance status.

Table 1.1 compares patients in terms of their sex, age, and weight. No statistically significant differences were found among the treatment groups in terms of the gender, age or weight of the patients (p<0.05).

Table 1.1
SUMMARY OF PATIENTS IN THE STUDY

Sex	Male			Female		
Procedure	*Open Cholecystectomy*	*Laparoscopic Cholecystectomy*	*ESWL*	*Open Cholecystectomy*	*Laparoscopic Cholecystectomy*	*ESWL*
Sample size	*25*	*26*	*128*	*74*	*72*	*326*
Public/private[1]	20/5	15/10	128/0	50/24	44/24	326/0
Age[1]	*24*	*26*	*127*	*74*	*72*	*321*
mean	53	47	53	46	49	49
median	52	41	53	49	49	48
std dev	± 15	± 16	± 14	± 15	± 15	± 16
range	20 - 79	19 - 79	28 - 80	18 - 72	14 - 77	16 - 81
Weight[1]	*22*	*24*	*119*	*59*	*72*	*302*
mean	76	77	83	74	71	71
median	75	78	80	70	68	68
std dev	± 13	± 15	± 15	± 16	± 16	± 17
range	52 - 105	47 - 110	52 - 138	47 - 110	41 - 147	41 - 176

[1] numbers vary according to the information on each variable for patients.

ESWL patients were treated on an out-patient basis, and had up to three sessions on the lithotripter (only one patient had four sessions) *(table 1.2)*. If the stone was not cleared following ESWL, the patient had a cholecystectomy. The ESWL sessions took place between 26/07/89 and 01/04/92. The open cholecystectomy patients were all treated between 28/07/89 and 03/01/91, overlapping with those treated by laparoscopic cholecystectomy, all of whom were treated between 30/11/90 and 24/06/91. These dates do not correspond and, in particular, open cholecystectomies were carried out significantly earlier than the laparoscopic cholecystectomies. This was the inevitable consequence of the progression of technology. Open cholecystectomy was replaced very rapidly by the laparoscopic procedure and, as a consequence, data on patients in the former group had to be constructed retrospectively. The implications of this are discussed in Cook and Richardson (1993*a*).

Table 1.2
NUMBER OF TREATMENTS RECEIVED BY ESWL PATIENTS

Number of treatments	1	2	3	4
Number of patients	258	147	48	1

1.4. Outline of the paper.

This paper describes how the cost of each treatment was estimated. Costing may be carried out in one of two ways. First, global estimates may be made of the total cost of each cost component from aggregate data, and average patient costs derived by simple division. Secondly, costs may be attributed to the individual patient, and average costs calculated by the summation of individual patient costs. This latter approach has been used as it permits analysis of cost differences by patient category, and, in particular for ESWL patients, stone size. This facilitates sensitivity analysis. In some cases this approach was not possible because insufficient information was collected at the time treatment was received. Where this is the case the sample of patients for whom information was available is indicated.

The economic cost of treatment includes the direct cost to the health system, the patient and their families, and the indirect cost arising from the loss of (paid or unpaid) productive activity. Sections 2 and 3 describe the hospital costs which were allocated directly to cholecystectomy and ESWL patients respectively. Data on patient characteristics and resource use was collected on protocols for individual patients by the biliary lithotripsy unit. These protocols recorded details of, for instance, the number and type of diagnostic tests, operating theatre time, medication received, and length of stay.

Estimates of the direct costs borne by patients and their families, and of indirect costs, were made using information gathered from a patient questionnaire. These costs are addressed in section 4.

Section 5 deals with further considerations and refinements to the results which were not accounted for within the structure of the study, including the effect on costs of patients changing treatment modalities (ESWL to cholecystectomy; laparoscopic to open cholecystectomy) for medical reason during treatment.

2. HOSPITAL COSTS: OPEN AND LAPAROSCOPIC CHOLECYSTECTOMY.

2.1. Introduction.

In this section the hospital costs associated with open and laparoscopic cholecystectomy are discussed. Most of the data on which the calculations are based are specific to individual patients. For example, the protocols designed by the biliary lithotripsy unit recorded details of the diagnostic tests conducted for each patient, or the type and dosage of medication received. Length of stay was the main indicator of nursing and overhead costs, and operating time was used to calculate surgeon and theatre staff costs.

Tables 2.1 and 2.2 provide details of the length of stay and operating time for open and laparoscopic patients. The mean length of stay was 8.8 days (± 2.2) for those who had open cholecystectomy and 5.6 days (± 2.8) for those who had laparoscopic cholecystectomy *(table 2.1)*. This difference was significant (p<0.001). Patients undergoing the laparoscopic procedure typically had a longer operation than those who had open surgery, 81.9 minutes (± 32.3) compared to 70.2 minutes (± 22.4) *(table 2.2)*. This difference in operating times was significant (p<0.01).

Table 2.1
AVERAGE LENGTH OF STAY

Procedure	***Open Cholecystectomy (days)***			***Laparoscopic Cholecystectomy (days)***		
Sex	*All*	*Male*	*Female*	*All*	*Male*	*Female*
Number	*100*	*25*	*74*	*99*	*26*	*72*
mean	8.8	9.2	8.7	5.6	5.8	5.5
standard deviation	± 2.2	± 2.4	± 2.1	± 2.8	± 3.3	± 2.6
mode	7	8	7	4	4	4
range	5 - 16	6 - 16	5 - 16	2 - 17	3 - 17	2 - 16

Table 2.2
AVERAGE OPERATING TIMES

Procedure	***Open Cholecystectomy (minutes)***			***Laparoscopic Cholecystectomy (minutes)***		
Sex	*All*	*Male*	*Female*	*All*	*Male*	*Female*
Number	*100*	*25*	*74*	*99*	*26*	*72*
mean	70.2	69.3	70.6	81.9	73.5	85.1
standard deviation	± 22.4	± 24.8	± 21.9	± 32.3	± 24.0	± 34.7
mode	60	50	50	60	80	60
range	30 - 150	40 - 150	30 - 140	25 - 220	45 - 150	25 - 220

21 open cholecystectomy patients and 13 laparoscopic cholecystectomy patients suffered post-operative complications *(table 2.3)*. The costs associated with complications will be captured in the assessment if they resulted in an extended hospital stay or additional resource use, such as medication.

Table 2.3
OPEN AND LAPAROSCOPIC PATIENTS SUFFERING COMPLICATIONS

	Open Cholecystectomy			***Laparoscopic Cholecystectomy***		
Complications	*All*	*Male*	*Female*	*All*	*Male*	*Female*
number (%)[1]	21 (24.1)	10 (45.5)	11 (16.9)	13 (13.3)	5 (19.2)	8 (12.5)
pulmonary	6	3	3	1	0	1
cardiac	2	1	1	1	0	1
abdominal	1	1	0	4	1	3
wound infection	5	3	2	6	3	3
urinary	9	5	4	3	2	1
central nervous system	3	1	2	0	0	0

[1] The total number of patients suffering complications is less than the total number of complications because some patients experienced more than one complication.

2.2. The Surgeon.

Both public and private patients received open and laparoscopic cholecystectomy. Payments to surgeons differ according to the insurance status of the patient. Private payments are discussed in appendix A1. In the following it is assumed that all patients were public.

The hospital pays doctors for treating public patients on a sessional basis, each session being of four hours duration. Table 2.4 shows the hourly rates for those surgeons who performed the operation on the patients in the study, together with the percentage of all cholecystectomy patients treated by surgeons at each scale. For 19.6% of patients the identity of the surgeon was not recorded. Of the remainder, 20.6% were operated on by a surgeon at scale MW5, and 58.3% by a surgeon at scale MW8.

Table 2.4
SURGEON SALARY SCALES
effective 01/11/91

Scale	Hourly Rate ($)	Patients treated (%)
MV8	35.71	1.0
MW5	47.17	20.6
MW6	49.07	0.5
MW8	51.08	58.3

The hourly rates for these scales were applied to all patients to derive estimates of the surgeon cost of the initial consultation and of treatment in theatre. It was estimated that a consultation including physical examination and review of investigations took thirty minutes, and this time was applied uniformly to all patients undergoing surgery.

With respect to the cost of the surgeon in theatre, in addition to the time of the operation, it was estimated that surgeons typically spend fifteen minutes in preparation for the operation, involving the injection of local anaesthetic, insertion of the bladder catheter, marking sites for incision, and checking

the equipment. After the operation, three quarters of an hour is spent cleaning up and in "down time" before another patient can be admitted to theatre. To account for this, an hour was added to the recorded operation time for all patients.

After the operation the surgeon would have visited the patient on the ward, spending about five minutes with them for each post-operative day the patient was in hospital.

Table 2.5 shows the estimates of surgeon costs. These estimates include 15% for on costs, such as superannuation and WorkCare payments. The upper estimates are based upon the surgeon being at scale MW8, while the lower estimates incorporate the assumption that the surgeon was on salary scale MW5. Standard deviations reflect the length of the operation. For open cholecystectomy patients the average cost of the surgeon ranged from $177 to $191, while for laparoscopic patients the range was from $173 to $187.

Table 2.5
AVERAGE COST OF THE SURGEON

Procedure	***Open Cholecystectomy***		***Laparoscopic Cholecystectomy***	
	Lower estimate ($)	*Upper estimate ($)*	*Lower estimate ($)*	*Upper estimate ($)*
mean	177	191	173	187
median	172	186	167	181
standard deviation	± 21	± 23	± 31	± 33
range	136 - 258	147 - 279	118 - 303	127 - 328

2.3. Diagnostic and Laboratory Tests.

2.3.1. Diagnostic tests.

A variety of tests were conducted on patients undergoing both elective procedures. Information on whether or not the test was performed on individual patients was not always recorded. In these cases it was assumed that patients had the same number of tests as those for whom information was available. Table 2.6 shows the proportions of open cholecystectomy and laparoscopic cholecystectomy patients who had tests of various kinds.

The cost of diagnostic tests has been approximated using the benefits payable for the relevant item number in the Commonwealth Medicare Benefits Schedule (CMBS). The benefit (at 75% of the schedule fee) has been used, since this is the payment applicable for professional services provided in hospital. Appendix table B1 provides the CMBS item number, schedule fee and 75% benefit for the tests and investigations which were conducted.

It is debatable whether or not the CMBS fees reflect the true economic cost of performing such tests. However the estimate is unlikely to cause bias because a similar number of tests were conducted on patients undergoing each treatment. Apportioning more accurate figures would adjust the absolute cost of performing the procedures but have little effect on their relative costs.

The total costs of these diagnostic tests amounted to an average of $131 (± 75) for open cholecystectomy patients and $133 (± 96) for laparoscopic cholecystectomy patients.

Table 2.6
DIAGNOSTIC TESTS AND INVESTIGATIONS

Test or Investigation	***Open Cholecystectomy number (%)***	***Laparoscopic Cholecystectomy number (%)***
Plain film of abdomen	36/85 (42)	19/98 (19)
Oral cholecystectogram	32/86 (37)	28/98 (29)
Ultrasound	82/87 (94)	91/97 (94)
Isotope biliary scan	13/86 (15)	19/97 (20)
CT abdomen	2/86 (2)	7/98 (7)

2.3.2. Laboratory tests.

All patients had a full blood examination (FBE), an electrolytes and urea test (E&U), a liver function test (LFT), and an estimation of prothrombin time (INR). Appendix table B1 shows the CMBS fees and benefits payable for the various tests. $46.90 has been applied to all patients as an approximation of the cost of the FBE, E&U, LFT and INR tests, this being the sum of the benefits for these tests. All women of childbearing age had a pregnancy test, which has a benefit of $7.65.

2.3.3. The average total cost of tests.

The average cost of all diagnostic and laboratory tests and investigations was estimated as being $180 (± 75) for open cholecystectomy patients and $182 (± 96) for laparoscopic cholecystectomy patients.

2.4. Operating Theatre.

2.4.1. Staff.

Appendix table B2 shows the medical, nursing and auxiliary staff in attendance at the operation, and their weekly salaries. A discussion of the cost of the surgeon was presented previously. Appendix A1 addresses private payments for the anaesthetist and assistant to the surgeon. Some staff were present for the duration of the operation only. The salary costs of these staff were applied according to the length of the operation. Other staff prepared the theatre before the patient's arrival, were present for the operation, and cleared up afterwards. It was estimated that, independent of the operation time, a total of 45 minutes were spent setting up equipment for the operation and cleaning up afterwards, and that it took 30 minutes taking the patient to and from the theatre. These times were applied to staff undertaking such duties.

Both the charge nurse and recovery room nurse divided their time between duties. The charge nurse had responsibilities in two theatres, and the recovery room nurse cared for two patients in recovery. The salary costs for these staff were calculated at 50% of the relevant time period. The time spent by

patients in the recovery room was estimated from theatre records of open and laparoscopic patients as being an average of 45 minutes.

Table 2.8 shows the average cost of theatre staff, including on costs, as being $291 (± 52) for open cholecystectomy and $318 (± 75) for laparoscopic cholecystectomy.

Table 2.8
AVERAGE COST OF THEATRE STAFF

Procedure	Open Cholecystectomy ($)	Laparoscopic Cholecystectomy ($)
mean	291	318
median	267	302
standard deviation	± 52	± 75
range	198 - 477	186 - 639

2.4.2. Non-salary operating theatre costs.

i) Anaesthetic equipment and anaesthetics.

Details of the resources used in providing the anaesthetic are provided in appendix table B3. These costs amount to $63, and do not differ according to procedure. However, patients having open cholecystectomy were administered pethidine and I-med in theatre, the cost of which amounted to $14 per patient. Details of the anaesthetics are provided in appendix table B4. The cost of other types of medication received during the hospital stay is addressed in section 2.6.

ii) Consumables.

Details of the consumables used for open and laparoscopic cholecystectomy are shown in appendix tables B4 and B5 respectively. The cost of consumables used in an operation amounts to $161 for open cholecystectomy and $159 for laparoscopic cholecystectomy.

iii) Equipment.

The cost of reusable equipment used in performing an open cholecystectomy was estimated at $17 per patient. Details are presented in appendix table B4. On the advice provided it has been assumed that the camera equipment and other reusable instruments used for the laparoscopic operation could be used for 100 weeks for six procedures a week each lasting approximately two hours. The cost of the equipment has been applied to individual patients by dividing the total figure by 600. The cost of reusable instruments amounts to $22 and that of the laparoscopic system to $76 per patient. Itemised details are presented in appendix tables B6 and B7.

Table 2.9 presents the total per patient cost of anaesthetics, consumables and equipment used in performing open and laparoscopic cholecystectomy. These amount to $255 and $319 respectively.

Table 2.9
NON-SALARY OPERATING THEATRE COSTS

	Open cholecystectomy ($)	Laparoscopic cholecystectomy ($)
Anaesthetic equipment	63	63
Additional anaesthetics	14	0
Consumables	161	159
Instruments	17	22
Laparoscopic system	0	76
Total per patient[1]	255	319

[1] Totals may not amount to the sum of the components because of rounding.

2.4.3. Capital.

The allocation of capital costs requires that the costs of the lost opportunity entailed by the investment of the capital and the depreciation of the asset itself are taken into account. The opportunity cost amounts to what would have been realised had the capital sum been invested in an alternative project. This is estimated by applying an interest rate to the capital sum. Because capital assets wear out over time, the cost of their depreciation must be considered also.

Although there are a number of methods for calculating capital costs, the method generally preferred is to calculate the `equivalent annual cost' (Drummond, Stoddart and Torrance, 1987). This incorporates both the depreciation and opportunity costs by annuitizing the initial capital outlay over the asset's useful life. The annual sum (E) will be equivalent to the capital sum (K) over a period of n years at an interest rate of r. The annuity factor A expresses the annual equivalent cost for different values of r and n, and are available in published tables. The formula for calculating the equivalent annual cost is:

$$E = K / A\ (n,r)$$

The cost of building an operating theatre, including administrative areas, anaesthetic rooms and recovery rooms, was estimated at $850,000 by the Victorian Health Department at 1992 prices. Although the theatre would be expected to last 60 years, refurbishment and renovation would be expected every ten years, at a cost of 40% of the initial capital outlay. In this case, therefore, the asset is to be depreciated over ten years, after which time equipment worth 60% of the original value is to remain. Therefore, adjustment is required to account for the resale value (S). To do this, the resale value needs to be discounted back to the present because it is preferable to receive a benefit earlier rather than later. Discount factors $(1 + r)^{-n}$ are also available for various values of r and n. The revised formula becomes:

$$E = [K - S\ (1 + r)^{-n}] / A\ (n,r)$$

Thus:
$$E = K\ [1 - 0.6\ (1 + r)^{-n}] / A\ (n,r)$$

$$= [K / A\ (n,r)] * [1 - 0.6\ (1 + r)^{-n}]$$

= [$850,000 / 7.0236] * [1 - 0.6 (0.5083)]

= $84,112

This equivalent annual cost has been allocated to the patients assuming that the cost is the same per operation (i.e. no adjustment has been made for, say, operating time). Approximately 9700 operations are conducted per year in the eight operating theatres at St Vincent's, or 1212.5 operations per theatre. Thus, the capital cost per operation amounts to $69.

2.5. Nursing Staff.

2.5.1. Methods.

Two methods could be used to estimate the cost of nursing staff for the patients in the study. The first is to calculate the average cost of nursing staff per inpatient bed day, by dividing the hospital's nursing salary bill by the total number of patient bed days for a given period, and then multiplying by the length of stay for the patients under consideration.[1]

The main limitation of using this estimate is that nursing costs have been applied irrespective of the treatment for which the patient was in hospital. This *per diem* cost makes no distinction amongst patients who have had kidney transplants, hysterectomies, or treatment for perianal abscess, although the *intensity* of nursing resource use is likely to be quite different for such patients. Only if cholecystectomy patients are truly average patients would it be appropriate to use these nursing costs. If not, the daily nursing cost of cholecystectomy patients will be over (under) estimated if they are of lower (higher) dependency than the average for all patients.

Ideally, the estimation of nursing costs should take account of the intensity with which nursing resources are used. To do this, length of stay should be adjusted by patient dependency. St Vincent's has a ward and shift specific dependency system based on empirical information regarding the amount of particular types of nursing time required to care for patients at each level of dependency. Table 2.10 shows the time estimates in the shaded columns for patients on St Joseph's ward for a morning shift. A patient at dependency level 4 requires 0.76 hours of a charge nurse's time, 5.05 hours of a registered nurse's time, and 0.13 hours of a student nurse's time. In the appendix, the time estimates for morning, afternoon and night shifts on two wards are presented. Those for St Joseph's are shown in table B8 and those for St Joan's in table B9. Over 90% of the public patients in the study were cared for on these wards. The time requirements on a further ward, St Phillip's, were used to examine the sensitivity of nursing costs to the type of ward. The resultant estimates were similar to those for St Joan's ward, and details have not been presented.

Table 2.10
NURSING TIME/DEPENDENCY, ST JOSEPH'S WARD
(hours and dollars per shift)

Morning Shift	*Patient Dependency (hours) and associated Nursing Salary ($)*											
Nurse Classification	4	Salary range		3	Salary range		2	Salary range		1	Salary range	
Charge Nurse	0.76	15.90	16.32	0.72	15.06	15.47	0.45	9.41	9.67	0.39	8.16	8.38
Registered Nurse	5.05	62.42	71.41	2.97	36.71	42.00	1.65	20.39	23.33	0.62	7.66	8.77

[1] The salary bill at St Vincent's for the year from June 1991 amounted to $23,871,200 and total inpatient bed days were 158,527. Thus the average nursing cost per bed day was $151. This estimate includes salaries for student nurses who are not always involved in direct patient care on the ward, spending time in the operating theatres, at lectures, and sometimes at other hospitals for part of their training. If the salaries of student nurses ($5,879,700) are excluded the average nursing cost per bed day would be $113.

Student Nurse	0.13	1.04	1.29	0.29	2.33	2.87	0.14	1.12	1.38	0.13	1.04	1.29
Total		79.36	89.02		54.10	60.34		30.92	34.38		16.86	18.44

For each shift spent at a particular dependency level the patient's time requirement of each category of nursing staff was multiplied by the hourly salary for that shift for that nursing category. The weekly and hourly salary scales effective from September 1991 are shown in table B10 in the appendix. As the time requirements for each dependency level indicate only broad categories of nursing types (i.e. student, registered and charge nurses) two sets of salary figures have been used to account for salary variation within these broad categories. For instance, for registered nurses the hourly salary of $12.36 for a grade 1 (YP1) was used for the lower bound, whilst for the upper bound that of $14.14 for a grade 4, third year (YP4) was used. Scales for registered nurses above this level were not considered because such nurses would not usually care for cholecystectomy patients at St Vincent's. For nurses working an afternoon or night shift an additional flat rate across all salary scales is paid on top of the hourly salary. To account for this, $1.46 was added to the hourly salaries of nurses working afternoon shifts, and $1.88 to those working the night shift. On the afternoon and night shifts, the duties of the charge nurse are undertaken by a registered nurse, who is paid a higher duty allowance for this shift equivalent to that of a grade 3A associate charge nurse (YT1).

The appropriate hourly salaries were multiplied by the time requirement at each dependency level, and summed to produce total nursing costs specific to each shift and dependency level. The non-shaded columns of table 2.10 show the nursing salaries associated with the care of patients at each level of dependency during a morning shift on St Joseph's ward. Full details of the shift and dependency level nursing salaries are presented in the appendix tables B8 and B9 for the St Joseph's and St Joan's wards respectively.

It is also necessary to account for the difference between what nurses are paid and what the hospital pays for them (the resource cost). In addition to the salary, the hospital pays on costs of approximately 15% for superannuation, WorkCare, and annual leave loading. Therefore, to estimate nursing costs, salaries were multiplied by 1.15.

Applying these final figures according to the shifts spent at each dependency level throughout the hospital stay, it would be possible to derive the total nursing costs for every patient. Unfortunately, however, information on the actual dependencies for the patients in the study was no longer available when the costing was conducted. Instead, patients who had more recently received cholecystectomies and for whom dependencies were available had to be used as proxies for the patients in the study.

Table 2.11
OPEN AND LAPAROSCOPIC PATIENTS TREATED BETWEEN 01/07/91 AND 17/12/91

Age	**Open Cholecystectomy (years)**			**Laparoscopic Cholecystectomy (years)**		
	Total	*Male*	*Female*	*Total*	*Male*	*Female*
Number	*24*	*8*	*16*	*71*	*21*	*50*
mean	47	57	42	48	48	48

standard deviation	± 19	± 12	± 21	± 15	± 15	± 15
range	13 - 82	38 - 76	13 - 82	19 - 82	26 - 82	19 - 72

The shift specific dependencies were collected for all those who had an open or a laparoscopic cholecystectomy between 01/07/91 and 17/12/91. Patients with co-morbidities and those receiving treatments in addition to cholecystectomy were excluded as was consistent with exclusion from the study itself. This left totals of 24 open cholecystectomy and 71 laparoscopic cholecystectomy patients. Table 2.11 provides information on the age and sex of these patients. No statistically significant differences were found between these patients and the patients in the study in terms of their age and gender *(see table 1.1)*.

The upper and lower nursing costs were applied to these more recently treated patients according to the shifts they spent at each dependency level. Summing these, the total nursing cost for each patient's hospital stay was derived. Because total nursing costs varied according to ward, on account of the ward variation in nursing time:dependency requirements, there are two ranges of total nursing costs for each patient, corresponding to St Joseph's and St Joan's wards. The patient's average daily nursing cost was calculated by dividing total nursing costs by their length of stay.

2.5.2. Average daily nursing costs.

The open and laparoscopic patients' average daily nursing costs are presented in table 2.12. The *per diem* nursing cost for all patients at St. Vincent's was $151, which exceeds the estimates for open and laparoscopic cholecystectomy presented here. Thus, for any given day in hospital it appears that cholecystectomy patients are less intense users of nursing time than patients in general.

The estimates vary according to the assumptions regarding the salary scales nurses were on and the type of ward where patients were cared for. On St Joseph's ward the estimated average daily cost of nursing a patient admitted for laparoscopic cholecystectomy ranged from $95 to $105. This difference of $10 is attributable to the different salary scales nurses might have been on. The cost estimates were more sensitive to the type of ward, the difference for the average laparoscopic cholecystectomy patient being $22 ($105 - $83) between St Joseph's and St Joan's, assuming nurses were on higher salary scales. Taken together, the difference in average costs was $26 ($105 - $79) when laparoscopic patients were cared for by nurses at the higher end of the salary scale on St Joseph's and at the lower end of the scale on St Joan's. The difference amounted to $29 ($112 - $83) for the average open cholecystectomy patient.

Open cholecystectomy patients were, on average, more expensive to care for than laparoscopic cholecystectomy patients. In general, for any given day in hospital, open cholecystectomy patients would be expected to be more intense users of nursing time than laparoscopic cholecystectomy patients, as they require more pain control, more dressing changes, more frequent turning to prevent pressure sores, and so on. However, the difference was not marked, amounting to a maximum of $7 ($112 - $105) when the average patient was cared for by nurses on higher salaries on St Joseph's ward. This result is surprising and suggests that while the dependency system was able to distinguish nursing resource use for cholecystectomy patients compared to patients admitted with other conditions, it was not sufficiently sensitive to distinguish between open and laparoscopic cholecystectomy.

Table 2.12
AVERAGE DAILY NURSING COSTS

Procedure	**Open Cholecystectomy**				**Laparoscopic Cholecystectomy**			
Ward	*St Joan's ($)*		*St Joseph's ($)*		*St Joan's ($)*		*St Joseph's ($)*	
	Lower	*Upper*	*Lower*	*Upper*	*Lower*	*Upper*	*Lower*	*Upper*
mean	83	87	101	112	79	83	95	105
median	82	86	100	111	78	82	95	105
standard deviation	± 20	± 22	± 25	± 28	± 15	± 16	± 18	± 20
range	26 - 124	27 - 132	32 - 152	35 - 169	47 - 119	48 - 125	58 - 139	63 - 154

2.5.3. Average total nursing costs.

To calculate total nursing costs, the average daily nursing costs for more recently treated patients were multiplied by the number of days spent in hospital by the patients in the study. Two sets of estimates are presented for total nursing costs. The lower estimate is based on the average daily nursing cost on St Joan's, assuming nursing staff at the lower end of the salary scale. The upper estimate is based on the average daily nursing cost on St Joseph's, assuming nursing staff at the upper end of the salary scale. The estimated average total nursing cost of caring for an open cholecystectomy patient ranged from $728 to $984, while for laparoscopic cholecystectomy the range was $442 to $588. Standard deviations reflect differences in length of stay. Results are presented in table 2.13.

Table 2.13
AVERAGE NURSING COSTS

Procedure	***Open Cholecystectomy***		***Laparoscopic Cholecystectomy***	
Estimate	*Lower ($)*	*Upper ($)*	*Lower ($)*	*Upper ($)*
mean	728	984	442	588
median	661	893	396	527
standard deviation	± 178	± 241	± 218	± 290
range	413 - 1,321	558 - 1,786	159 - 1,348	211 - 1,792

2.6. Ward and Hospital Overheads.

2.6.1. Ward overheads.

i) Nursing allowances.

Nurses are paid $0.83 and $0.21 per day as uniform and laundry allowances. These have been attributed to patients on the basis of an average per bed day, by dividing the number of nursing staff on each ward for all three shifts by the number of beds. In total, there are 16 nursing staff on St Joseph's and St Joan's wards, which have 27 and 28 beds respectively. Thus, the average cost of allowances per bed day amounts to $0.62 and $0.59 for patients on St Joseph's and St Joan's wards.

ii) Consumables and laundry services.

The cost of non-salary expenses, such as consumables, stationary and linen was estimated for St Joseph's and St Joan's by dividing the total bill for each ward for the year from June 1991 by the total bed days spent on the ward during this period. The average cost per bed day for each of these wards is shown in table 2.14, ranging from $11 on St Joan's to $14 on St Joseph's.

Table 2.14
NON-SALARY EXPENSES BY WARD
June 1991 - June 1992

Ward	Total Ward Days	Total Non-Salary Expenses ($)	Non-Salary Expenses per Bed Day ($)
St Joseph's	7080	100,900	14
St Joan's	8016	87,300	11

iii) Floor space.

An estimate of the cost of floor space has been made by dividing the size of each ward by the number of beds and multiplying by the present rental value for office space in the city. Whether this reflects the opportunity cost of the floor space is debatable. Given that there is presently an office vacancy rate of about 20% in Melbourne, the short run opportunity cost might well be close to zero. From a longer term perspective it is not reasonable to assume that land is valueless. A defensible alternative assumption would be that the opportunity cost is the expected flow of income that could be derived from the next best alternative use and that this should be adjusted to reflect the probability of short term use. This is not done in the present study, and the values incorporated properly represent an upper estimate of the true opportunity cost.

Using the Civil and Civic Extended Masterplan, St Joseph's and St Joan's wards were found to be 521 and 454 square metres respectively. This includes the ward area, nursing station, toilet facilities and associated passageways. There are 27 beds on St Joseph's ward, and 28 on St Joan's. Thus the floor space per bed on these respective wards is 19.30 and 16.21 square metres. In 1992 the rental for a square metre of office space in the area around the hospital was approximately $160 per year, or $0.44 per day. Thus, cost of floor space per bed day has been estimated at $8 and $7 for St Joseph's and St Joan's respectively.

2.6.2. Hospital overheads.

i) Catering, domestic services, electricity, and administration.

The cost of catering, cleaning, electricity, and administration were calculated as an average per bed day for St Vincent's by dividing the total amount paid for these items by the total bed days for the year from June 1991. Details are provided in table 2.15. Catering, cleaning and electricity amounted to $29, $27, and $6 respectively per bed day. The other overhead costs of medical administration, nursing administration, data processing, quality assurance and accreditation programmes, and general services including engineering, transport, telephones and water, was estimated as $84. These items amount to $146 for each day spent in hospital. It is estimated that 20% of these overheads, apart from catering, can be apportioned to out-patient activity, making the cost per in-patient bed day $123. To attribute these costs to patients this figure has been multiplied by the number of days spent in hospital by the open and laparoscopic cholecystectomy patients.

Table 2.15
OVERHEADS
June 1991 - June 1992

	Total Expenses ($)	**Average Expenses per Bed Day ($)**
Catering	4,584,900	29
Cleaning	4,266,500	27
Electricity	1,009,400	6
Administration	13,359,000	84

2.6.3. Total overhead costs.

Table 2.16 presents the estimate of average overhead costs, including allowances, non-salary expenses, floor space, and hospital overheads associated with the full hospital stay. On St Joseph's ward, the average cost for open cholecystectomy patients was $1,286 (± 314), while that for laparoscopic patients was $814 (± 402). The average cost on St Joan's ward $1,244 (± 304) for open cholecystectomy patients, and $788 (± 389) for laparoscopic cholecystectomy patients. Standard deviations reflect differences in length of stay. Ward and hospital overheads were also calculated for St Phillip's ward, but little difference was found with the estimates of costs associated with St Joan's ward, and the results have not been presented.

Table 2.16
AVERAGE TOTAL OVERHEAD COSTS

Procedure	**Open Cholecystectomy**		**Laparoscopic Cholecystectomy**	
Ward	*St Joan's ($)*	*St Joseph's ($)*	*St Joan's ($)*	*St Joseph's ($)*
mean	1,244	1,286	788	814
median	1,130	1,168	706	730
standard deviation	± 304	± 314	± 389	± 402
range	706 - 2,260	730 - 2,336	283 - 2,401	292 - 2,482

2.7. Pharmacy.

2.7.1. Medication.

Information on the type and amount of analgesia prescribed was collected for individual patients. However, the protocols did not record the actual dosage for each patient who had heparin and antibiotics. Consequently it was assumed that each patient who had heparin received two dosages of 5000 units. For those patients recorded as having had antibiotics, it was assumed that open cholecystectomy patients received three 80mg doses of gentamicin and four 1g doses of keflin, and laparoscopic cholecystectomy patients received three 80mg doses of gentamicin, four 1g doses of ampacillin and three 500mg doses of flagyl. Medication administered in theatre was included in the theatre costs.

The cost of the medication was derived from the pharmacy buying guide of the Victorian Hospitals Association (VHA), an independent trading company established to negotiate bulk purchases from the drug companies, and to offer pharmaceutical products at discount prices to all hospitals in Victoria. Prices from the VHA were compared with those of Sigma, a pharmaceutical company, but showed little variation. Discounts for bulk buying or contractual arrangements were offered by both companies, but were ignored in this analysis. The higher price of the smallest purchasable unit was applied for the costing for all drugs. Appendix table B11 provides information on the form of medication, and the related prices.

Table 2.17 shows the average cost of medication. This was $24 (± 11) for open cholecystectomy and $25 (± 7) for laparoscopic cholecystectomy.

Table 2.17
AVERAGE COST OF MEDICATION

	Open Cholecystectomy ($)	Laparoscopic Cholecystectomy ($)
mean	24	25
median	23	26
standard deviation	11	7
range	1 - 51	0 - 47

2.7.2. Overheads.

The overhead costs of prescribing were estimated by dividing the salary expenses incurred in pharmacy ($1,233,000) by total in-patient bed days (158,527) for the year from June 1991. This provided an estimate of $8 per in-patient day. The average cost amounted to $69 (± 17) and $43 (± 21) for open cholecystectomy and laparoscopic cholecystectomy respectively.

2.8. ERCP.

Endoscopic retrograde cholangio-pancreatography (ERCP) is conducted if stones are left in the common bile duct. If necessary an endoscopic sphincterotomy is performed in conjunction with ERCP to remove the stones. An ERCP was carried out on 2 of the open cholecystectomy patients with ERCP followed by endoscopic sphincterotomy performed for one patient. 7 laparoscopic cholecystectomy patients had an ERCP and one had ERCP followed by endoscopic sphincterotomy.

The costs of these procedures have been approximated using the CMBS, which specifies an anaesthetic of 8 units (further anaesthetic is not required when ERCP is followed by endoscopic sphincterotomy). The total benefits amount to $262.50 and $555.00 for ERCP and ERCP followed by endoscopic sphincterotomy respectively. Details are provided in appendix table B2. Appendix A2 discusses private payments for these procedures.

In the absence of more detailed information it has been presumed that patients undergoing these procedures did so during their cholecystectomy operation rather than being returned to theatre at a later stage during their hospital stay. ERCP may result in increased resource use of other hospital resources. If so, this will have been captured in the protocol data or in increased length of stay for these patients. However, it is not possible to separately attribute this resource use to the ERCP procedure. The estimated cost of ERCP averaged over all patients amounted to $11 for open cholecystectomy and $27 for laparoscopic cholecystectomy.

2.9. Conclusion: Average Total Hospital Costs.

The estimated hospital cost varies with the basis used for estimation. Consequently, two average cost estimates are presented for each treatment. The bases for these lower and upper estimates are indicated below:

COST CATEGORY	*BASIS FOR ESTIMATION*		*DETAILS IN TABLE*
	lower	*upper*	
Surgeon	Salary MW5	Salary MW8	*2.5*
Diagnostic tests	Single estimate	-	*2.7*
Theatre	Single estimates	-	*2.8 and 2.9*
Nursing staff	Daily nursing cost: St Joan's, low salary scale.	Daily nursing cost: St Joseph's, high salary scale.	*2.12 and 2.15*
Overheads	Ward: St Joan's Hospital: single estimate	Ward: St Joseph's -	*2.16*
Pharmacy	Single estimate	-	*2.17*
ERCP	Single estimate	-	

The lower and upper estimates of average total hospital costs are shown in table 2.18. The single most important factor for the difference between lower and upper estimates was the type of ward, which effected the estimation of nursing costs and overheads. Various surgeon and nursing salary scales were the other reasons for the difference.

On average, the total hospital costs were estimated as ranging from $3,053 to $3,366 for open cholecystectomy and from $2,393 to $2,581 for laparoscopic cholecystectomy. The cost difference between treatments was significant (p<0.001).

Table 2.18
AVERAGE TOTAL HOSPITAL COSTS

Procedure	**Open Cholecystectomy**		**Laparoscopic Cholecystectomy**	
Estimate	*Lower ($)*	*Upper ($)*	*Lower ($)*	*Upper ($)*
mean	3,053	3,366	2,393	2,581
median	2,936	3,225	2,156	2,319
standard deviation	± 531	± 603	± 736	± 820
range	2,051 - 4,687	2,233 - 5,242	1,395 - 5,690	1,468 - 6,232

[1] One patient in each treatment group had missing diagnostic and laboratory test information. These cases were dropped when total costs were calculated.

Neither age nor weight were significantly correlated with the costs of open or laparoscopic cholecystectomy. Although mean costs were higher for men than women, the difference being $112 for open cholecystectomy and $42 for laparoscopic cholecystectomy, neither difference was statistically significant. Nor was there a statistically significant difference in the cost of public and privately insured patients who had open cholecystectomy, the former group costing $61 more than the latter. The difference was significant (p<0.05) for laparoscopic cholecystectomy, however, with the mean cost of public patients $369 higher than that for privately insured patients. This difference cannot be explained by the costing methodology because the components which form final costs were based on the assumption that all patients were treated on a public basis and used public facilities, whether or not this was actually the case. Incorporating surgeon fees and patient co-payments would reverse rather than reinforce the finding, making private patients more expensive than public patients *(see Appendix A)*. The main reason for the higher cost is that public patients who had laparoscopic cholecystectomy were in hospital for longer than private patients. There are at least four possible explanations for this higher length of stay, none of which can be tested. First, the difference may be a random result (one in twenty "significant" results will occur because of chance at a 95% significance level). Second, public patients may have, on average, a lower health status than private patients, which might have been exemplified in their recovery from this treatment. Third, public patients may have waited longer for treatment than private patients, causing a deterioration in their condition prior to admission. Finally, St. Vincent's Private Hospital may have had different discharge policies than the Public Hospital. It is not known which, if any, of the private patients were cared for in the Private Hospital.

3. HOSPITAL COSTS: EXTRACORPOREAL SHOCKWAVE LITHOTRIPSY.

3.1. Introduction.

It is hypothesised that the cost of ESWL is influenced by the number and size of stones, patients with smaller stone mass requiring fewer sessions on the lithotripter and, all else being equal, less litholytic therapy to dissolve the stone fragments. To test the hypothesis, costs were examined for all ESWL patients as well as for patients sub-grouped according to stone size into the following four categories:

a) single small stones of less than 10 mm diameter,
b) single medium stones of between 10 mm and 20 mm diameter,
c) single large stones of more than 20 mm diameter, and
d) multiple stones.

Table 3.1 shows the number of patients in each category. The majority of ESWL patients (325) had a single stone. Of these, the size of the stone was less than 10 mm in diameter in 69 patients, between 10 mm and 20 mm in 212 cases, and greater than 20 mm in the remaining 44 patients. 129 patients had multiple stones, although most of these (69%) had only two.

Table 3.1
NUMBER OF PATIENTS IN EACH STONE CATEGORY

	Stone size/number			
	Single stone <10mm	*Single stone 10-20mm*	*Single stone >20mm*	*Multiple stones*
Number of patients	69	212	44	129

Following their initial consultation, patients received treatment on the lithotripter. They returned to the biliary lithotripsy unit at St Vincent's periodically for follow-up, where the size of the stone was monitored by ultrasound and further sessions on the lithotripter may have been suggested. Patients were prescribed litholytic therapy (bile salts) to facilitate the dissolution and removal of stone fragments.

ESWL patients were treated as out-patients, although some were admitted to hospital if they developed significant medical problems. The cost of hospital admission is discussed in section 3.6. 20% of ESWL patients subsequently underwent cholecystectomy, with ESWL being deemed to have failed. The cost implications of conversion are discussed in section 5.2.

3.2. Initial Consultation.

ESWL patients had a variety of medical examinations and investigations during the course of their treatment. At the initial consultation 32.8% of patients had an oral cholecystectogram, 34.6% had an ultrasound, and 79.1% had a plain film of abdomen. All patients had FBE, E&U, LFT and INR tests. Women of childbearing age had a pregnancy test. These tests and investigations have been costed using the CMBS as an approximation to the true economic cost. CMBS details are presented in appendix table B1. The average cost of the initial consultation has been estimated as $119.

3.3. Treatment.

Patients received up to four ESWL treatments *(table 3.2)*. On average, patients with single small stones received 1.17 treatments, those with single medium stones received 1.50 treatments, those with single large stones had 1.98 treatments, and those with multiple stones received 1.65 treatments. 82.6% of patients with a single small stone required only one treatment, whereas 72.7% of patients with a single large stone required more than one. However, the size of the largest stone was only weakly correlated with number of treatments (r = 0.256).

Table 3.2
NUMBER OF TREATMENTS RECEIVED BY ESWL PATIENTS

	Stone size/number			
	Small stone	*Medium stone*	*Large stone*	*Multiple stones*
Number of treatments	number of patients (%)	number of patients (%)	number of patients (%)	number of patients (%)
1	57 (82.6)	127 (59.9)	12 (27.3)	62 (48.1)
2	12 (17.4)	64 (30.2)	21 (47.7)	50 (38.8)
3		20 (9.4)	11 (25.0)	17 (13.2)
4		1 (0.5)		
Average	1.17	1.50	1.98	1.65

i) Physician costs.

All ESWL patients were treated in the biliary lithotripsy unit at St Vincent's as public patients, irrespective of their insurance status. The cost of providing ESWL to private patients is discussed in appendix A1. Typically the doctor spent 15 minutes with the patient conducting an examination and administering premedication, following which there was approximately 30 minutes "down time" before the patient was ready to receive treatment. Although the doctor might have used this time productively, it has been attributed as a cost to ESWL. The patient spent an hour undergoing treatment on the lithotripter, with the doctor in constant attendance. Two estimates are provided which correspond with the assumptions that the doctors providing the treatment were on the lower scale of MW5 or the higher scale of MW8. Accordingly, the upper and lower estimates of the cost of the doctor are $89 and $83 respectively.

ii) Staff costs.

In addition to the doctor, an ultrasonographer and a nurse were present for the duration of treatment. As of 1 November 1991, the weekly salary for a grade 2, year 4 ultrasonographer was $760.90. The nurse was a grade 2, year 4 registered nurse (YP5) for whom the weekly salary was $565.40. Generally, the patient spent three quarters of an hour receiving pre-medication, an hour on the lithotripter, and an hour in recovery. The hourly salaries of these staff have been applied to the standard treatment time of 2 hours 45 minutes to derive a staff cost of $96 per treatment.

iii) Ultrasound.

Ultrasound was performed in 99% of cases of treatment. The cost of ultrasound has been approximated using the CMBS benefit of $42.

iv) Equipment.

The lithotripter and colour doppler were acquired from Dornier in 1989 for $2,056,538. In 1992 prices this amounts to $2,268,361, calculated by inflating by the consumer price index which rose by 10.3% over the period *(Australian Bureau of Statistics)*. On advice, it has been assumed that the machine has a useful life of five years.

700 treatments were performed during the course of the study, which was conducted over a two and a half year period. However, because the machine was not used to capacity, a throughput of 1000 treatments per year (*Rx*) has been assumed.

Calculated using the equivalent annual cost method, assuming a discount rate of 7% (*r*), the capital cost per treatment (*CC*) amounts to:

$$CC = [K / A\ (n,r)] / Rx$$

$$= [\$2,268,361 / 4.1002] / 1000$$

$$= \$553$$

In addition to the capital cost, there is an associated maintenance charge of $227,218 per annum. With a throughput of 1000 treatments, the cost per treatment is $227. Either one or two electrodes are used during treatment, the number depending on the energy level at which shocks are delivered. As many as 2000 shocks are delivered during treatment. Originally shocks were delivered at 18-20 kV, with one electrode used. After September 1990 energy levels were increased to 24-26 kV, and two electrodes were used routinely per treatment to increase fragmentation of the stones. Electrodes cost $252 each. Assuming a discount rate of 7%, a useful life of five years, and the use of two electrodes, the equipment cost per treatment amounts to $1,284. If the machine lasted ten years and only one electrode was used the equipment cost would amount to $802.

v) Medication.

Patients received 100mg of pethidine and 10mg of maxolon as pre-medication before ESWL. While undergoing treatment, 20mg of diazepam and 75mg of pethidine were taken intravenously. Appendix table B18 provides details of medication prices. The cost of medication during ESWL amounted to $1.60 per treatment.

vi) Overheads.

The cost of cleaning, electricity, and administration were calculated by dividing the total amount paid for these items at St Vincent's by the total bed days for the year from June 1991. This amounted to $117.55 per bed day. Details were presented previously in table 2.13. From the average time it takes to perform an episode of ESWL and the associated administration, it has been assumed that overhead

costs are approximately 20% of the cost of a bed day. An estimate of $24 has been used for each attendance.

vii) Floor space.

The floor space for the biliary lithotripsy unit was 213 square metres. At a rental of $0.44 per square metre per day the daily rental cost of the lithotripsy unit amounts to $93.72. Assuming a throughput of four patients per day, the cost per patient is $23.

Table 3.3
THE COST OF ESWL TREATMENT

	Lower estimate ($)	***Upper estimate ($)***
Physician	83	89
Staff	96	96
Ultrasound	42	42
Equipment	802	1,284
Medication	2	2
Overheads	24	24
Floor Space	23	23
TOTAL[1]	1,071	1,560

[1] Totals may not add to the sum of the components because of rounding.

These costs are summarised in table 3.3 which shows lower and upper estimates of the cost of a single ESWL treatment as $1,071 and $1,560 respectively. Table 3.4 shows the implication of these costs for the four categories of patients. Using the upper estimate, the average cost of ESWL ranges from $1,831 for patients with a single small stone to $3,085 for patients with a single large stone. Analysis of variance showed that there were significant differences in treatment costs between the groups (p<0.001). Subsequent multiple comparison testing using Tukey's "honestly significant difference" (HSD) test showed that treatment cost differences were significant between all stone categories, except when comparing patients with medium stones to those with multiple stones.

Table 3.4
AVERAGE COST OF TREATMENT

Stone size/number	***Lower estimate ($)***	***Upper estimate ($)***
all patients	1,652 (± 737)	2,406 (± 1,074)
single small stone	1,257 (± 409)	1,831 (± 596)
single medium stone	1,612 (± 734)	2,347 (± 1,069)
single large stone	2,118 (± 783)	3,085 (± 1,140)
multiple stones	1,768 (± 753)	2,576 (± 1,097)

3.4. Follow-up.

ESWL patients received follow-up examinations in the first two weeks after treatment, six weeks later, and thereafter at intervals of approximately three months. Follow-up continued for more than two years after the original treatment in some cases. On average, patients received 5.2 follow-up examinations. The average number of attendances ranged from 4.9 for those with single small stones to 6.5 for those with single large stones.

During follow-up an ultrasound and a liver function test were performed, although not necessarily on each occasion. Table 3.5 shows the proportion of follow-up sessions at which LFT and ultrasound were performed.

Table 3.5
PERCENTAGE OF PATIENTS HAVING TESTS DURING FOLLOW-UP

Stone size/number	*LFT (%)*	*Ultrasound (%)*
all patients	36.5	93.8
single small stone	33.7	93.5
single medium stone	36.0	91.9
single large stone	36.8	97.9
multiple stones	38.5	95.1

The cost of the these tests has been estimated using the benefit level in the CMBS for these items. The average cost of follow-up was calculated according to the number of sessions attended and the tests conducted during the examination. Table 3.6 presents the average costs for each stone category. The average cost of follow-up varied from $345 for patients with a single small stone to $480 for those with a single large stone.

Table 3.6
AVERAGE COST OF FOLLOW-UP

Stone size/number	*LFT ($)*	*Ultrasound ($)*	*Total ($)*
all patients	30	340	370
single small stone	26	319	345
single medium stone	28	322	350
single large stone	38	442	480
multiple stones	32	347	379

3.5. Litholytic Therapy.

Litholytic or bile salt therapy represents a significant proportion of the cost of ESWL. Patients were prescribed either chenodeoxycholic or ursodeoxycholic acid to dissolve the gallstone fragments remaining after treatment on the lithotripter. At the beginning of the study, between August 1989 and May 1990, only chenodeoxycholic acid was available. Ursodeoxycholic acid was introduced in June 1990 but withdrawn by the regulatory authorities in December 1990. Patients were prescribed

chenodeoxycholic or ursodeoxycholic acid in dosages of about 12 to 14 mgms per kilogram of body weight per day. A few patients were prescribed dosages outside this range. If ursodeoxycholic acid was prescribed in combination with chenodeoxycholic acid, both drugs were prescribed at a dosage of 7mgm per kilogram per day.

15.2% of patients were not prescribed litholytic therapy. 32.2% of patients ceased medication, usually after being declared stone free, although 3.3% of patients are known to have stopped because of side effects, notably diarrhoea. The average time on medication for such patients was 337 days (± 177). 20.0% of ESWL patients subsequently had surgery, and stopped taking medication for this reason (3% of the patients who had subsequent surgery had not been prescribed medication). For such patients it has been assumed that they were on medication (if it had been prescribed) from the date of their first ESWL session to their date of surgery. On average, such patients, including those not prescribed bile salts, were on medication for 261 days (± 203). 8.4% of patients were `lost to follow-up', in that they did not return as requested to the biliary lithotripsy unit, and the time spent on medication is unknown. It has been assumed that all other patients (27.3%) took bile salts for eighteen months as laid down in the treatment protocol.

Table 3.7 shows the average number of days patients were on litholytic therapy, by stone category, excluding those lost to follow-up. The average number of days on litholytic therapy ranged from 313 days (± 225) for those with single small stones to 434 days (± 192) for those with single large stones.

Table 3.7
AVERAGE TIME ON MEDICATION
excluding those lost to follow-up

Stone size/number	***number of patients***	***mean number of days on medication***
all patients	416	336 (± 220)
single small stone	65	313 (± 225)
single medium stone	193	318 (± 217)
single large stone	42	434 (± 193)
multiple stones	116	345 (± 226)

Many patients received both chenodeoxycholic and ursodeoxycholic acid at some stage during the course of their treatment. It was not possible to cost the actual drugs prescribed because of the lack of a consistent pattern throughout the study. Consequently, costs have been calculated as if patients were prescribed only chenodeoxycholic acid or only ursodeoxycholic acid. Patient compliance with litholytic therapy was recorded as unsatisfactory in only 12.3% instances of follow-up. Although the outcomes of treatment might differ, the cost of medication is the same whether or not the patient actually took the drug. Therefore, no adjustment has been made in the assessment of costs to account for compliance.

The cost of a 125mg capsule of chenodeoxycholic acid, supplied through the VHA as chendol, was $0.43. It is difficult to estimate a unit cost for ursodeoxycholic acid, which is not freely available in Australia. St Vincent's imported a quantity of the drug from overseas at an estimated cost of $0.24 for a 125mg capsule - or 55% of the cost of chenodeoxycholic acid. However, this estimate does not make allowance for overheads or profits. The cost of ursodeoxycholic acid would be considerably higher if

supplied by a commercial drug company, from whom it was estimated that a 125mg capsule would cost $0.67 - or 156% of the cost of chenodeoxycholic acid.
The final cost estimates are presented in table 3.8. Estimates based on the three sources of medication are presented for comparison. However, in assessing the cost of ESWL, chendol (chenodeoxycholic acid) has been used as the best estimate of the cost of litholytic therapy. When prescribed chendol, the estimates range from $1,044 (± $791) for those with single small stones to $1,359 (± $729) for those with single large stones. However, no two groups were significantly different at the 0.05 level of significance.

Table 3.8
AVERAGE COST OF MEDICATION
excluding those lost to follow-up

Stone size/number	***chendol*[1]**	***urso StV*[2]**	***urso com*[3]**
all patients	1,094 (± 769)	610 (± 429)	1,704 (± 1,199)
single small stone	1,044 (± 790)	582 (± 441)	1,626 (± 1,232)
single medium stone	1,062 (± 763)	593 (± 426)	1,654 (± 1,189)
single large stone	1,359 (± 729)	758 (± 407)	2,117 (± 1,137)
multiple stones	1,079 (± 773)	602 (± 431)	1,682 (± 1,205)

[1] Chenodeoxycholic acid.
[2] Ursodeoxycholic acid, produced by St Vincent's.
[3] Ursodeoxycholic acid, supplied by a commercial drug company.

3.6. Subsequent Hospital Admission.

34 (7.5%) patients were admitted to hospital subsequent to their first ESWL treatment. Of these, the reasons for admission were the following: severe colic (41%), acute pancreatitis (23.5%), jaundice (20.5%), acute cholecystitis (3%), cholangitis (3%), and unspecified (20.5%). (The percentages sum to more than 100 because three patients were admitted with more than one complaint).

During admission the following investigations or procedures were conducted: biliary scan (18%), ERCP (32%), ERCP with endoscopic sphincterotomy (12%), and endoscopic sphincterotomy alone (15%). Details were not recorded for four (12%) of the patients. These services have been costed using the CMBS benefit. CMBS details are presented in appendix table B2. Appendix A2 discusses private payments for these procedures (except for biliary scans).

The specified benefit of $75 for eight units of anaesthetic for both ERCP and endoscopic sphincterotomy has been included in the calculation of the cost. The cost of these procedures averaged over all ESWL patients was $18.

More detailed information on the hospital admissions was not recorded. It is not known if procedures were performed on an out-patient basis or if patients were admitted as in-patients and the cost estimate used here does not include costs other than for the procedure itself. The sensitivity analysis described in Cook, Richardson and Street (1993*b*) addresses the cost implications of varying the assumptions about length of stay if treatment was required in hospital subsequent to ESWL.

3.7. Conclusion: Average Hospital Cost of ESWL.

Table 3.9 presents the average hospital cost of ESWL by stone category. These average costs are based on the upper estimate of treatment costs and chenodeoxycholic acid being used for litholytic therapy. On average, the cost of ESWL for a patient with a single small stone was $3,356 compared to $5,061 for a patient with a single large stone.

Table 3.9
AVERAGE COST OF ESWL, UPPER ESTIMATE

Stone size/number	***Initial consultation ($)***	***Treatment ($)***	***Follow-up ($)***	***Litholytic therapy ($)***	***Hospital admission ($)***	***Total ($)***
all patients	119	2,406	370	1,094	18	4,007
single small stone	119	1,831	345	1,044	18	3,356
single medium stone	119	2,347	350	1,062	18	3,896
single large stone	119	3,085	480	1,359	18	5,061
multiple stones	119	2,576	379	1,079	18	4,171

SUMMARY: AVERAGE HOSPITAL COSTS, UNCONVERTED PATIENTS.

Table S1 shows the average hospital cost of each procedure. Laparoscopic cholecystectomy is the least expensive procedure, with ESWL being more expensive than open cholecystectomy for all but the small stone category. These estimates do not include the costs incurred outside the hospital, which are addressed in the next section. Moreover, the estimates are for *unconverted* procedures only. In other words, they do not include the cost of surgery subsequent to ESWL, nor of the laparoscopic operation being converted to the open procedure. The effect of these on total costs is discussed in section 5.

Table S1
AVERAGE HOSPITAL COSTS

Procedure	*Open cholecystectomy ($)*	*Laparoscopic cholecystectomy ($)*	*ESWL ($)*			
			small stone	*medium stone*	*large stone*	*multiple stones*
Lower estimate	3,053	2,393	2,783	3,161	4,094	3,362
Upper estimate	3,366	2,581	3,356	3,896	5,061	4,171

4. INDIRECT AND PATIENT COSTS.

4.1. Introduction.

In March 1992, questionnaires were sent to all open and laparoscopic cholecystectomy patients and the first 400 ESWL patients. Follow-up questionnaires were sent to non-respondents. An overall response rate of 66% (395/599) was achieved. However, 54 of the non-respondents could be excluded from the calculation due to changed or unknown address, death, or some other reason. This resulted in an effective response rate of 74% (395/537) overall; 69% (61/89) for open cholecystectomy, 82% (65/79) for laparoscopic cholecystectomy, and 73% (269/369) for ESWL.

No statistically significant difference between respondents and non-respondents in the three treatment groups was found in terms of their gender. The age distributions of respondents and all patients are shown in figures 1, 2 and 3 for open cholecystectomy, laparoscopic cholecystectomy and ESWL respectively. On average, respondents were older than non-respondents for all three procedures. The difference was statistically significant in the case of laparoscopic cholecystectomy ($p>0.05$), with respondents 7 years older than non-respondents on average. In the following analysis the possibility of systematic bias influencing the cost estimations is overcome by assuming the same work force participation for the three treatments, implying similar age structures. In a randomised control trail, the gold standard for these analyses, there would be no age and sex differences.

Although the response rates are comparable, it should not be assumed that the quality of information is similar. The time lapse between receiving treatment and receiving the questionnaire differed according to treatment. All open cholecystectomy patients were treated over a year before receiving the questionnaire, as were approximately half of the ESWL patients. This has to be accepted as a limitation of the study, and no attempt has been made to investigate the issue. For each question respondents providing values more than three standard deviations from the mean were treated as outliers and trimmed from the data. When trimming occurred details of the untrimmed data are presented in a footnote to the relevant table. Due to rounding subsequent to each calculation, the cost estimates may differ from a figure derived by multiplying presented data by the relevant dollar values.

Among other things, patients were asked about the lost time, travel, and additional care related to their treatment and recovery. The section of the questionnaire relevant to costs is reproduced in appendix C. This section deals with the estimation of the following costs:

1. The cost of time lost to paid work and home duties (indirect costs);
2. The cost of travel to and from hospital; and
3. The cost of care received outside the hospital.

Figure 1: **Open** Cholecystectomy **age distributions**

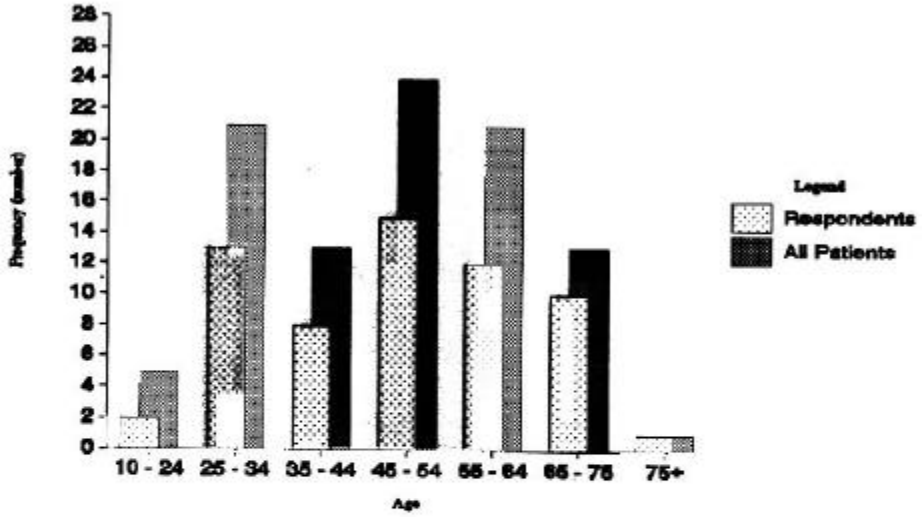


Figure 2: Laparoscopic **C**holecystectomy **age** distributions

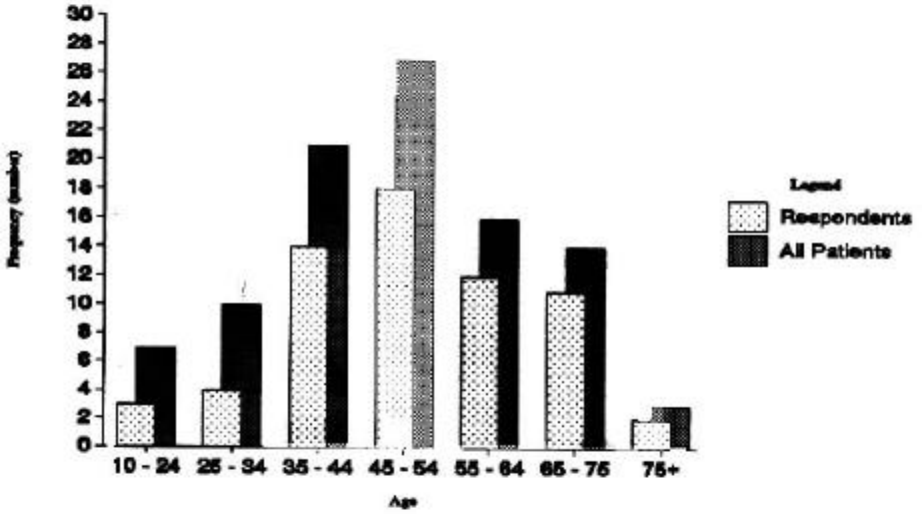
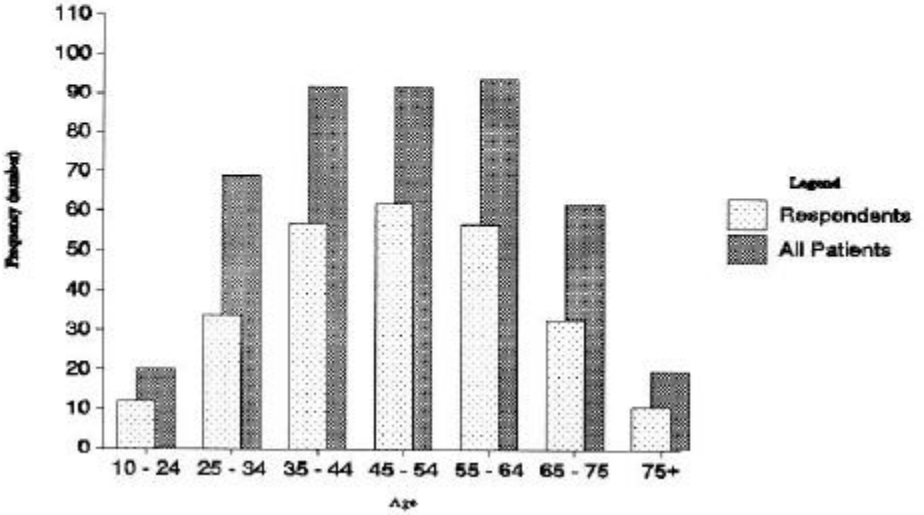


Figure 3: **ESWL age** distributions



4.2. Indirect Costs.

4.2.1. Introduction.

Indirect costs are defined as the production losses resulting from treatment, because the patient is unable to return to work while recovering. It is important to identify those losses which arise as a result of treatment, rather than those which would have occurred anyway because the patient was ill. Put another way, the objective is to evaluate the *consequences* of treatment, not the *costs* of illness. Patients were asked how much time they lost to paid and regular activity as a result of treatment and recovery. On average, treatment prevented open cholecystectomy patients from undertaking normal activity for over four weeks, compared to a fortnight for those who had laparoscopic cholecystectomy. ESWL patients were unable to engage in normal activity for an average period of less than four days. The data on these patients is presented in table 4.1 below.

Table 4.1
DAYS LOST TO NORMAL ACTIVITY, ALL RESPONDENTS

Days lost	***Open Cholecystectomy (days lost)***	***Laparoscopic Cholecystectomy (days lost)***	***ESWL (days lost)***
number of respondents	*59*	*64*	*265*
mean	30.1	14.0	3.7
median	20	10	2
standard deviation	± 37.6	± 13.5	± 5.3
range	0 - 180	0 - 60	0 - 30

[1] Prior to trimming, the mean values were 39.0 (± 62.4, max 365), 15.3 (± 17.1, max 65), and 4.5 (± 8.7, max 90) for open cholecystectomy, laparoscopic cholecystectomy and ESWL respectively.

Up to a point, these consequences can be included on the benefit side of the equation. The impact on quality of life resulting from a treatment reducing the recovery period can be viewed as a benefit to the patient. The companion paper assesses the value to an individual of time spent in different health states following treatment. However, individual and social valuations do not necessarily coincide. Recovery might also entail productive losses borne by employers which cannot be easily incorporated in quality of life estimates. Hence, in this analysis, the productive consequences are included on the cost rather than benefit side of the equation.

Patients were asked to indicate their occupation at the time of treatment. Their responses are provided in table 4.2. A lower proportion (31.1%) of open cholecystectomy respondents were in paid employment than respondents who had undergone laparoscopic cholecystectomy (49.2%) or ESWL (47.6%). Correspondingly, a higher proportion of open cholecystectomy respondents were engaged in home duties (37.7%) or were retired, unemployed, or students (29.5%). This has implications for costing that will be discussed below *(section 4.2.7)*.

Table 4.2
OCCUPATION

Occupation	*Open Cholecystectomy (%)*[1]	*Laparoscopic Cholecystectomy (%)*	*ESWL (%)*[1]
paid employment	31.1	49.2	47.6
home duties	37.7	32.3	28.6
retired/unemployed/student	29.5	18.5	22.3

[1] One open cholecystectomy and four ESWL respondents did not indicate their occupation.

4.2.2. Days lost to paid work.

Patients were asked to indicate the number of days lost from paid work as a result of treatment and recovery. Information on the number of days lost to paid work is provided in table 4.3 for those who were in employment at the time of treatment. After omitting outliers, the average number of paid work days lost was 27.1 (± 22.8), 11.8 (± 11.1), and 3.1 (± 4.1) for open cholecystectomy, laparoscopic cholecystectomy, and ESWL respondents respectively.

Table 4.3
DAYS LOST TO PAID WORK OF THOSE IN EMPLOYMENT

Days of paid work lost	*Open Cholecystectomy (days lost)*	*Laparoscopic Cholecystectomy (days lost)*	*ESWL (days lost)*
number of respondents	*19*	*32*	*125*
mean	27.1	11.8	3.1
median	25	10	2
standard deviation	± 22.8	± 11.1	± 4.1
range	0 - 84	0 - 45	0 - 22
respondents indicating no time lost (%)	21	22	30

[1] Only ESWL was effected by trimming, the untrimmed mean being 3.9 (± 6.5, max 40).

The number of respondents who estimated that treatment and recovery did not disrupt their paid activities was higher than expected. The proportion of respondents who estimated that no days were lost to paid work was reasonably similar amongst treatments, at 21% for open cholecystectomy, 22% for laparoscopic cholecystectomy, and 30% for ESWL respondents. This high proportion was especially surprising for patients who underwent surgery. Open cholecystectomy patients had an average length of hospital stay of 8.8 days, while for laparoscopic cholecystectomy patients it was 5.6 days, and no-one had a length of stay of less than two days *(table 2.1)*.

One plausible explanation for the large number of respondents who reported no time loss is that the question was inappropriately worded. Patients were asked "how much time did you lose from your regular activities as a result of your treatment and recovery?" *(see questionnaire, appendix C)*. The patient was then asked to provide an estimate in one box for days of paid work lost and a second estimate for the number days lost to regular activity, including paid work, in another box. Although some wrote zero in the boxes, others

indicated that the question was not applicable to them by writing n/a or drawing a line through the box. A number of these explained that they were on sick leave or were collecting some form of sickness benefit such as WorkCare. It is likely, therefore, that even though patients spent time off work they did not consider it time *lost*.

However, although patients may have incurred no financial cost personally, the cost of sick days should be included in an economic evaluation, because the loss of production is borne somewhere in the economy, even though the incidence might be unclear. Because the amount of lost time has been underestimated, the value of this lost time will be biased downwards. In an effort to account for this two estimates of indirect costs are presented for those in the work force. The first is based on the responses of all who were in paid employment. The second excludes those who said they lost no time to paid work, and is therefore based on positive estimates only. Table 4.4 presents information on the number of days lost to paid work by those who provided positive estimates only. The mean number of days lost was 34.3 (± 20.1), 15.2 (± 10.3), and 4.5 (± 4.3) for open cholecystectomy, laparoscopic cholecystectomy and ESWL respondents respectively.

Table 4.4
DAYS LOST TO PAID WORK FROM THOSE IN EMPLOYMENT, POSITIVE ESTIMATES ONLY

Days of paid work lost	***Open Cholecystectomy (days lost)***	***Laparoscopic Cholecystectomy (days lost)***	***ESWL (days lost)***
number of respondents	*15*	*25*	*87*
mean	34.3	15.2	4.5
median	28	14	3
standard deviation	± 20.1	± 10.3	± 4.3
range	7 - 84	3 - 45	1 - 22

4.2.3. The cost of time lost to paid work.

Having estimated time lost to paid activity, the question arises of how to value this lost time. The object is to ascertain the value of the resources lost to alternative activities as a result of the patients' treatment and recovery. Typically, the wage rate (including on costs) is used to estimate the value of time lost. Under ideal conditions, the daily wage equals the marginal product of labour, i.e. the extra revenue that can be made from selling the output produced in a day by an employee.[2]

Table 4.5 presents figures from the Australian Bureau of Statistics on the average weekly and daily ordinary time earnings for full time males, females, and persons in Australia in May 1992. The average weekly employment cost was obtained by adding on costs, estimated at 17.5% of the wage rate, and comprising the following components: worker's compensation (1.4%), payroll tax (7%), annual leave loading (1.35%), long service leave (3.75%), and superannuation (4%). Take home pay was calculated at a tax rate of 38%. Daily rates assume a working week of 5 days.

[2] It could be argued that when unemployment is common the opportunity cost is minimal because the worker can easily be replaced by someone else, without productive loss being incurred. In the case of this analysis, however, the time off work is for period too brief for costless replacement to be likely.

Table 4.5
AVERAGE EMPLOYMENT COSTS, EARNINGS, AND TAKE HOME PAY

	Average Employment Costs ($)		***Average Earnings ($)***		***Average Take Home Pay ($)***	
	Weekly	*Daily*	*Weekly*	*Daily*	*Weekly*	*Daily*
males	730.98	146.20	623.70	124.74	386.70	77.34
females	612.41	122.48	521.20	104.24	323.14	64.63
persons	690.08	138.02	587.30	117.46	364.13	72.83

Source: Australian Bureau of Statistics.

In the calculation of the cost of days lost to paid activity, the figure of $138 was used, which is the estimated daily employment cost of persons. Estimates of the cost of productive activity are presented in table 4.6, derived by multiplying this daily cost by the estimates of lost time presented in table 4.3. The average cost of days lost to paid employment was $3,734 (± 3,147), $1,635 (± 1,528), and $432 (± 571) for open cholecystectomy, laparoscopic cholecystectomy, and ESWL respondents respectively.

Table 4.6
THE COST OF DAYS LOST TO PAID WORK OF THOSE IN EMPLOYMENT, ALL ESTIMATES

Cost of days of paid work lost	***Open Cholecystectomy ($)***	***Laparoscopic Cholecystectomy ($)***	***ESWL ($)***
number of respondents	*19*	*32*	*125*
mean	3,734	1,635	432
median	3,451	1,380	276
standard deviation	± 3,147	± 1,528	± 571
range	0 - 11,594	0 - 6,211	0 - 3,036

[1] Only ESWL was effected by trimming, the untrimmed mean being 538 (± 898, max 5,521).

After excluding those who provided estimates of no days lost to paid work, the estimated value of time lost was $4,730 (± 2,772) for open cholecystectomy, $2,092 (± 1,421) for laparoscopic cholecystectomy, and $620 (± 593) for ESWL. Details are presented in table 4.7

Table 4.7
THE COST OF DAYS LOST TO PAID WORK OF THOSE IN EMPLOYMENT, POSITIVE ESTIMATES ONLY

Cost of days of paid work lost	***Open Cholecystectomy ($)***	***Laparoscopic Cholecystectomy ($)***	***ESWL ($)***
number of respondents	*15*	*25*	*87*
mean	4,730	2,092	620
median	3,965	1,932	414
standard deviation	± 2,772	± 1,421	± 593
range	966 - 11,594	414 - 6,211	138 - 3,036

[1] Only ESWL was effected by trimming, the untrimmed mean being 765 (± 988, max 5,521).

4.2.4. Days lost to home duties.

Respondents were not asked to specify their `time lost to home duties'. For those who gave their occupation as home duties it has been assumed that the `time lost to home duties' was equal to `time lost to regular activities'. This assumption may cause an upward bias in the estimate if `time lost to regular activities' included activities other than home duties. On the other hand, it is possible that many of those in paid employment or who were retired, unemployed or students would normally have undertaken home duties, but were prevented from doing so when recovering from treatment. Whether or not this was the case is unknown. In the absence of additional information it was assumed that these respondents did not undertake home duties, which, if incorrect, would result in a downward bias in the estimate of `time lost to home duties'. This must be accepted as a limitation of the study, and the following discussion should be read with this in mind.

As with those engaged in paid work, a high proportion of respondents who performed home duties estimated no time lost to regular activity. This proportion differs considerably amongst the treatments: 21% for open cholecystectomy, 33% for laparoscopic cholecystectomy, and 54.5% for ESWL. The previous hypothesis used to explain the anomaly for those in paid employment who offered zero estimates does not apply in this case. No compensation is provided for those engaged in home duties, so respondents would have been unlikely to report no time loss when they had not been able to engage in such activities. Thus, it has been accepted that those who said no time was lost to such activity did, in fact, lose no time. Table 4.8 shows the number of respondents engaged in home duties and the mean number of days lost (after exclusion of outliers). The mean value ranged from 3.0 days (± 4.9) for ESWL to 25.6 days (± 34.7) for those who had undergone open cholecystectomy.

Table 4.8
DAYS LOST TO HOME DUTIES, ALL ESTIMATES

Days lost to home duties	***Open Cholecystectomy (days lost)***	***Laparoscopic Cholecystectomy (days lost)***	***ESWL (days lost)***
number of respondents[1]	*22*	*20*	*74*
mean	25.6	7.2	3.0
median	17	7	1
standard deviation	± 34.7	± 7.6	± 4.9
range	0 - 120	0 - 30	0 - 25

[1] The proportion of respondents engaged in home duties who indicated no time was lost was 22% for open cholecystectomy, 33% for laparoscopic cholecystectomy, and 46% for ESWL.
[2] Prior to trimming, the mean values were 32.4 (± 46.8, max 180), 9.7 (± 13.7, max 60), and 4.1 (± 7.7, max 42) for open cholecystectomy, laparoscopic cholecystectomy and ESWL respectively.

4.2.5. The cost of days lost to home duties.

i) Replacement cost of household production.

For those activities which are regarded as productive but which are not included in the Gross Domestic Product (GDP) or for which there is no market price, such as housework, a value must be imputed from other sources. One approach to valuing housework is to

assess the replacement cost of household production. This can be done by assessing the market value of the individual functions of cooking, cleaning and so on, although this is likely to exaggerate the skill requirement of performing the function (Smith, 1987). The alternative replacement cost method is to use the wage that would be paid to a full time domestic for performing the work. This assumes that the domestic is as efficient as the present houseworker, and that running a household can be done within the normal working week. It is generally accepted that these conditions are unlikely to be met and, therefore, that the method might undervalue the role of housekeeping. Offsetting this in this analysis, housework performed by the employed and retired has been excluded.

As an estimate of the value of home duties for those who indicated this as their occupation the market price for a housekeeper was used. This was taken to be $10.77 per hour, being the most common hourly rate for council provided home helpers in Victoria. Assuming a 38 hour week, the corresponding weekly and daily wages would be $409.26 and $81.80. Using the replacement cost method, the average cost of the time lost to home duties was estimated as $2,098 (± 2,841), $585 (± 622), and $242 (± 399) for open cholecystectomy, laparoscopic cholecystectomy, and ESWL respondents respectively. Details are presented in table 4.9.

Table 4.9
THE COST OF DAYS LOST TO HOME DUTIES, REPLACEMENT COST METHOD

Cost of days lost to home duties	***Open Cholecystectomy ($)***	***Laparoscopic Cholecystectomy ($)***	***ESWL ($)***
number of respondents	*22*	*20*	*74*
mean	2,098	585	242
median	1,391	573	82
standard deviation	± 2,841	± 622	± 399
range	0 - 9,822	0 - 2,456	0 - 2,046

[1] Prior to trimming, the mean values were 2,648 (± 3,827, max 14,733), 791 (± 1,122, max 4,911), and 339 (± 631, max 3,438) for open cholecystectomy, laparoscopic cholecystectomy and ESWL respectively.

ii) Opportunity cost of housework.

An alternative to the replacement cost approach is to estimate the opportunity cost of housework. This is the amount the person engaged in housework would earn if they were in the labour force. The approach is based on the assumption that the value of the housework must be worth at least the take home pay (i.e. gross income minus tax) associated with this wage otherwise the person would enter the labour market. It has been argued that the method upwardly biases the valuation because, firstly, "staying at home" rather than housework itself is being valued, and, secondly, those who do choose to stay at home might do so because their opportunity cost is relatively low (Smith, 1987). Castles (1990) estimated an hourly wage rate of $9.12 in November 1987 for females engaged in unpaid household work. (All respondents to our questionnaire who indicated their occupation as being "home duties" were women). Assuming an increase similar to that for average weekly ordinary time earnings for women of 32.5% from November 1987 to May 1992, an hourly wage rate of $12.13 for home duties was used. Castles' data indicated that time spent in household activity for those not employed was between 27.95 and 47.75

hours for unmarried and married women respectively. Information on the marital status of the patients in the study was unavailable. Thus a 38 hour week has been assumed (which is both the midpoint between Castles' time estimate, and the length of the common working week), the weekly wage being $460.78. Finally, Castles' estimate was not net of tax, which is desired in this case, because the decision to enter the work force depends on the personal monetary reward for doing so. At a tax rate of 38%, weekly and daily take home pay would be $286.92 and $57.38.

For those engaged in home duties the average cost of the time lost to such activities was estimated using the opportunity cost method as $1,471 (± 1,992), $410 (± 436), and $170 (± 280) for open cholecystectomy, laparoscopic cholecystectomy, and ESWL respondents respectively. Details are presented in table 4.10.

Table 4.10

THE COST OF DAYS LOST TO HOME DUTIES, OPPORTUNITY COST METHOD

Cost of days lost to home duties	***Open Cholecystectomy ($)***	***Laparoscopic Cholecystectomy ($)***	***ESWL ($)***
number of respondents	*22*	*20*	*74*
mean	1,471	410	170
median	975	402	57
standard deviation	± 1,992	± 436	± 280
range	0 - 6,886	0 - 1,721	0 - 1,435

[1] Prior to trimming, the mean values were 1,856 (± 2,683, max 10,328), 555 (± 786, max 3,443), and 238 (± 442, max 2,410) for open cholecystectomy, laparoscopic cholecystectomy and ESWL respectively.

4.2.6. Time lost to leisure.

Leisure is an important way in which society takes advantage of its economic growth. If leisure activity were not valued people would not engage in it. It has been proposed that national output include only consumption and investment items that contribute directly to economic well-being. Samuelson and Nordhaus (1992) call this measure net economic welfare (NEW), which includes the satisfaction derived from leisure as well as goods and services.

By a similar token the interruption to leisure activity caused by undergoing treatment should also be included in a full cost benefit analysis. However, this loss of leisure time appears on the benefit rather than the cost side of the equation. The companion paper which describes the outcomes of gallstone treatment in terms of the effect on quality of life necessarily incorporates the valuation of time lost to leisure activity. Including this as a cost of treatment would amount to double counting. However, quality of life estimates do not readily incorporate the additional *economic* value of productive losses entailed by recovery from treatment. It is these economic costs which are the focus of this paper.

4.2.7. Average indirect costs.

The average cost of total time lost was estimated for all respondents, based on the estimates of the cost of days lost to paid work and home duties. As noted at the beginning of this section, the proportion of respondents in each occupation differs for open cholecystectomy from the other treatments. With a lower proportion of respondents in the

work force, there is a resultant downward bias in the indirect costs related to this treatment. To overcome the effect of the bias, the same work force composition has been assumed for each patient group (as would occur in a randomised control trail). This is done by imposing on the open cholecystectomy population the work force pattern of the ESWL patients, which was virtually identical to that of the laparoscopic cholecystectomy patients. The estimate of the cost of lost time for an average patient after open cholecystectomy (AC_{OC}) is calculated in the following way:

$$AC_{OC} = p_{1ESWL} (\$pw / p_{1OC}) + p_{2ESWL} (\$hd / p_{2OC}) + p_{3ESWL} (\$ra / p_{3OC})$$

where \$pw, \$hd, and \$ra are the open cholecystectomy respondents' mean costs of time lost to paid work, home duties, and regular activity respectively; p_{1ESWL}, p_{2ESWL}, and p_{3ESWL} are the proportions of ESWL respondents who were engaged in paid work, home duties, or unemployed/retired respectively; and p_{1OC}, p_{2OC}, and p_{3OC} are the proportions of open cholecystectomy patients engaged in these activities.

Lower and upper estimates of indirect costs are presented according to the different bases for estimating the components of total time. For both sets of estimates it has been assumed that the cost of time lost to activities other than paid work and home duties was zero. Table 4.11 presents lower cost estimates after trimming for outliers, but including those in paid work who provided zero estimates of time lost *(see table 4.6)*. The estimates of the cost of time lost to home duties were based on the opportunity cost method, details of which were presented in table 4.10.

Table 4.11
AVERAGE INDIRECT COSTS, ALL RESPONDENTS, LOWER ESTIMATE

Cost of days of lost	***Open Cholecystectomy ($)***	***Laparoscopic Cholecystectomy ($)***	***ESWL ($)***
number of respondents	*60*	*64*	*262*
mean	2,219	946	254
median	261	483	0
standard deviation	± 3,724	± 1,307	± 458
range	0 - 17,745	0 - 6,211	0 - 3,036

[1] Prior to trimming, the mean values were 2,311 (± 3,762, max 17,745), 984 (± 1,333, max 6,211), and 324 (± 698, max 5,521) for open cholecystectomy, laparoscopic cholecystectomy and ESWL respectively.

The upper estimates are presented in table 4.12. Again, outliers have been trimmed from the data. For paid work the estimates were derived from table 4.7, with those respondents who said that they had lost no days to paid work excluded, hence the smaller sample sizes compared to those in table 4.11. The cost of days lost to home duties was based on the replacement cost method, with the estimates previously presented in table 4.9.

Table 4.12
AVERAGE INDIRECT COSTS, ALL RESPONDENTS, UPPER ESTIMATE

Cost of days of lost	*Open Cholecystectomy ($)*	*Laparoscopic Cholecystectomy ($)*	*ESWL ($)*
number of respondents	*56*	*57*	*224*
mean	2,564	1,123	321
median	869	819	138
standard deviation	± 3,869	± 1,338	± 503
range	0 - 17,745	0 - 6,211	0 - 3,036

[1] Prior to trimming, the mean values were 3,012 (± 4,026, max 17,745), 1,286 (± 1,366, max 6,211), and 461 (± 732, max 5,521) for open cholecystectomy, laparoscopic cholecystectomy and ESWL respectively.

The different approaches to the estimation of lost time provide an average cost range of $2,219 to $2,564 for open cholecystectomy, $946 to $1,123 for laparoscopic cholecystectomy, and $254 to $321 for ESWL. Analysis of variance showed significant differences between the groups ($p<0.001$). Subsequent multiple comparison testing using Tukey's HSD test showed that the mean costs were significantly different for each treatment group.

Table 4.13 presents average indirect costs for ESWL by stone category. Using upper estimates these average costs ranged from $244 (± 421) for those with multiple stones to $511 (± 785) for those with large stones. However, no two groups were significantly different at the 0.05 level of significance.

Table 4.13
AVERAGE INDIRECT COSTS FOR ESWL PATIENTS, BY STONE CATEGORY

Stone size/number	*Number of respondents*	*Lower estimate ($)*	*Upper estimate ($)*
single small stone	36	206 (± 402)	245 (± 422)
single medium stone	117	286 (± 446)	354 (± 488)
single large stone	27	421 (± 745)	512 (± 785)
multiple stones	88	181 (± 363)	244 (± 421)

4.2.8. Discussion.

Any attempt to estimate indirect costs is fraught with theoretical and practical difficulties. While many argue that indirect costs ought to be included in a full analysis, few studies have attempted to include them. It might be argued that until the methods for valuation have been significantly improved it is pointless to include such costs because the present state of the art would result in estimates which are highly inaccurate. Given that the standard deviation around the mean value in every estimation presented in this section was very large, caution in interpreting the results would certainly be advisable.

However, rather than throw the baby out with the bath water, the counter argument is that approximations are better than no estimates at all. The inclusion of indirect costs in this

project alters the costliness and cost effectiveness of the options. In the absence of such estimates there is greater scope for cost shifting, especially if it is presumed that indirect costs are close to zero. It is hoped that an attempt to value indirect costs, however inaccurately, will contribute towards an efficient allocation of resources in society rather than in hospitals only. This is not to deny that the methodology for the estimation of these costs requires considerable improvement.

Some of the practical problems have been mentioned above in the discussion of indirect costs. These relate to two broad issues: how to ascertain how much time has been lost to productive activity, and how to establish what this time is worth. Efforts can be made to improve factual accuracy, for instance by improving the questionnaire design. However, it is unlikely that there will ever be consensus about the basis for the valuation. Is the average employment cost useful for valuing paid activity if it is doubted that it reflects the marginal product of labour? Should the value of women's payed employment be treated as less than men's as implied by respective wage rates?[3] Is replacement cost a better method for valuing housework than opportunity cost?

It is unlikely that satisfactory answers will be found to these questions in the near future. In the meantime, if it is recognised that indirect costs might be important, the only solution to the impasse (short of asserting that the costs are/are not significant but that they cannot be measured) is to provide upper and lower estimates of the costs, and test the sensitivity of the results to changes in the basis for the estimation. The lower estimate might simply accord a value of zero to indirect costs. The sensitivity analysis for this study is discussed in the companion paper.

The theoretical problem of whether or not indirect costs should be included depends on the question that is to be answered. The estimation of the value of a person's time amounts to valuing their livelihood, and (perhaps) consequently, their life. When considering different treatments for different sections of the population, the valuation might promote ends which it is not clear ought to be pursued. For example, it might well be that the cost of not treating those in the work force would be higher than for others, so the former ought to be favoured for treatment, all else being equal. Such a conclusion would necessarily follow from the assumption that the productive are the more valuable members of society, and the inclusion of indirect costs is equivalent to this assumption. However, it is not at all clear that preferential treatment for the productive would result in a fair health system. Many societies would not wish to discriminate in this way, and few would wish to make it explicit.

On the other hand excluding such costs would also be discriminatory, in this case against the productive. Society does benefit from treatment allowing people to return to work earlier than they might otherwise have done. The social benefit is additional to the benefit experienced by the individual because of the alleviation of their sickness. If the productive consequences of treatment are ignored there may be a misallocation of resources away from treatments which increase *both* social and individual welfare to those which increase individual welfare *only*, resulting in a decrease in net social benefit.

However, the purpose of the present analysis is not to discriminate between persons, but between treatments. The basis for preferring one treatment to another is that it produces the same outcome for a lower cost, or a better outcome for the same cost. As long as there

[3] The average wage rate of persons was used in this analysis.

is no difference in the patient populations receiving each treatment we can be confident that the resulting cost or outcome differences are attributable to the treatment rather than to specific patient characteristics. By broadening the analysis so that indirect as well as direct costs are incorporated it is hoped that social welfare and not merely hospital efficiency will be improved.

4.3. Travel Costs.

4.3.1. Introduction.

Travel costs consist of two components: the cost of transportation and the cost of time spent travelling. Patients were asked how many trips they made to the hospital, how far they lived from hospital, and the mode of transport they used to get there. Table 4.14 and figure 4 present data on the first of these questions. On average open cholecystectomy patients made 4 visits, laparoscopic cholecystectomy patients made 3 visits, and ESWL patients visited the hospital 7 times. Over 60% of ESWL respondents estimated that they had made over 6 trips to the hospital.

Table 4.14
NUMBER OF TRIPS MADE TO ST VINCENT'S

Number of trips to hospital	***Open Cholecystectomy***	***Laparoscopic Cholecystectomy***	***ESWL***
number of respondents	*60*	*63*	*264*
mean	3.8	3.2	6.9
median	3	3	7
standard deviation	± 2.9	± 2.2	± 4.6
range	1 - 13	1 - 10	1 - 22

[1] Prior to trimming, the mean values were 4.1 (± 3.4, max 18), 3.5 (± 2.8, max 15), and 7.5 (± 5.3, max 30) for open cholecystectomy, laparoscopic cholecystectomy and ESWL respectively.

Figure 4
NUMBER OF TRIPS MADE TO HOSPITAL

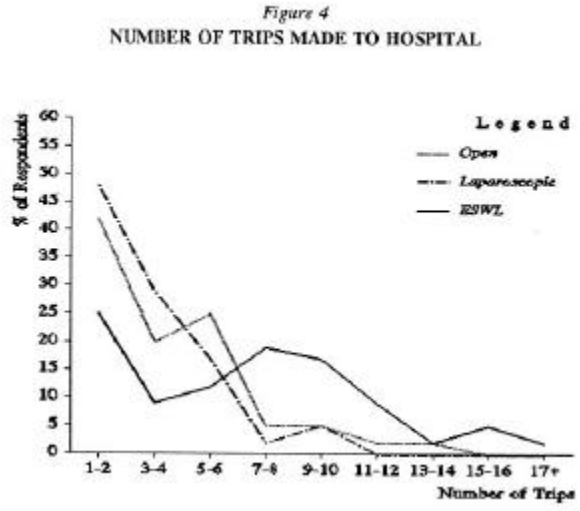


Table 4.15 shows the distance respondents lived from hospital. A high proportion of ESWL respondents (27.1%) lived more than 40 kilometres from the hospital. Because ESWL was unavailable elsewhere in Australia, patients were referred from further afield than those undergoing surgery. If ESWL were as widely available as the surgical treatments there would be no difference in the patient catchment area for each treatment and the distance patients lived from hospital would be unrelated to the treatment they received. For this reason, transportation costs have been calculated on the assumption that *all* patients lived the same distance from hospital. Lower and upper estimates of 11 and 20 kilometres have been used.

Table 4.15
DISTANCE RESPONDENTS LIVE FROM ST VINCENT'S

Distance from hospital	*Open Cholecystectomy number (%)*	*Laparoscopic Cholecystectomy number (%)*	*ESWL number (%)*	*All respondents number (%)*
less than 10 km	21 (35.0)	16 (25.8)	37 (13.9)	74 (19.1)
11 - 20 km	24 (40.0)	18 (29.0)	80 (30.1)	122 (31.4)
21 - 30 km	4 (6.7)	9 (14.5)	51 (19.2)	64 (16.5)
31 - 40 km	5 (8.3)	7 (11.3)	26 (9.8)	38 (9.8)
more than 40 km	6 (10)	12 (19.4)	72 (27.1)	90 (23.2)

4.3.2. Transportation costs.

Table 4.16 shows the mode of transport used by patients to travel to hospital. The majority of respondents travelled to hospital in a private car on at least one occasion. Public transport and taxis were used to a lesser extent. Some respondents used more than one mode of transport on a single trip. A small minority of respondents travelled interstate by airplane for ESWL. The cost of their transportation has been ignored as such costs would not occur if the technology diffused throughout the country.

Table 4.16
MODE OF TRANSPORT USED ON AT LEAST ONE OCCASION

Mode of transport	*Open Cholecystectomy number (%)*	*Laparoscopic Cholecystectomy number (%)*	*ESWL number (%)*
private car	44 (72.1)	57 (87.7)	203 (75.5)
taxi	9 (14.8)	7 (10.8)	38 (14.1)
public transport	15 (24.6)	22 (37.8)	94 (34.9)
other (pedestrian, ambulance, airplane)	6 (9.8)	4 (6.2)	16 (5.9)

The cost of transportation has been applied to each patient according to the number of trips they made to the hospital. To account for the mode of transport it has been assumed that all patients travelled by private car, or, alternatively, that all trips were made on public transport. Other modes of transport have been ignored.

The Public Sector Board recommends reimbursement to cover petrol and wear and tear of $0.48 per kilometre for cars with two litre engines or above. This figure was used to estimate the cost of a trip to and from hospital by private car.

As estimates of the cost of using public transport the price of one and two zone day tickets ($3.60 and $5.40) were used, assuming patients lived 11 km or 20 km from hospital (zone two begins beyond a 20 km circle drawn from Melbourne's General Post Office). No attempt has been made to account for subsidisation of the public transport system.

Table 4.17
ESTIMATES OF TRANSPORTATION COSTS

Transportation costs	***Open cholecystectomy***		***Laparoscopic cholecystectomy***		***ESWL***	
	Lower estimate ($)	*Upper estimate ($)*	*Lower estimate ($)*	*Upper estimate ($)*	*Lower estimate ($)*	*Upper estimate ($)*
mean	14	74	11	61	25	133
standard deviation	± 10	± 56	± 8	± 42	± 16	± 88
range	4 - 47	19 - 250	4 - 36	19 - 192	4 - 79	19 - 422

[1] Prior to trimming, the mean values ranged from $15 (± 12) to $78 (± 65) for open cholecystectomy, $13 (± 10) to $67 (± 54) for laparoscopic cholecystectomy and from $26 (± 19) to $140 (± 101) for ESWL.

Table 4.17 shows the estimated transportation costs incurred by respondents during the full course of their treatment. The lower estimate of the average cost of transportation for open cholecystectomy respondents was $14 (± 10) if the patient lived within 11 km of the hospital and used public transport. The upper estimate was $74 (± 56) if the patient lived 20 km from hospital and used a private car for transport. The corresponding estimates for laparoscopic cholecystectomy range from $11 (± 7) to $61 (± 42), and from $25 (± 16) to $133 (± 88) for ESWL.

4.3.3. Travel time costs.

The estimation of the cost of time spent travelling poses a number of methodological problems. First, patients were not asked to provide estimates of their travel times. However, given the above comments about transportation costs, it would be inappropriate to estimate travel time on the patients' actual experiences because of the different catchment areas for each treatment. To overcome this, travel time has been estimated on the basis of a typical journey by private car or public transport for patients living at a distance of 11 and 20 kilometres from the hospital, these distances chosen for reasons outlined earlier.

It was assumed (after fieldwork) that it took approximately 30 minutes to travel 11 km to St Vincent's by private car, compared to an hour by public transport, including waiting time. For distances of 20 km, times of 45 minutes and 90 minutes were assumed for travel by private car and public transport respectively.

The second problem is how the cost of travel time ought to be estimated. The rationale for including such costs is that travel time has an opportunity cost, because the time could be otherwise spent working or engaging in leisure activity. A number of studies have assessed the value of road building projects in terms of the time savings they would produce. In

general these separate working and non-working time savings, on the basis of behavioural studies which suggest that people place a lower valuation on the latter.

Travel undertaken as part of a person's employment is usually treated as an input into production, and therefore time savings are valued in terms of the marginal product of labour, or employment cost. However, this assumes that time spent travelling is unproductive, and that employers are able to utilise time savings. Neither condition need hold: travellers may read documents on the train, workers spending less time on the road may have an extra five minutes for morning coffee. Applying hourly employment costs might therefore overestimate the value of working time saved. On the other hand, it has been argued that hourly employment costs underestimate the value, because of the cost of overhead capital left idle when the worker is absent (Commission on the Third London Airport, 1970). However, assessing the cost according to the marginal product of labour would be inappropriate because it cannot be assumed that all of the employed patients were at work on the day(s) they visited the hospital. The patients' travel was not work related, and should not be valued as such. Consequently, a value for non-working time has been used here.

The valuation of non-working time savings is complex, and economists have attempted to impute values using a variety of methods. Beesley (1965) estimated the value of leisure time at half the earning rate by examining preferences for choices of transport in terms of the savings the mode made to time or money. Dalvi and Lee (1971) used questionnaires to analyse the determinants of demand for motor travel, and estimated the actual and perceived costs faced by motorists. Motorists were found to ignore some of their marginal costs, such as maintenance expenditure, when making a choice about the mode of transport. They estimated a range for the value of time savings from 40% if actual marginal costs were used in the calculation to 10% when calculated on the basis of perceived marginal costs. The UK Department of Transport currently uses an estimate of 40% of the average hourly earnings of commuters for the value of non-working time savings (Sharp 1988).

In calculating the cost of travel time the 40% estimate used by the UK Department of Transport was used for all respondents. The average weekly earnings for persons, rather than separate estimates for males and females, was used, from which an estimate was derived of $6.18 per hour spent travelling. When patients travelled by public transport, the average cost was $18 (± 13), $15 (± 10), and $32 (± 21) for open cholecystectomy, laparoscopic cholecystectomy, and ESWL respectively. If travelling by private car the respective average costs were estimated at $24 (± 18), $20 (± 13), and $43 (± 28). Details are provided in table 4.18.

Table 4.18
ESTIMATES OF TRAVEL TIME COSTS

Travel time costs	***Open cholecystectomy***		***Laparoscopic cholecystectomy***		***ESWL***	
	Lower estimate ($)	*Upper estimate ($)*	*Lower estimate ($)*	*Upper estimate ($)*	*Lower estimate ($)*	*Upper estimate ($)*
mean	18	24	15	20	32	43
standard deviation	± 13	± 18	± 10	± 13	± 21	± 28
range	5 - 60	6 - 80	5 - 46	6 - 62	5 - 102	6 - 136

[1] Prior to trimming, the mean values ranged from $19 (± 16) to $25 (± 21) for open cholecystectomy, $16 (± 13) to $22 (± 17) for laparoscopic cholecystectomy, and from $34 (± 24) to $45 (± 33) for ESWL.

4.3.4. Average total travel costs.

Table 4.19 presents upper and lower estimates of the average cost of travel, incorporating both the cost of transportation and travel time. The lower estimate applies when the patient travels by public transport with the journey taking 45 minutes, while the upper estimate corresponds with a journey lasting one hour in a private car. Journeys lasting an ninety minutes by public transport and thirty minutes by private car fell within these estimates, and details have not been reported. The range in the estimate of average total travel cost was \$32 (± 24) to \$97 (± 74) for open cholecystectomy, \$26 (± 18) to \$81 (± 55) for laparoscopic cholecystectomy, and \$56 (± 38) to \$175 (± 116) for ESWL. Tukey's HSD test revealed that ESWL mean costs were significantly different from those of the two surgical procedures (p<0.001), because of the greater number of trips made by ESWL patients.

Table 4.19
AVERAGE TOTAL COST OF TRAVEL

Estimate	***Open Cholecystectomy ($)***	***Laparoscopic Cholecystectomy ($)***	***ESWL ($)***
Lower	32 (± 24)	26 (± 18)	57 (± 38)
Upper	97 (± 74)	81 (± 55)	175 (± 116)

[1] Prior to trimming, the mean values ranged from \$33 (± 28) to \$103 (± 87) for open cholecystectomy, \$29 (± 23) to \$89 (± 71) for laparoscopic cholecystectomy, and from \$60 (± 43) to \$185 (± 134) for ESWL.

4.4. Costs Borne by Carers.

Patients were asked whether they had been assisted and cared for during the course of their treatment and recovery by professional carers (other than in hospital) or by a relative or friend, and, if so, how much care they had received.

4.4.1. Professional carers.

Few respondents indicated that they required any form of professional care. Table 4.20 shows the type of professional care received, while table 4.21 provides information on the amount of care provided, in hours. 9.8% of open cholecystectomy respondents used some form of professional care, amounting to an average of 12 minutes for all respondents, after outliers had been trimmed from the data. One open cholecystectomy patient spent a week recovering with a religious community, and was treated as an outlier. Professional care was required by 4.6% of laparoscopic cholecystectomy respondents, amounting to an average of 2 minutes after trimming. Only 1.5% of ESWL respondents used such care. However, because of the trimming criteria, these cases were treated as outliers.

Table 4.20
PROFESSIONAL CARE RECEIVED

Care Provided	***Open Cholecystectomy (%)***	***Laparoscopic Cholecystectomy (%)***	***ESWL (%)***
none	90.2	95.4	98.5
housekeeper/home help	3.3	3.1	1.1
home nursing/district nurse	1.6	1.5	0.0
general practitioner	3.3	0.0	0.4
other	1.6	0.0	0.0

Table 4.21
HOURS OF PROFESSIONAL CARE RECEIVED

Hours of professional care received	***Open Cholecystectomy (hours)***	***Laparoscopic Cholecystectomy (hours)***	***ESWL (hours)***
number of respondents	*59*	*63*	*266*
mean	0.2	0.0	0.0
median	0	0	0
standard deviation	± 1.1	± 0.3	± 0.0
range	0 - 6	0 - 2	0 - 0

[1] Prior to trimming, the mean values were 2.05 (± 10.7, max 75), 1.94 (± 10.9, max 72), and 0.03 (± 3, max 3) for open cholecystectomy, laparoscopic cholecystectomy and ESWL respectively.

The cost of professional carers has been calculated according to the type of carer. For care received by housekeepers and home helpers the hourly award rate of $10.77 was used, as this was the usual rate for home helps in Victoria. (This rate was also used to cost the care received by the patient at the religious community, assuming 38 hours of care had been provided (see footnotes to tables 4.21 and 4.22 regarding untrimmed data)). Home and district nurses were assumed to be Grade 3A registered nurses on a weekly salary $671.80. The benefit for a level 'C' surgery consultation of $46.50 for visits of longer duration than forty minutes was used to cost the time spent with general practitioners or hospital out-patient departments.

Table 4.22 shows the estimated average cost of professional care. This amounted to $8 (± 55) for open cholecystectomy respondents, $0 (± 3) for laparoscopic cholecystectomy respondents, and $0 (± 0) for ESWL respondents.

Table 4.22
THE COST OF PROFESSIONAL CARE

Cost of professional care received	***Open Cholecystectomy ($)***	***Laparoscopic Cholecystectomy ($)***	***ESWL ($)***
mean	8	0	0
median	0	0	0
standard deviation	± 55	± 3	± 0
range	0 - 419	0 - 22	0 - 0

[1] Prior to trimming, the mean costs were $36 (± 184, max 1,326), $29 (± 171, max 1,272), and $0 (± 4, max 47) for open cholecystectomy, laparoscopic cholecystectomy and ESWL respectively.

4.4.2. Informal carers.

Patients were asked if they were cared for by a relative or friend and, if so, for how much time. 86.9% of open cholecystectomy respondents indicated that they had received such care, compared to 72.3% of laparoscopic cholecystectomy respondents, and 48.7% of ESWL respondents.

Tables 4.23 and 4.24 show the number of days lost to paid work and regular activity as a result of the provision of care. The mean number of days lost to paid work and regular activity was 1.1 and 8.9 days for carers of open cholecystectomy respondents, while the corresponding mean days lost were 0.7 and 1.8 for carers of respondents who had undergone laparoscopic cholecystectomy, and 0.3 and 0.4 by carers of ESWL respondents.[4]

Table 4.23
DAYS LOST TO PAID WORK BY CARERS

Days of paid work lost	***Open Cholecystectomy (days lost)***	***Laparoscopic Cholecystectomy (days lost)***	***ESWL (days lost)***
number of respondents	*59*	*64*	*265*
mean	1.1	0.7	0.3
median	0.0	0.0	0.0
standard deviation	± 3.1	± 1.8	± 0.7
range	0 - 14	0 - 10	0 - 4

[1] The proportion of respondents saying no time was lost was 80% for open cholecystectomy, 79% for laparoscopic cholecystectomy, and 85% for ESWL. [2] Prior to trimming, the mean days lost were 1.9 (± 5.22, max 28), 1.4 (± 5.8, max 45), and 0.4 (± 1.3, max 14) for open cholecystectomy, laparoscopic cholecystectomy and ESWL respectively.

[4] Note that the sample sizes differ in table 4.23 from table 4.24 because of trimming of the data.

Table 4.24
DAYS LOST TO REGULAR ACTIVITY BY CARERS

Days of regular activity lost	*Open Cholecystectomy (days lost)*	*Laparoscopic Cholecystectomy (days lost)*	*ESWL (days lost)*
number of respondents	*60*	*62*	*260*
mean	8.9	1.8	0.4
median	0.0	0.0	0.0
standard deviation	± 25.4	± 4.5	± 1.3
range	0 - 120	0 - 30	0 - 8

[1] The proportion of respondents saying no time was lost was 67% for open cholecystectomy, 69% for laparoscopic cholecystectomy, and 81% for ESWL. [2] Prior to trimming, the mean days lost were 12.6 (± 38.9, max 240), 3.8 (± 10.3, max 55), and 0.9 (± 2.9, max 24) for open cholecystectomy, laparoscopic cholecystectomy and ESWL respectively.

i) Opportunity cost of caring.

Two approaches have been used to estimate the value of time lost by informal carers in their care of patients recovering from treatment for gallstones. The first method estimates the cost of lost production by those who lost days to paid work using average employment costs, and the opportunity cost to those who lost time to their regular activities using 40% of average earnings. Tables 4.25 and 4.26 show the estimated value of days of paid work and regular activities respectively. Analysis of variance showed significant differences between the treatment groups in the value time lost to both paid work and regular activity (p<0.001). Tukey's HSD test for multiple comparisons showed the mean cost of days lost to paid work by carers of open cholecystectomy patients was significantly greater than for ESWL patients, but no significant difference was found between open cholecystectomy and laparoscopic cholecystectomy or between ESWL and laparoscopic cholecystectomy. The difference in mean cost of days lost to regular activity was significantly different for open cholecystectomy compared to both laparoscopic cholecystectomy and ESWL carers. Combining these averages by simple addition, the average cost of carers was estimated as $570, $187, and $57 for open cholecystectomy, laparoscopic cholecystectomy, and ESWL respondents respectively.

Table 4.25
THE COST OF DAYS LOST TO PAID WORK BY CARERS

The cost of days of paid work lost	*Open Cholecystectomy ($)*	*Laparoscopic Cholecystectomy ($)*	*ESWL ($)*
mean	154	101	36
median	0	0	0
standard deviation	± 426	± 255	± 102
range	0 - 1,932	0 - 1,380	0 - 552

[1] Prior to trimming, the mean costs were $260 (± 720, max 3,865), $195 (± 799, max 6,211), and $51 (± 173, max 173) for open cholecystectomy, laparoscopic cholecystectomy and ESWL respectively.

Table 4.26
THE COST OF DAYS LOST TO REGULAR ACTIVITY BY CARERS

Cost of days of regular activity lost	***Open Cholecystectomy ($)***	***Laparoscopic Cholecystectomy ($)***	***ESWL ($)***
mean	416	86	21
median	0	0	0
standard deviation	± 1,192	± 214	± 63
range	0 - 5,638	0 - 1,409	0 - 376

[1] Prior to trimming, the mean costs were $594 (± 1,825, max 11,275), $179 (± 482, max 2,584), and $42 (± 135, max 1128) for open cholecystectomy, laparoscopic cholecystectomy and ESWL respectively.

ii) Replacement cost of caring.

The alternative approach to valuing the care provided by family and friends is to consider who could have provided the care in their absence. It is hypothesised that the patient would be likely to seek care through the home help system if relations were unavailable. Using this as an estimate will be inaccurate if home helps are not perfect substitutes for family and friends. No distinction is made between days lost to paid or regular activity. The mean number of days when care was provided was 15 (± 39) for open cholecystectomy patients, 4 (± 8) for laparoscopic cholecystectomy patients, and 1 (± 2) for ESWL patients.[5]

Table 4.27 shows the estimates of the average cost of care if it had been provided by home helps paid a daily wage of $82 (or $11 per hour). The average cost of caring for an open cholecystectomy patient was estimated as $881 (± 2,066), compared to $307 (± 662) for laparoscopic cholecystectomy respondents, and $69 (± 145) for ESWL respondents. Between group differences were significant ($p<0.001$). The difference in the mean replacement cost was significantly different for open cholecystectomy compared to both laparoscopic cholecystectomy and ESWL.

Table 4.27
THE COST OF CARE PROVIDED BY RELATIVES, BASED ON COST OF ALTERNATIVE PROVIDERS

Cost of care provided	***Open Cholecystectomy ($)***	***Laparoscopic Cholecystectomy ($)***	***ESWL ($)***
number of respondents	*60*	*64*	*261*
mean	881	306	69
median	41	0	0
standard deviation	± 2,066	± 662	± 145
range	0 - 9,822	0 - 3,274	0 - 819

[1] Prior to trimming, the mean costs were $1,189 (± 3,157, max 19,644), $428 (± 1,177, max 8,185), and $104 (± 249, max 1,964) for open cholecystectomy, laparoscopic cholecystectomy and ESWL respectively.

[5] These estimates may not equal the sum of the estimates presented in tables 4.23 and 4.24 because of trimming subsequent to summing.

4.5. Conclusion: Average Total Patient Costs.

Average total patient costs are presented in the following tables. As with the preceding discussion these are presented as lower and upper estimates. The best estimate of mean cost for each variable is derived from responses falling within three standard deviations of the untrimmed mean. Thus, the sample size differs for each cost variable because of trimming. The lower and upper estimates have been based on the following components:

COST CATEGORY		*BASIS FOR ESTIMATION*		*DETAILS IN TABLE*	
		Lower	*Upper*	*Lower*	*Upper*
Indirect:	*Paid activity*	all those who were in paid employment	those in paid employment who provided positive estimates of lost time	*4.6*	*4.7*
	Home duties	opportunity cost	replacement cost	*4.9*	*4.10*
	Leisure	none	none		
	Total			*4.11*	*4.12*
Travel:	*Transportation*	public transport	private car	*4.17*	*4.17*
	Travel time	45 minutes	60 minutes	*4.18*	*4.18*
	Total			*4.19*	*4.19*
Professional care		various wage rates	various wage rates	*4.22*	*4.22*
Informal care		opportunity cost (paid work: average employment cost; others: 40% average earnings)	replacement cost (home help)	*4.27*	*4.25 and 4.26*

The lower and upper estimates of total patient costs are presented in tables 4.28 and 4.29 respectively. The average indirect and patient costs of treatment have been calculated as ranging from $2,830 to $3,556 for open cholecystectomy, from $1,162 to $1,518 for laparoscopic cholecystectomy, and from $371 to $575 for ESWL.

Table 4.28
AVERAGE TOTAL PATIENT COSTS, LOWER ESTIMATE

Average total patient cost	***Open Cholecystectomy ($)***	***Laparoscopic Cholecystectomy ($)***	***ESWL ($)***
paid activity and home duties	2,219	946	254
travel	33	29	60
professional care	8	0	0
informal care	570	187	57
total	2,830	1,162	371

[1] Prior to trimming, the lower estimates for mean total costs were $3,235, $1,416, and $478 for open cholecystectomy, laparoscopic cholecystectomy and ESWL respectively.

Table 4.29
AVERAGE TOTAL PATIENT COSTS, UPPER ESTIMATE

Average total patient cost	*Open Cholecystectomy ($)*	*Laparoscopic Cholecystectomy ($)*	*ESWL ($)*
paid activity and home duties	2,564	1,123	321
travel	103	89	185
professional care	8	0	0
informal care	881	306	69
total	3,556	1,518	575

[1] Prior to trimming, the upper estimates for mean total costs were $4,340, $1,831, and $750 for open cholecystectomy, laparoscopic cholecystectomy and ESWL respectively.

For ESWL patients these average total costs are also presented according to stone size in table 4.30. The lowest average patient costs were associated with those who had single small stones, where the mean ranged from $311 to $453, while those with single large stones had the highest average patient costs, ranging from $558 to $786. This reinforces the estimate of hospital costs for ESWL, where a similar ranking by stone size and number occurred, except for those with multiple stones and those with single medium size stones where the former incurred lower patient costs.

Table 4.30
AVERAGE TOTAL ESWL PATIENT COSTS BY STONE CATEGORY

Stone size/number	*Maximum number of respondents*[1]	*Lower estimate ($)*	*Upper estimate ($)*
single small stone	36	311	453
single medium stone	117	394	599
single large stone	27	558	786
multiple stones	88	297	492

[1] As a result of trimming, the sample size differs for each cost component. Prior to trimming, the mean costs for the respective categories were $333, $505, $741, and $419 based on lower estimates, and $569, $773, $1,028, and $711 based on upper estimates.

SUMMARY: AVERAGE TOTAL COSTS, UNCONVERTED PATIENTS.

Table S2 shows the combined results of sections 2, 3, and 4. The inclusion of indirect and patient costs is of more significance for the surgical procedures, accounting for 50% of the total cost of open cholecystectomy and almost 40% of the total cost of laparoscopic cholecystectomy. In contrast, indirect and patient costs amount to less than 15% of the total cost of ESWL.

When total costs are considered open cholecystectomy is clearly the more expensive option. In general, the cost advantage of laparoscopic cholecystectomy over ESWL remains when indirect and patients costs are included, the exception being ESWL patients with single small stones, for whom treatment is least expensive on average.

These estimates do not yet include the cost of surgery following ESWL, nor of the conversion to open surgery during laparoscopic cholecystectomy. The cost consequences of conversion are discussed in the next section.

Table S2
AVERAGE HOSPITAL AND PATIENT COSTS

Procedure	*Open cholecystectomy ($)*	*Laparoscopic cholecystectomy ($)*	*ESWL ($)*			
			small stone	*medium stone*	*large stone*	*multiple stones*
Lower estimate						
Hospital	3,053	2,393	2,783	3,161	4,094	3,36
Patient	2,830	1,162	311	394	558	29
Total	5,883	3,555	3,094	3,555	4,652	3,65
Upper estimate						
Hospital	3,366	2,581	3,356	3,896	5,061	4,17
Patient	3,556	1,518	453	599	786	49
Total	6,922	4,099	3,809	4,495	5,847	4,66

5. CONVERSION TO OTHER PROCEDURES.

5.1. Laparoscopic conversions.

It can be expected that a proportion of patients undergoing laparoscopic cholecystectomy will be converted to the open procedure because of difficulties encountered during the course of the operation, which could not be anticipated beforehand. Unfortunately such patients had been excluded from the study. However, a valid comparison of treatment options must consider all of the consequences of each option even when unanticipated outcomes occur.

Table 5.1
ESTIMATED COST OF CONVERSION TO OPEN SURGERY

Components	*Lower estimate ($)*	*Upper estimate ($)*
Surgeon[1]	241	261
Tests and investigations[2]	182	182
Theatre costs:		
staff[3]	457	457
equipment[4]	393	393
capital	69	69
Nursing[5]	728	984
Hospital & ward overheads[6]	1,244	1,286
Pharmacy[7]		
medication	40	40
overheads	69	69
CBD damage	27	27
Indirect and patient costs[8]	2,830	3,556
Total	6,280	7,324

[1] The estimate of the cost of the surgeon was the average cost of the full time spent in theatre by the surgeon performing open cholecystectomy *(table 2.5)*, plus the average cost of the time spent performing the laparoscopic operation. [2] Assumes the average cost for laparoscopic cholecystectomy. [3] The estimate comprises the cost of staff present in theatre during open cholecystectomy *(table 2.8)*, plus the staff cost derived from the average time of a laparoscopic operation. [4] The cost of theatre consumables and equipment was estimated as the sum of that used for the laparoscopic cholecystectomy procedure *(table 2.9)*, plus any additional items which would have been used following conversion. It was assumed that these additional items were the instruments used for open cholecystectomy, the anaesthetic, and consumables listed in appendix table B4 but not in table B5. [5] The lower estimate of nursing costs assumed nurses on St Joan's ward were at the lower end of their relevant pay scales *(table 2.13)*. The upper estimate assumed nursing staff on St Joseph's ward were at the higher end of their salary scales *(table 2.13)*. [6] The lower and upper estimates of ward and hospital overheads were those associated with St Joan's and St Joseph's respectively *(table 2.16)*. [7] Pharmacy costs were calculated as the sum of the medication used by laparoscopic patients plus the analgesia for open cholecystectomy patients *(table 2.17)*, with overheads those for open cholecystectomy patients. [8] The lower and upper estimates of indirect and patient costs incurred by open cholecystectomy patients were assumed for these costs *(tables 4.28 and 4.29)*.

Table 5.1 shows the estimated cost of converting a patient to open cholecystectomy as $6,280 or $7,324 depending on the basis for estimation. The average cost of laparoscopic cholecystectomy was estimated using a weighted average of the cost of converted and unconverted patients. With an assumed 10% conversion rate, based on the lower

worldwide estimate (Cook *et al*, 1993*a*), the lower and upper estimates of the average cost of laparoscopic cholecystectomy becomes $3,827 and $4,422 respectively.

5.2. ESWL conversions.

Of the 454 patients who received ESWL, 20% were subsequently admitted for surgery *(table 5.2)*. This percentage differs by stone size, with 16% of patients who first presented with single small stones requiring subsequent surgery compared to 24% of patients with multiple stones.

Table 5.2
PERCENTAGE OF ESWL PATIENTS WHO REQUIRED SUBSEQUENT SURGERY

Stone size/number	***All patients***	***Converted patients***	***% converted***
all patients	454	91	20
single small stone	69	11	16
single medium stone	212	39	18
single large stone	44	10	23
multiple stones	129	31	24

It has been assumed that patients who subsequently convert to surgery incur the same treatment, follow-up and patient costs, on average, as other ESWL patients. However, their costs differ in two respects. Firstly, patients who underwent subsequent surgery typically took litholytic therapy for a shorter period than those who did not convert. The average cost of litholytic therapy was $848 (± 686) for the former group and $1,163 (± 778) for the latter. Details according to stone category are presented in table 5.3.

Table 5.3
AVERAGE COST OF LITHOLYTIC THERAPY, CONVERTED AND NON-CONVERTED PATIENTS
excluding those lost to follow-up

Stone size/number	***Patients who do not have surgery ($)***	***Converted patients ($)***
all patients	1,163	848
single small stone	1,112	707
single medium stone	1,102	902
single large stone	1,403	1,219
multiple stones	1,214	709

Secondly, it has been assumed that the former group incur the average total cost of laparoscopic cholecystectomy (with a 10% probability of converting to open surgery during the course of the operation) *in addition* to their costs associated with ESWL. The average cost of ESWL followed by surgery comprises the components shown in table 5.4.

Table 5.4
ESTIMATED COST OF ESWL WITH CONVERSION TO LAPAROSCOPIC SURGERY

Components	*Lower estimate ($)*	*Upper estimate ($)*
Initial consultation	119	119
Treatment	1,652	2,406
Follow-up	370	370
Litholytic therapy	848	848
Subsequent hospital admission	18	18
Indirect and patient costs	371	575
Laparoscopic cholecystectomy	3,827	4,422
Total	7,205	8,758

Cost details of ESWL followed by surgery are presented in table 5.5 for each stone category, with details for those who do not subsequently undergo surgery in table 5.6. The mean cost estimates in table 5.6 differ from those presented in table 3.9 because of the difference in the cost of litholytic therapy as shown above *(table 5.3)*.

Table 5.5
AVERAGE COST OF ESWL PLUS LAPAROSCOPIC CHOLECYSTECTOMY

Stone size/number	*Lower estimate ($)*	*Upper estimate ($)*
all patients	7,205	8,758
single small stone	6,585	7,895
single medium stone	7,222	8,757
single large stone	8,339	10,129
multiple stones	7,118	8,715

Table 5.6
AVERAGE COST OF ESWL WITHOUT LAPAROSCOPIC CHOLECYSTECTOMY

Stone size/number	*Lower estimate ($)*	*Upper estimate ($)*
all patients	3,773	4,731
single small stone	3,163	3,878
single medium stone	3,595	4,535
single large stone	4,696	5,891
multiple stones	3,796	4,798

The average cost of ESWL for each stone category was estimated using a weighted average of the cost of converted and unconverted patients, assuming the conversion probabilities shown in table 5.2 for each stone category. The average cost of ESWL for all patients including those who subsequently undergo surgery is presented in table 5.7. This ranged from $4,521 for those with small stones to $6,865 for those with large stones, assuming upper estimates.

Table 5.7
AVERAGE COST OF ESWL

Stone size/number	*Lower estimate ($)*	*Upper estimate ($)*

all patients	4,459	5,536
single small stone	3,711	4,521
single medium stone	4,248	5,295
single large stone	5,534	6,865
multiple stones	4,593	5,737

6. CONCLUSION.

Table 6.1 shows the final estimates of average hospital and total costs of each procedure, including the cost of conversion to other procedures. When only hospital costs are considered, laparoscopic cholecystectomy is unambiguously the least expensive procedure. The inclusion of indirect and patient costs reduces its cost advantage relative to ESWL, although, in general, it remains the cheaper option. The exception is ESWL for patients with small stones who may be least expensive to treat ($3,711 compared to $3,827, assuming low cost estimates). However, this conclusion is sensitive to the basis for estimation, such patients being more expensive than laparoscopic cholecystectomy when upper estimates are used ($4,521 compared to $4,422).

If total costs are considered, ESWL has a cost advantage over open cholecystectomy for all patients except those with single large stones, but again this exception is sensitive to the basis for estimation. Moreover, if only hospital costs are considered, open cholecystectomy is a cheaper option than ESWL for all stone categories. The inclusion of indirect and patient costs might reverse the choice of procedure if only ESWL and open cholecystectomy were available (and the outcomes were the same). This demonstrates that an efficient allocation of resources within the hospital sector might be sub-optimal socially.

The average cost of ESWL varies considerably depending on stone category, with those with large stones costing approximately 50% more than those with small stones.

Table 6.1
AVERAGE TOTAL COSTS

Procedure	*Open cholecystectomy ($)*	*Laparoscopic cholecystectomy ($)*	*ESWL ($)*			
			small stone	*medium stone*	*large stone*	*multiple stones*
Lower estimate						
Hospital only	3,053	2,498	3,187	3,615	4,670	3,97
Total	5,833	3,827	3,711	4,248	5,534	4,59
Upper estimate						
Hospital only	3,366	2,699	3,792	4,386	5,683	4,82
Total	6,922	4,422	4,521	5,295	6,865	5,73

No conclusion as to which treatment is most cost beneficial can be drawn from these cost figures because nothing has been said about the outcomes experienced by patients, which is the other side of the equation. This aspect of the study is dealt with in the companion papers by Cook and Richardson (1993*a*, 1993*b*). The costs and the outcomes of the three treatments are discussed in Cook, Richardson and Street (1993*b*), which presents a summary and overview of the full study, including sensitivity analysis.

It should also be noted that the objective of this study has not been to ascertain the average cost of performing each procedure for all patients who might be treated by that procedure. Instead what is being estimated is the average treatment cost for that subset of patients

who could have received *any* of the three treatments. Extrapolation to patients for whom open cholecystectomy (say) is the *only* option from patients who have choice would be inappropriate. It is not known how many patients are in this former category.

This paper has described in some detail the methodology employed in the estimation of hospital, indirect and patient costs. Crucial to the results has been the quality of information available. As regards hospital costs, the information collected for each patient by the biliary lithotripsy unit was extraordinarily detailed and enabled costing to be conducted on a patient specific basis for most items. It is not surprising, however, that some costs had to be approximated (for instance, the dosages of heparin) or derived from alternative sources (for instance, average daily nursing costs). As information itself is not costless to collect, one has to weigh up the collection costs against the additional value that the information will provide. With the cost of the average dose of heparin being only $0.27, ascertaining actual patient dosages would have made next to no difference to the final results. On the other hand, some effort was spent deriving nursing costs because it was believed that these would be a major component of hospital costs (they accounted for approximately 20% of total hospital costs for open and laparoscopic cholecystectomy).

With hospitals collecting (and retaining) more information through Management Information Systems (MIS) and other databases, the cost side of economic evaluation will be aided in the future. It is hoped that MIS will improve the quality of information available and reduce the marginal cost of collecting additional data.

There is still some way to go before the same can be said of the information pertaining to patient and indirect costs. Some of the deficiencies in the questionnaire used in this study have been acknowledged. Improvements to questionnaire design should generate improvements in the information received. However, even if patients respond as intended (let alone if they respond at all) most of the problems in estimating indirect and patient costs arise not from the quality of the information, but rather from the bases for the valuation. With it being disputed which costs should be included in an analysis in the first place, there is even less agreement as to what should guide the estimation of the components that might be included. The questions about how to value paid and non-paid activity or travel time cannot be resolved within the confines of a single evaluation. This paper has attempted to outline some of the problems in so far as they impact on the study itself, but no attempt has been made to suggest one method of estimation is preferable to another. Nor is it claimed that there are no other methods that could have used. Both the theoretical questions and practical considerations regarding indirect and patient costing deserve the attention of a separate investigation.

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APPENDIX A

Private Payments

Payments for treatment provided to private patients are made by Medicare, and by the patients themselves directly as a result of co-payments. Medicare pays 75% of the schedule fee specified in the Commonwealth Medicare Benefits Schedule for the service provided.

A1. Cholecystectomy and ESWL.

1. Physician services.

i) Open and laparoscopic cholecystectomy.

In the fourth quarter of 1991, 1095 cholecystectomies performed throughout Australia attracted benefits from the Health Insurance Commission (HIC), which administers Medicare reimbursements. The item numbers and schedule fees were altered during the fourth quarter of 1991, from when data has been used to estimate private payments. The schedule fee for cholecystectomy was increased from $465 (item number 3798) to $510 (item number 30420). Table A1 shows the total number of cholecystectomies which attracted benefits in this quarter, together with the sum of benefits and charges.

Separate item numbers do not yet exist for open and laparoscopic cholecystectomy. It has been assumed, therefore, that the surgeon bills for performing a laparoscopy as well as a cholecystectomy when laparoscopic cholecystectomy is performed. Details of total number of laparoscopies which attracted HIC benefits are provided in table A1.

Table A2 shows the average benefits and charges for performing cholecystectomy and laparoscopy. The average charge for cholecystectomy was $578, while the average benefit paid amounted to $368 *(table A2)*. For laparoscopy the average charge and benefit were $220 and $145 respectively. The average benefit amounted to 64% and 70% of the average charge for the two procedures. Thus, it is assumed that the patient co-payment amounted to 36% and 30% of the respective average charge. No information is available about the rate of non-payment to estimate actual average payment levels.

ii) ESWL.

There is at present no item number in the CMBS for ESWL treatment for patients with gallstones. As a proxy the code for ESWL to the urinary tract has been used. Details of the 508 instances in which ESWL attracted benefits from the HIC are provided in table A1. In addition to the treatment itself, payment under the item specifies that treatment is to be accompanied by the provision of post-treatment care for three days, and includes the pre-

treatment consultation. The average charge for the provision of ESWL was $614, while the average benefit paid amounted to $369 *(table A2).* The average benefit amounted to 60% of the average charge.

2. Assistance at the operation.

An assistant to the surgeon is required when cholecystectomy is performed. The CMBS specifies that the fee payable to a medical practitioner providing assistance at the operation is to be derived as one fifth of the established fee for the operation. The schedule fee for cholecystectomy amounts to $510, so the assistant's fee would be $102. The benefit payable to the assistant would amount to $76.50 (i.e. 75% of the schedule fee). To derive average charges, it has been assumed that the difference would reflect that between average benefits and charges for all claims made under the item number by general surgeons and urologists. Details of the total claims for assistance at the operation are presented in table A1, with the average benefit and charge presented in table A2. The average benefit amounted to 60% of the average charge. If the difference were the same for assistance provided during cholecystectomy, the charge would be $127.

3. Anaesthetist

The CMBS assigns anaesthetic units in connection with surgical procedures which are assigned benefit amounts. Cholecystectomy and ESWL to the urinary tract have values of 11 and 12 units respectively. Table A1 shows the total claims made for the administration of anaesthetic at these values for the fourth quarter of 1991. Table A2 shows the average benefits and charges derived from the aggregate information. The average benefit and charge were $76 and $132 for 11 units, and $102 and $173 for 12 units.

4. Total payments.

Table A3 shows the estimated total CMBS payments for each of the three procedures when provided to private patients, derived from the above components. The average total charges were estimated as $829 for open cholecystectomy, $1,050 for laparoscopic cholecystectomy, and $787 for ESWL. The patient co-payment was 37% of the total charge for cholecystectomy and 40% of the total charge for ESWL.

A2. Common Bile Duct Damage.

Exploration of the common bile duct and related procedures were conducted on a number of cholecystectomy and ESWL patients. The average benefit paid in the fourth quarter of 1991 for ERCP alone amounted to $171. An anaesthetic of eight units is specified for the service, and the average benefit for this was $58, giving a total of $230. The total charge amounted to $328. When a endoscopic sphincterotomy is conducted with ERCP, the total average benefit amounted to $533, with a total average charge of $738. When an endoscopic sphincterotomy was conducted alone (with an anaesthetic of eight units), the average benefit amounted to $361, with an average charge of $504.

The average cost to the HIC (AC_b) and average total cost (AC_t) of common bile duct damage for each of the three procedures was calculated as follows:

$$AC_b = p_1 (\$ER_b) + p_2 (\$ERES_b) + p_3 (\$ES_b)$$

$$AC_t = p_1 (\$ER_c) + p_2 (\$ERES_c) + p_3 (\$ES_c)$$

where p1, p2 and p3 are the proportions of patients who had ERCP only, ERCP and endoscopic sphincterotomy, and endoscopic sphincterotomy only, and $\$ER_b$, $\$ERES_b$, $\$ES_b$, $\$ER_c$, $\$ERES_c$, $\$ES_c$ are the average benefits and charges for ERCP only, ERCP and endoscopic sphincterotomy, and endoscopic sphincterotomy only.

The benefit and charge averaged across all patients amounted to $10 and $14 for open cholecystectomy, to $22 and $31 for laparoscopic cholecystectomy, and $14 and $19 for ESWL.

Table A1
TOTAL MEDICARE PAYMENTS AND CHARGES FOR SERVICES
Fourth Quarter 1991

Service	*Item Number*	*Volume*	*Benefit ($)*	*Schedule Fee ($)*	*Charge ($)*
Cholecystectomy	3798/30420[1]	1,095	402,893	536,664	633,398
Laparoscopy	4194/30585	224	32,487	43,259	49,324
Assistance at operation	2953/51303	3,162[2]	313,662	420,569	522,339
ESWL (urinary tract)	5700/36546	508	187,368	247,960	311,900
ERCP	3860/30453	566[3]	96,917	128,302	132,527
Endoscopic sphincterotomy	3862/30456	273[4]	82,720	109,953	111,851
Anaesthetic, 8 units	517/17908	43,873	2,561,461	3,383,543	4,115,234
Anaesthetic, 11 units	522/17911	30,284	2,304,533	3,068,454	3,728,632
Anaesthetic, 12 units	523/17912	7,974	810,954	1,080,728	1,376,103

[1] Includes 6 claims under item number 30419 (cholecystectomy provided by a generalist) or its former item number 3793.
[2] Total claims under this item number for general surgeons and urologists only.
[3] Total claims under this item number for general surgeons only (no claims were made by urologists).
[4] Total claims under this item number for general surgeons only (no claims were made by urologists).

Source: Health Insurance Commission

Table A2
AVERAGE MEDICARE PAYMENTS AND CHARGES FOR SERVICES
Fourth Quarter 1991

Service	*Item Number*	*Benefit ($)*[1]	*Charge ($)*	*Benefit as % of Charge*
Cholecystectomy	3798/30420[2]	368	578	64
Laparoscopy	4194/30585	145	220	70
Assistance at operation	2953/51303	99	165	60
ESWL (urinary tract)	5700/36546	369	614	60
ERCP	3860/30453	171	234	73
Endoscopic sphincterotomy	3862/30456	303	410	74
Anaesthetic, 8 units	517/17908	58	94	62
Anaesthetic, 11 units	522/17911	76	123	62
Anaesthetic, 12 units	523/17912	102	173	59

[1] Average benefits will not equal the 75% benefit specified in the Medicare Benefits Schedule because the schedule fee (and consequently the 75% benefit) was changed during the quarter. This resulted in a mix of services billed at the old and new rate.
[2] Includes claims under item number 3793/30419.

Source: derived from table A1.

Table A3
ESTIMATES OF TOTAL PAYMENTS FOR EACH PROCEDURE

Procedure	*Benefit ($)*	*Charge ($)*	*Benefit as % of Charge*
Open cholecystectomy	521	829	63
Laparoscopic cholecystectomy	666	1050	63
ESWL	471	787	60

APPENDIX B

Hospital Costs: Additional Tables

Table B1
CMBS BENEFITS FOR DIAGNOSTIC AND LABORATORY TESTS
effective 1 November 1991

Test or Investigation	***Item Number***	***Schedule Fee ($)***	***Benefit at 75% ($)***
Plain film of abdomen	58903	46.00	34.50
Oral cholecystectogram	58924	76.00	57.00
Ultrasound	55003	93.00	69.75
Isotope biliary scan	61359	245.00	183.75
CT abdomen	56400	138.00	103.50
Full Blood Examination (FBE)	65004	7.95	5.95
Electrolytes and Urea (E&U)	66212	21.00	15.75
Liver Function Test (LFT)	66212	21.00	15.75
Prothrombin Ratio (INR)	65030	12.60	9.45
Pregnancy Test	72528	10.20	7.65
Endoscopic Retrograde Cholangio-pancreatography (ERCP)	30453	250.00	187.50
Endoscopic Sphincterotomy	30456	390.00	292.50
Anaesthetic (eight units)	17908	100.00	75.00

Table B2

WEEKLY AND HOURLY PAY SCALES FOR THEATRE STAFF

effective 05/09/91

Staff	Scale	Time spent in attendance	Weekly Pay ($)	Hourly Pay ($)[1]
Medical Team *(excluding surgeon)*				
Surgical Registrar	MP8	Operation time	838.70	19.50*
Surgical Resident	MP4	Operation time	542.70	14.28
Consultant Anaesthetist	MQ5	Operation time plus 45 minutes	986.10	25.95
Anaesthetic Assistant	MP8	Operation time plus 45 minutes	838.70	19.50*
Radiographer	AF8	30 minutes	649.00	17.08
Nursing Staff				
Instrument Nurse	YS9	Operation time plus 45 minutes	680.30	17.90
Circulating Nurse	YP3	Operation time plus 45 minutes	510.90	13.44
OR Charge Nurse	YZ2	50% of operation time plus 45 minutes	816.20	21.48
Anaesthetic Nurse	YS9	1 hour	680.30	17.90
Recovery Room Nurse	YP6	50% of 45 minutes	593.40	15.62
Ancillary Staff				
Orderly	HZ5	45 minutes	417.40	10.98
Porter	IH6	30 minutes	379.20	9.98

[1] Calculated on the basis of a 38 hour week, except when indicated * where calculated on the basis of a 43 hour week.

Table B3

ANAESTHETIC COSTS FOR OPEN AND LAPAROSCOPIC CHOLECYSTECTOMY

Anaesthetic usage		
Anaesthetic	disposable gloves x5 pairs	1.00
	needles	0.30
	syringes	0.55
	jelco	0.84
	alcohol swabs	0.01
	IV giving set	0.98
	extension set	2.00
	airway	1.15
	nasal gastric tube	1.05
	drainage bag	0.75
	Yankeur sucker x2	0.72
	Tegaderm	0.52
	minimum volume tubing	2.20
	CO_2 lead	7.50
	ECG electrode	0.25
	Hudson mask	1.18
	O_2 tubing	0.59
	kidney dishes (disposable)	0.24
	sleek	0.30
	Hartmanns	1.19
	Lignocaine	0.32
	Vercuronium	11.64
	Thiopentone	3.95
	Diprivan	10.40
	Fentanyl	0.63
	Xylocaine jelly	2.60
	Ethrane	10.00
	Subtotal	**62.86**

Table B4

CONSUMABLES AND EQUIPMENT USED DURING AN OPEN CHOLECYSTECTOMY OPERATION

Costs particular to Open Cholecystectomy		
Operating room attire[1]	theatre clothes	0.50
	overboots	0.99
	hats	0.44
	masks	0.70
General materials	scrub and prep lotions, nail brush, suction, diathermy, & calf	5.00
	specimen receptacle	0.08
	heavy duty rubbish bags	0.58
	other rubbish bags	0.21
	contaminated waste and linen disposal	2.00
	anaesthetic monitor and diathermy plate	4.60
	electrodes	0.20
Open cholecystectomy	laparotomy bundle	14.00
	double gown x2	13.18
	sterile gloves x4	1.68
	sterile plastic drape	0.58
	abdominal packs	5.20
	raytec swabs x2	0.74
	suction tubing @ $46.24[2]	7.71
	sterile saline x2	2.62
	Urografin	56.50
	suture	22.00
	drain tube	6.90
	diathermy pencil	9.00
	mayo stand cover	4.40
	dressing	0.50
	scalpel blade	0.48
Open cholecystectomy	laparotomy set @ $12000[3]	5.00
	extra instruments	1.00
	glass syringes x2	11.00
Additional anaesthetics	IV infusion-Pethidine	7.50
	I-Med	6.93
	Subtotal	**192.22**

[1] Worn by the eleven staff in theatre, for two procedures.
[2] Assumes suction tubing used six times.
[3] Assumes laparotomy set used 16 times a week for three years.

Table B5

CONSUMABLES USED WHEN PERFORMING LAPAROSCOPIC CHOLECYSTECTOMY

Costs particular to laparoscopic cholecystectomy		
Operating room attire[1]	theatre clothes	0.50
	overboots	0.99
	hats	0.44
	masks	0.70
General materials	scrub and prep lotions, nail brush, suction, diathermy, & calf stimulator	5.00
	specimen receptacle	0.08
	heavy duty rubbish bags	0.58
	other rubbish bags	0.21
	contaminated waste and linen disposal	2.00
	anaesthetic monitor and diathermy plate	4.60
	electrodes	0.20
Laparoscopic consumables	laparotomy bundle	14.00
	double gown x2	13.18
	sterile gloves x5 pairs	2.10
	sterile plastic drape	1.16
	abdominal packs	5.20
	raytec swabs	0.37
	suction tubing @ $46.24[2]	7.71
	sterile water x4 litres	5.24
	IV saline x1 litre	1.19
	Urografin	56.50
	scalpel blades	0.48
	urinary catheter	0.95
	urinary bag	4.95
	uretheric catheter	7.95
	sutures	10.10
	dressing Tegaderm x4	1.04
	syringes	0.52
	needles	0.11
	KY jelly	0.30
	Marcaine 0.5% with adrenaline	10.18
	Subtotal	**158.53**

[1] Worn by the eleven staff in theatre, for two procedures.
[2] Assumes suction tubing used six times.

Table B6

REUSABLE INSTRUMENTS USED DURING LAPAROSCOPIC CHOLECYSTECTOMY

Reusable instruments		
Laparoscopic instruments	Verres needle 10cm	79.00
	Verres needle 12cm	85.00
	Hasson port	1150.50
	trocar/cannula 5mm x2	1520.00
	trocar/cannula 10mm x2	1589.40
	trocar/cannula 11mm x2	1584.46
	reducing tube	98.00
	CO_2 tubing	40.00
	forceps: 5mm with claw	550.00
	forceps: 10mm with claw	632.00
	forceps: spoon	630.00
	grasping forceps	455.00
	grasping forceps with ratchet	570.00
	grasping forceps with heel grip atraumatic grasper	595.00
	diathermy hook	120.00
	suction tube/irrigation	195.00
	scissors	595.00
	Liga clip applicator	1276.00
	cholangiogram forceps	850.00
	diathermy lead	74.20
	endoshears	40.00
	minor set	600.00
	catheter tray	1.00
	Subtotal	**13,329.56**

Table B7
LAPAROSCOPIC CAMERA SYSTEM

Laparoscopic system		
Laparoscopic system	Opsis camera system	11600.00
	colour monitor large	1900.00
	colour monitor: small	1400.00
	Xenon light source	14480.00
	insufflator	8015.00
	0° telescope	3367.00
	30° telescope	3754.00
	light cable	890.00
	diathermy cable	41.00
	gases CO_2	8.00
	lamp	3.00
	Subtotal	**45,458.00**

Table B8

NURSING TIME/DEPENDENCY, ST JOSEPH'S WARD

(hours and dollars per shift)

Morning Shift	*Patient Dependency (hours) and associated Nursing Salary ($)*											
Nurse Classification	4	Salary range		3	Salary range		2	Salary range		1	Salary range	
Charge Nurse	0.76	15.90	16.32	0.72	15.06	15.47	0.45	9.41	9.67	0.39	8.16	8.38
Registered Nurse	5.05	62.42	71.41	2.97	36.71	42.00	1.65	20.39	23.33	0.62	7.66	8.77
Student	0.13	1.04	1.29	0.29	2.33	2.87	0.14	1.12	1.38	0.13	1.04	1.29
Total	5.94	79.36	89.02	3.98	54.10	60.34	2.24	30.92	34.38	1.14	16.86	18.44
Afternoon Shift	*Patient Dependency (hours) and associated Nursing Salary ($)*											
Nurse Classification	4	Salary range		3	Salary range		2	Salary range		1	Salary range	
Charge Nurse[1]	0.62	12.14	12.14	0.68	13.31	13.31	0.30	5.87	5.87	0.28	5.48	5.48
Registered Nurse	4.10	56.66	63.96	2.37	32.75	36.97	1.27	17.55	19.81	0.53	7.32	8.27
Student	0.1	0.95	1.14	0.1	0.95	1.14	0.19	1.8	2.16	0.12	1.14	1.36
Total	4.82	69.75	77.24	3.15	47.01	51.42	1.76	25.22	27.84	0.93	13.94	15.11
Night Shift	*Patient Dependency (hours) and associated Nursing Salary ($)*											
Nurse Classification	4	Salary range		3	Salary range		2	Salary range		1	Salary range	
Charge Nurse[1]	0.21	4.20	4.20	0.35	7.00	7.00	0.18	3.60	3.60	0.12	2.40	2.40
Registered Nurse	3.57	50.84	57.19	1.59	22.64	25.47	1.04	14.81	16.66	0.53	7.55	8.49
Student	0.06	0.59	0.99	0.1	0.99	1.18	0.1	0.99	1.18	0.09	0.89	1.06
Total	3.84	55.63	62.38	2.04	30.63	33.65	1.32	19.40	21.44	0.71	10.84	11.95

[1] The Charge Nurse's duties are undertaken by a Registered Nurse on afternoon and night shifts, who is paid a higher duty allowance for these shifts equivalent to that of a grade 3A Associate Charge Nurse (YT1).

Table B9
NURSING TIME/DEPENDENCY, ST JOAN'S WARD
(hours and dollars per shift)

Morning Shift	*Patient Dependency (hours) and associated Nursing Salary ($)*											
Nurse Classification	4	Salary range		3	Salary range		2	Salary range		1	Salary range	
Charge Nurse	0.43	9.00	9.24	0.5	10.46	10.74	0.45	9.41	9.67	0.28	5.86	6.01
Registered Nurse	2.58	31.89	36.48	1.52	18.79	21.49	0.42	5.19	5.94	0.18	2.22	2.55
SEN	1.33	14.88	14.88	1.1	12.31	12.31	0.48	5.37	5.37	0.1	1.12	1.12
Senior Student	0.5	4.95	4.95	0.38	3.76	3.76	0.63	6.23	6.23	0.41	1.38	1.38
Total	4.84	60.72	65.55	3.5	45.32	48.30	1.98	26.20	27.21	0.97	10.58	11.06
Afternoon Shift	*Patient Dependency (hours) and associated Nursing Salary ($)*											
Nurse Classification	4	Salary range		3	Salary range		2	Salary range		1	Salary range	
Charge Nurse[1]	0.55	10.77	10.77	0.4	7.83	7.83	0.38	7.44	7.44	0.28	5.48	5.48
Registered Nurse	1.79	24.74	27.92	1.22	16.86	19.03	0.38	5.25	5.93	0.18	2.49	2.81
SEN	1.15	14.55	14.55	0.71	8.98	8.98	0.48	6.07	6.07	0.08	1.01	1.01
Senior Student	0.24	2.72	2.72	0.23	2.61	2.61	0.42	4.77	4.77	0.3	3.41	3.41
Total	3.73	52.78	55.96	2.56	36.28	38.45	1.66	23.53	24.21	0.84	12.39	12.71
Night Shift	*Patient Dependency (hours) and associated Nursing Salary ($)*											
Nurse Classification	4	Salary range		3	Salary range		2	Salary range		1	Salary range	
Charge Nurse[1]	0.28	5.60	5.60	0.35	7.00	7.00	0.23	4.60	4.60	0.19	3.80	3.80
Registered Nurse	1.35	19.22	21.63	0.98	13.96	15.70	0.22	3.13	3.52	0.16	2.28	2.56
SEN	0.87	11.37	11.37	0.56	7.32	7.32	0.35	4.57	4.57	0.08	1.05	1.05
Senior Student	0.24	2.82	2.82	0.17	2.00	2.00	0.33	3.88	3.88	0.19	2.24	2.24
Total	2.74	39.01	41.42	2.06	30.28	32.02	1.13	16.18	16.57	0.62	9.37	9.65

[1] The Charge Nurse's duties are undertaken by a Registered Nurse on afternoon and night shifts, who is paid a higher duty allowance for these shifts equivalent to that of a grade 3A Associate Charge Nurse (YT1).

Table B10
WEEKLY AND HOURLY PAY SCALES
effective September 1991

Classification	*Scale*	*Weekly Pay*	*Hourly Pay AM*[1]	*Hourly Pay PM*[2]	*Hourly Pay ND*[3]
Student Nurse	YN2	305.30	8.03	9.49	9.91
	YN3	328.70	8.65	10.11	10.53
	YN4	375.80	9.89	11.35	11.77
State Enrolled Nurse	IH2	425.40	11.19	12.65	13.07
Registered Nurse Grade 1	YP1	469.70	12.36	13.82	14.24
Registered Nurse Grade 2	YP2	484.40	12.75	14.21	14.63
	YP3	510.90	13.44	14.90	15.32
	YP4	537.50	14.14	15.60	16.02
Associate Charge Nurse Grade 3A	YT1	688.60	18.12	19.58	20.00
Charge Nurse	YZ1	794.90	20.92	22.38	22.80
	YZ2	816.20	21.48	22.94	23.36

[1] Calculated on the basis of a 38 hour week.
[2] An additional $11.70 is payable to every nurse on the eight hour afternoon shift, increasing the hourly salary by $1.46.
[3] An additional $18.80 is payable to every nurse on the ten hour night shift, increasing the hourly salary by $1.88.

Table B11
MEDICATION PRICES
effective February 1992

Product	Unit of Sale	Price $	Single dose
Heparin sod amp 5000u/0.2ml	box of 5	3.33	0.67
Gentamicin vial 80mg/2ml	box of 5	4.60	0.92
Keflin vial neutral 1g	box of 10	28.30	2.83
Ampacillin (Austrastaph) injection vial 1g	box of 5	17.22	3.44
Flagyl IV infusion 0.5% 100ml	box of 10	28.70	2.87
Pethidine hydrochloride (infusion) bag 500mg/500ml	single	7.60	7.60
Pethidine hydrochloride (intramuscular) amp 100mg/2ml	box of 5	1.33	0.27
Morphine sulphate (infusion & intramuscular) amp 10mg/1ml	box of 5	1.17	0.23
Omnopon scopolamine amp 20mg-400mcg	box of 5	2.75	0.55
Diazepam amp 10mg/2ml	box of 50	16.00	0.32
Maxolon amp 10mg/2ml	box of 10	4.68	0.47
Chendol cap 125mg	box of 100	43.29	0.43

APPENDIX C

Patient Questionnaire

Please answer every question. If you are not sure or cannot remember the exact details, please make a guess.

SECTION ONE

INSTRUCTIONS

In this section we are trying to find out about the costs and benefits to you, the patient, of the treatment you have received for gallstones at St Vincent's Hospital.

QUESTION 1 **How many times did you go to St Vincent's Hospital during your entire course of treatment?** ***(Please write number in box.)***	**Number of Trips** **Type of Transport** ☐1 Private vehicle ☐2 Taxi ☐3 Public transport ☐4 Other (*please specify*) ☐5 **Total**

QUESTION 2 **How far away from the hospital do you live?** ***(Please _ appropriate box.)***	☐6 Less than 10 kms ☐7 11-20 kms ☐8 21-30 kms ☐9 31-40 kms ☐10 More than 40 kms (*please specify*)

QUESTION 3 **How many nights did you stay in hospital?** ***(Please write number in box.)***	☐11 Number of nights during first stay ☐12 Total number of nights during subsequent stay(s)

QUESTION 4 **While you were in hospital, how many visits did you receive from relatives or friends? (If 3 people visited you at the same time please count this as 3 visits.)** ***(Please write number in box.)***	☐13 Number of visits

QUESTION 5 **How much time did you lose from your regular activities as a result of your treatment and recovery?** ***(Please write number in box.)***	☐14 Days of paid work ☐15 Days of regular activity (including paid work)

QUESTION 6 **During the course of your treatment and recovery have you been assisted and cared for by a relative or friend?** ***(Please _ appropriate box.)***	☐16 Yes ☐17 No

QUESTION 7 **If yes, please estimate the number of full days the person(s) lost from regular activities as a result of caring for you during your recovery.** ***(Please write number in box.)***	☐18 Days of paid work ☐19 Days of regular activity (including paid work)

QUESTION 8 **While you were recovering, were you cared for by a professional care-giver, eg housekeeper, home nursing service, other?** ***(Please write number in box.)***	Please specify ☐20 Number of hours

QUESTION 9 **What was your occupation at the time of your treatment?** ***(Please _ appropriate box.)***	☐21 Home duties ☐22 Retired/unemployed ☐23 Paid employment (*please specify*)