Evolving treatments for primary urolithiasis: Impact on services and renal preservation in 16,679 patients in Western Australia

J.B. Semmens, C.D.J. Holman, J.A. Bass

Centre for Health Services Research, The Department of Public Health, The University of Western Australia, 35 Stirling Highway, Nedlands, Western Australia

Z.S. Wisniewski

Safety and Quality of Surgical Care Committee, Royal Australasian College of Surgeons, Western Australian Branch, Nedlands, Western Australia

The Western Australian Safety and Quality of Surgical Care Project

The quality and safety of health care is now a major health issue, which is being addressed in all western countries and is a high priority in Australia. Increasing public awareness, including a more active participation in individual health care and active consumer organisations, along with concomitant political forces are changing the face of health care in developed countries. Improving the safety and quality of health care is now a central concern of all those in the health care system. Clinicians and hospitals are now being held accountable for the level of health care provided while at the same time governments are pushing for improved economic efficiency in the health care system. There is a strong international commitment towards a systematic approach in identifying current best practice in terms of patient and economic outcomes, or evidence-based medicine, into health care systems.

In keeping with the focus on evaluating outcomes of surgical care The WA Safety and Quality of Surgical Care Project (SQSCP) was established in June of last year to evaluate surgical outcomes in Western Australia. The Project is a collaborative venture among the Royal Australasian College of Surgeons (WA Branch), the Department of Public Health (Centre for Health Services Research, University of Western Australia) and the State Health Department. The SQSCP is a unique quality assurance activity in Australia and involves collaboration among the WA Branch of the Royal Australasian College of Surgeons, UWA Department of Public Health and the Health Department of WA. The specific objectives of the SQSCP are to 1) describe the epidemiology of selected diseases requiring surgical care; 2) monitor trends in utilisation; 3) compare standards of surgery in WA with national and international standards of best practice; 4) evaluate and compare the outcomes of new and established surgical procedures; 5) establish benchmark standards of procedural care; 6) provide a mechanism for the independent review of clinical practice; 7) evaluate the morbidity and mortality resulting from surgical practice; 8). assess the risk and outcomes of adverse events resulting from procedural care; 9) recommend and evaluates the implementation of appropriate changes in surgical practice; and 10) disseminate the outcomes of the evaluation process to surgeons, RACS, health service managers, policy makers, consumers and the WA Consumer Council. The SQSCP is only possible because of the unique population-based record linkage available in this state. A state management committee oversees the SQSCP and its three working arms, which includes representatives from surgical and clinical specialties, health service managers and policy makers, and health service researchers. The committee provides a forum to facilitate multidisciplinary collaboration towards better planning, provision and evaluation of surgical services in WA.

Urinary lithiasis in WA: Study objectives

The next part of my presentation will be to present you with the initial results of a state-wide review of the evolving treatments for urinary lithiasis in WA from 1980–1997. The present study has used data obtained through the WA Safety and Quality of Surgical Care Project from the WA Health Service Research Linked Database. It contains population-based information linking all hospital admissions and deaths in a state of 1.8 million people over a period of three decades. We have used linked data commencing from 1980 to examine trends in the use of different surgical and non-surgical interventions, readmissions, repeat procedures, cumulative hospital utilisation and kidney preservation in patients presenting with renal and ureteral calculi for the first time.

Introduction

Urolithiasis accounts for 16% of all urological admissions and 1–2% of total hospital admissions in western societies [1,2]. Usually affecting people in the prime of life, this disease causes significant morbidity and loss of productivity. The total economic burden of urolithiasis is estimated between \$1.8 billion and \$2.4 billion annually in the United States [2,3]. Modern technologies have provided less invasive techniques for dealing with urinary calculi. Percutaneous nephrolithotomy (PCN) followed by extracorporeal shock wave lithotripsy

(ESWL), and now lasertripsy, have relegated open surgery to a rare event for complex renal stones [4–6].

Access to a particular modality of treatment dictates the practice undertaken. ESWL monotherapy is recommended as a first-line intervention for small-volume renal calculi [7]. ESWL is recommended also as first-line therapy for stones _1cm in the proximal ureter and as being equally acceptable to ureteroscopy to treat stones _1cm in the distal ureter [8]. The recommendations appear to be followed in practice, although an exception is the frequent use of stenting with ESWL, especially in the case of larger ureteral calculi [9]. Ureteroscopic lasertripsy is now becoming more popular and needs further evaluation.

That EWSL is used to treat the majority of calculi in the upper urinary tract is not surprising, given that it has consistently out-performed even minimally-invasive endourological procedures in clinical trials of cost-effectiveness [10–14]. Moreover, patients have a preference to avoid surgery in the treatment of stone disease, with ESWL being perceived by them as the most desirable treatment option [15].

At the population level, however, a different picture can emerge concerning health care utilisation and outcomes. Following the introduction of ESWL in the USA there was a 71% increase in physician costs [16], and in Quebec the costs of treating stone disease were higher when ESWL became available due to total (non-surgical plus surgical) intervention rates increasing by 52% in women and 34% in men [17]. The growing assortment of treatment options for stones has led to complexity in the way that patients interact with the health system, with ancillary, combination and repeat procedures becoming commonplace during an illness episode. Thus changes in procedural interventions for urolithiasis, and their effects on resource utilisation, renal preservation and the chances of remaining stone-free, need to be evaluated at the level of the health system serving an entire population.

The present study has used data obtained through the Quality of Surgical Care Project [18] from the WA Health Services Research Linked Database [19]. It contains population-based information linking all hospital admissions and deaths in a state of 1.8 million people over a period of three decades. We have used linked data commencing from 1980 to examine trends in the use of different surgical and non-surgical interventions, readmissions, repeat procedures, cumulative hospital utilisation and renal preservation in patients presenting with renal and ureteral calculi for the first time.

Patients and methods

The WA Linked Database was used to extract all hospital morbidity data and death records of patients who first separated from an acute hospital in Western Australia in 1980–97 with a principal condition of one or more renal or ureteral calculi (ICD–9-CM 592.X [20]). Patients with any prior mention of renal or ureteral calculus on a hospital separation record in 1970–79 were excluded, as were patients presenting at first admission with calculi in the bladder or urethra as well as the upper urinary tract. The linked file was date-stamped 22 March 2000.

There were 16 679 patients admitted for the first time for renal or ureteral calculi in the period 1980–97. Of these, 9 095 underwent at least one procedural intervention, including open procedures, transurethral clearance via ureteroscopy or its antecedents, PCN, ESWL, ancillary endourological procedures including insertion of a ureteral stent, and partial or total nephrectomy including ureterectomy (see appendix for ICPM [21] and ICD–9-CM [20] procedural codes).

PCN was first performed in WA in 1984. The ICPM system, used to code surgical procedures in the hospital morbidity data prior to 1988, did not distinguish between open lithotomy and percutaneous nephrostolithotomy. Thus for the period 1984 to 1987, it was impossible to separate the specific rates of open procedures and PCN. The first litotripter in WA was commissioned in 1991, and hence the absence of an ICPM code for ESWL prior to 1988 was of no consequence. However, a further limitation of the coding was that the placement of a ureteral stent could not be distinguished prior to 1988 from other ancillary endourological procedures such as 'push-back' of stones into the renal pelvis.

Some 4 150 patients underwent multiple procedures up to 30 June 1999, allowing a maximum of 19.5 years of follow-up. There were 12 412 hospital readmissions, including 5 402 for recurrence of upper urinary tract calculus. Total or partial nephrectomies were performed on 229 patients and there were 1 539 deaths. Actuarial adjustments were made for loss to follow-up of deceased patients.

Age-standardised annual admission and procedure rates in the male and female populations of WA between the years 1981 and 1997 were calculated using the direct method and the census population in 1996 as the standard set of weights [22].

The cumulative incidence of hospital readmission, including procedural readmissions, within 30 days and 12 months of first-time (index) separation for renal or ureteral calculi were estimated using actuarial methods [23]. The risks of any procedural intervention, any surgical procedure and undergoing a total or partial nephrectomy were estimated in a similar fashion, except follow-up commenced from the date of index admission thereby including index procedures as events. Cumulative length of stay within 12 months was the sum of days spent occupying a hospital bed up to but excluding the first anniversary of the index admission date. Cumulative hospital admissions within 12 months were the number of times the patient was admitted to hospital during the same period. In all analyses using cumulative incidence or utilisation measures, study subjects were censored at their date of death or, for those who remained alive, on 30 June 1999. Differences in cumulative incidence of outcomes between difference subgroups were assessed for statistical significance using the Wilcoxon (Gehan) test [23].

Results

The mean age of the 16 679 patients was 48.3 years (range 1–95 years) and 70.3% were males. In 41.9% the calculi were sited in the kidney alone, in 53.7% only the ureter was affected and in the remaining 4.4% of patients the calculi were located in multiple sites involving both the kidney and ureter. Over one-half (57.1%) of patients were admitted as emergency cases.

Trends in the annual rates of first-time hospital admission and total (first and subsequent) admissions involving a procedural intervention for renal or ureteral calculi in WA from 1981 to 1997 are shown in Figure 1. There was a net increase in the rates of first-time hospital admission of +21.3% in males (from 77.8 to 94.4 per 100,000PY) and +11.7% in females (from 33.4 to 37.3 per 100,000PY). There were very much larger increases in the rates of inpatient procedures (+153.3% in males; +89.7% in females). The increases in procedural interventions commenced in the late 1980s and remained a feature throughout the 1990s.

Trends in use of different procedural interventions

Table 1 shows the trends in the proportion of index cases treated conservatively and the use of different procedural interventions. Despite the increases in population-based procedure rates shown in Figure 1, there was a consistent proportion of index cases treated conservatively, with the percentage fluctuating around the 59% mark throughout the entire 18 years of observation.

There were, however, changes in the use of different treatments in patients who underwent one or more procedural interventions during the index admission. The proportion of patients undergoing open procedures fell from 30.4% in 1980 to 3.4% in 1997. During the late 1980s, PCN replaced open surgery as the most common intervention, reaching a peak of 19.6% of cases in 1990, before falling to 3–5% after introduction of ESWL. Transurethral clearance of calculi using ureteroscopy or its antecedents was undertaken in around 10–13% of patients prior to 1992, and in 6–8% of patients thereafter. Since 1992, ESWL and the use of ureteral stents and other ancillary endourological procedures have been the predominant modes of therapy, although ESWL was used less frequently in 1995–97 during index admission than during the first few years after its introduction. Placement of ureteral stents accounted for 77.9% of the 1 329 ancillary endourological procedures during index admission in 1988–97. The proportion of cases treated by total or partial nephrectomy at index admission fell throughout the study period, reaching low levels by 1994.

In Table 2, trends in the use of the different procedural interventions are shown separately for patients with renal calculi only and those with ureteral calculi only. Transurethral clearance and the use of ancillary procedures were favoured more for ureteral calculi, whereas PCN and ESWL were used more frequently in patients with renal calculi. Total and partial nephrectomy also occurred more frequently in the surgical management of renal calculi. Otherwise the time trends in the relative use of different procedures were the same regardless of the site of the calculus.

Trends in readmission for recurrence of calculus and repeat procedures

The risk of hospital readmission increased markedly, especially commencing from 1991 when ESWL was introduced. This is shown in Figure 2, where the absolute increases in cumulative incidence of readmission within the first 30 days from index separation, comparing the risks in 1997 with those in 1980, were +12.6% for procedural readmission and +12.2% for all readmissions for calculus. At 12 months post-index-separation the absolute increases were +15.0% for procedural readmissions and +16.2% for all readmissions for calculus. These results indicated that all of the increase in readmissions for calculus within the first 30 days, and four-fifths of the increase with the first 12 months were explained by a four-fold increase in risk of procedural readmissions within 30 days from 4.2% in 1980 to 16.8% in 1997.

Table 3 shows the patterns of urological practice accounting for the high risk of short-term procedural readmission. It shows the relative frequencies of different combinations of index and subsequent procedures in patients readmitted for a procedure within 30 days. Often, patients were treated conservatively during the index admission and readmitted for ESWL (15.4%) or other interventions. A common scenario was the placement of a ureteral stent during index admission, followed by a second admission for ESWL (19.6%) or other procedure. The third most common pattern, occurring in 7.3%, consisted of ESWL at the index admission followed by a readmission for a second ESWL. It should be said, however, that the overall pattern was one of considerable diversity in the use of different combinations of therapeutic procedures within the first 30 days of presentation.

Trends in risk of surgical intervention and hospital use

Despite the large increase in short-term readmissions for additional procedures, there was a sizeable drop in the proportion of patients treated surgically within the first 12 months from initial presentation at index admission. Figure 3 shows that whilst the cumulative incidence of receiving at least one procedural intervention within 12 months of presentation rose from 47% to 54%, the risk of undergoing a surgical procedure in the first 12 months fell from 48% to 30%. Most of the reduction in surgical interventions was first observed in patients presenting in 1991, coinciding with the introduction of ESWL.

There was a decline in the average length of hospital stay during index admission, from 6.5 to 2.7 days, and the cumulative length of stay for renal or ureteral calculi summed over the first 12 months from presentation, from 7.8 to 3.9 days (Figure 4). These trends were not apparently driven solely by the introduction of ESWL in 1991, but occurred smoothly during most of the 18 years of study. Also shown in Figure 4 are the concomitant increases in the cumulative numbers of total and procedural hospital admissions within 12 months of presentation, as would be expected from the increase in risk of hospital readmission.

Trends in renal preservation

Figure 5 shows the trends in cumulative incidence of total or partial nephrectomy within 12 months of index admission for renal or ureteral calculi. Taking the period averages shown in the figure, there was a substantial drop in the risk of kidney loss in 1995–97 compared with previous periods (p=0.007 comparing 0.48% in 1995–97 with 1.11% in 1991–94).

Discussion and conclusions

In this study the rate of hospital admission for procedural interventions for renal and ureteral calculi more than doubled in the population from 1980 and 1997. Within that growing area of health care, there were marked changes in modalities of treatment carried on the crest of each new wave of technology. In 1980, open lithotomy accounted for 75% of first-line interventions, but by 1997 it was relegated to the least common intervention. It was replaced initially by PCN introduced in 1984, and then by ESWL introduced in 1991, which dominated treatment patterns by 1992. The introduction of ESWL appeared to be the principal factor associated with rising population-based intervention rates.

The increase in the rate of all interventions for urolithiasis in WA was consistent with trends reported from the USA and Canada [16, 17], but the underlying reasons for our results appeared to be different. Unlike the situation in Quebec [17], there was little evidence of an increase in the number of people being actively treated due to a broadening of criteria [24]. Between 1980–1997 there was only a 1% p.a. increase in the rate of first-time hospital admission for renal and ureteral calculi, suggesting a stable incidence rate of urolithiasis in the population. Of those presenting with the problem for the first time, the proportion treated conservatively during their first hospital admission remained constant at around 59%. Using record linkage, it was possible to take a longitudinal view of the risk of a new patient receiving any form of intervention during the first 12 months after presentation, and this rose only marginally from 1980 to 1997, from 47% to 54%.

The reason why the population-based intervention rate for upper urinary tract urolithiasis more than doubled in WA was due to a large increase in procedural readmissions in the same patient, and usually for the same episode of illness. There was a four-fold increase in procedural readmissions within 30 days of index admission, and these short-term readmissions for repeated, staged or postponed interventions accounted for well over eighty percent of all readmissions during the first 12 months of follow-up. The patterns of urological practice responsible for readmissions within 30 days were complex, involving instances of variable treatment combinations. Commonly, patients underwent initial stabilisation with conservative management or placement of a ureteral stent, followed by ESWL. Other patients were readmitted for a second treatment with ESWL or to have their stent removed.

In a series of patients with solitary renal stones, Low and others found that stent placement made no difference to stone-free rates or the need for a repeat treatment with ESWL [25]. Similarly, Sulaiman and colleagues reported no effect of ureteral stents on the incidence of steinstrasse in patients with stones smaller than 2cm, although in patients with larger stones, steinstrasse developed more than twice as often when no stent was placed [26]. In a randomised clinical trial of 400 patients with stones 1–5–3.5cm in diameter, Al-Awadi and others found that the placement of a ureteral stent before ESWL reduced the risk of steinstrasse from 13% to 6% (p<0.05) and that the incidence of steinstrasse increased with the size of the calculus [27]. Thus, although the use of ureteral stents in patients undergoing ESWL for urinary calculi remains controversial, there is an empirical basis for stent placement in the management of larger stones. Hollowell et al, in their internet and postal survey of endourologic practice patterns among American urologists, found a pattern of practice consistent with this evidence. Placement of stents was reported by 25% of urologists for a 1.0cm calculus, 57% for a 1.5cm calculus and 87% stated they would place a stent for a calculus 2.0cm in diameter [9].

The increased need for multiple procedures in patients treated with ESWL compared with other therapeutic modalities was documented by the Clinical Guidelines Panels from results of their meta-analyses of 110 and 327 studies [7,8]. For staghorn renal calculi treated with ESWL monotherapy, the average number of ESWL procedures was 2.12 compared with 1.49 procedures per patient treated with PCN monotherapy [7]. For calculi in the distal ureter, there were an average of 1.24 ESWL treatments needed compared with 1.01 for ureteroscopy [8]. Our results depict the impact of these different ratios on the health care of a population.

The shortcomings of this study should be considered. There were no data available on ambulatory care and it was possible that a number of episodes of renal colic did not need hospitalisation. However, the study identified all instances of the relevant therapeutic procedures, as these were not performed on an outpatient basis in WA during the study period. The study was based on administrative health data and provided no details of the type that would be expected in smaller clinical studies. Due to coding limitations, we could not distinguish between calculi presenting in the proximal and distal parts of the ureter, nor was information available on stone diameter, shape or laterality. Despite its limitations, the strengths of the study were that it was population-based, covered a period of 17 years, identified virtually all of the initial and subsequent therapeutic procedures and offered good precision due to the large number of subjects.

In conclusion, the changes in urological practice in the management of urinary calculi appear to have conferred at least three benefits on the population and the health system. The introduction of ESWL has greatly reduced the chance of a patient undergoing any form of surgical intervention either at initial presentation or during subsequent follow-up. The risk of an invasive procedure within 12 months of index admission fell by 38%. A second advantage has been a much-reduced length of hospital stay, both during the first admission and even when stays were summed over a 12 month period, despite the rise in short-term procedural readmissions. Using estimates of cost per bed day for conditions of the kidney and urinary tract in Australian hospitals [28], the fall from 7.8 to 3.9 days in the average cumulative length of stay within the first 12 months of treatment from 1980 to 1997 (Figure 4) corresponded to a reduction from Aus$4,748 to Aus$2,374 per patient, albeit such figures take no account of changes in resources utilisation per inpatient day. These outcomes are generally consistent with results of other population-based research [16, 17] and clinical trials of the cost-effectiveness of the non-invasive and minimally invasive treatment modalities [10–14].

The third benefit has been the increased chance of renal preservation. The risk of losing a kidney to urolithiasis within the first 12 months after presentation has fallen in WA from 1–2% in the early 1980s to a risk of 0.1% or less. Renal preservation figures following treatment for urolithiasis are rarely reported in the literature. The Nephrolithiasis Clinical Guidelines Panel reported no data on kidney loss following ESWL, but did report average risks of 3.8% after an open procedure and 1.6% following PCN for staghorn calculi [7]. Kidney loss in patients with ureteral calculi was not reported [8]. This is surprising given that renal preservation is a highly desirable outcome and even a risk of 0.1% of kidney loss is important. It should be considered as one of several key indicators of the quality of surgical care for urolithiasis at the population level.

Year of separation	*Number of first-time cases*	*Conservative management %*	*Open procedure %*	*Transurethral clearance %*	*PCN %*	*ESWL %*	*Ancillary endourological procedure %*	*Total or partial nephrectomy %*
1980	588	59.9	30.4	7.5	-	-	1.0	1.7
1981	662	51.2	30.5	13.3	-	-	3.9	2.3
1982	688	50.3	33.6	13.1	-	-	2.6	1.6
1983	802	59.0	27.9	12.5	-	-	1.9	1.5
1984	796	61.9	NA*	9.3	NA*	-	2.9	1.3
1985	858	59.1	NA	11.9	NA	-	2.4	1.3
1986	843	59.1	NA	13.4	NA	-	2.7	1.5
1987	850	57.9	NA	10.2	NA	-	3.3	0.4
1988	1,015	62.5	9.6	11.2	14.4	-	5.5	0.8
1989	957	59.5	8.0	11.4	17.7	-	4.9	0.9
1990	922	57.3	9.5	10.1	19.6	-	8.0	0.7
1991	1,001	59.4	6.4	6.9	11.3	9.9	10.4	0.5
1992	991	57.0	6.3	6.3	6.4	17.8	10.2	0.8
1993	1,061	60.3	5.7	6.4	5.1	15.2	11.3	0.5
1994	1,120	61.5	4.8	6.1	4.7	15.2	12.9	0.2
1995	1,103	65.7	4.7	6.9	3.4	9.8	14.1	0.3
1996	1,216	58.0	4.8	8.3	3.6	10.9	21.1	0.1
1997	1,206	56.8	3.4	8.5	4.4	12.8	22.4	0.0
Total	16,679	59.0	14.5	9.4	5.5	6.0	8.9	0.8

Table 1 First-time hospital admissions for renal or ureteral calculi in Western Australia 1980 to 1997, showing trends in proportion treated conservatively and proportions treated using different procedural interventions (shaded ares indicate most common type of intervention in different years)

*Figures not available from 1984 to 1987 due to lack of coding specificity.

Year of separation	*Number of first-time cases*	*Conservative management %*	*Open procedure %*	*Transurethral clearance %*	*PCN %*	*ESWL %*	*Ancillary endourological procedure %*	*Total or partial nephrectomy %*
Renal calculus only								
1980-83	1,159	59.4%	34.9%	2.3%	-	-	0.6%	3.7%
1984-87	1,459	54.3%	38.9%	5.1%	-	-	1.2%	2.1%
1988-90	1,275	55.9%	8.5%	3.6%	28.9%	-	4.5%	1.3%
1991-94	1,851	54.0%	4.4%	1.9%	10.1%	24.3%	7.7%	0.8%
1995-97	1,251	57.2%	3.8%	1.6%	7.1%	21.7%	12.1%	0.3%
Total	6,995	55.9%	17.3%	2.9%	9.2%	10.3%	5.4%	1.6%
Ureteral calculus only								
1980-83	1,489	51.0%	27.3%	19.5%	-	-	3.9%	0.3%
1984-87	1,770	63.0%	19.0%	16.6%	-	-	4.2%	0.1%
1988-90	1,504	63.0%	9.7%	17.0%	7.0%	-	7.3%	0.5%
1991-94	2,107	63.0%	7.2%	10.5%	3.9%	7.1%	14.1%	0.2%
1995-97	2,080	60.9%	4.5%	12.1%	1.6%	5.5%	24.1%	0.0%
Total	8,950	60.5%	12.6%	14.7%	2.5%	2.9%	11.6%	0.2%

Table 2 First-time hospital admissions, separately for renal and ureteral calculi in Western Australia 1980–83 to 1995–97, showing trends in proportion treated conservatively and proportions treated using different procedural interventions

*Figures not available from 1984 to 1987 due to lack of coding specificity.

Index procedure	*Procedural readmission within 30 days*						
	Open procedure	*Transurethral clearance*	*PCN*	*ESWL*	*Ureteral stent*	*Other ancillary procedure*	*Total or partial nephrectomy*
None	*4.6*	*12.7*	*5.1*	*15.4*	*13.5*	*3.4*	*0.1*
Open procedure	*0.1*	*0.4*	*0.1*	*1.4*	*0.8*	-	-
Transurethral clearance	*0.2*	*0.9*	*0.5*	*1.2*	*0.9*	*0.6*	-
PCN	*0.5*	*0.5*	*0.4*	*0.6*	*1.1*	*0.1*	*0.1*
ESWL	*1.4*	*1.6*	*1.9*	*7.3*	*1.7*	*0.5*	-
Ureteral stent	*1.9*	*5.1*	*1.3*	*19.6*	*4.6*	*2.6*	-
Other ancillary procedure	*0.2*	*0.4*	*0.1*	*0.5*	*0.1*	*0.8*	-
Total or partial nephrectomy	-	-	-	-	*0.1*	-	-

Table 3 Proportions (%) of procedural readmissions within 30 days of an index separation for renal or ureteral calculi in Western Australia in 1991–97 according to combinations of index and subsequent procedures (n=928)

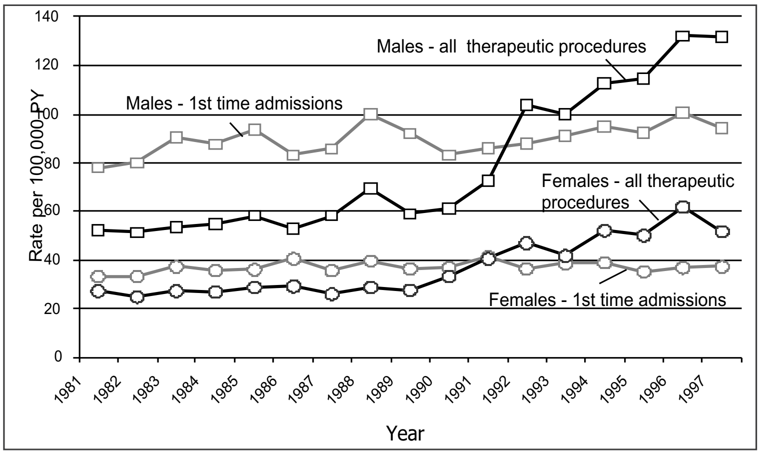

Figure 1 Age standardised incidence rates of first-time hospital admission and all procedural interventions for renal and ureteral calculi in males and females in Western Australia 1981 to 1997

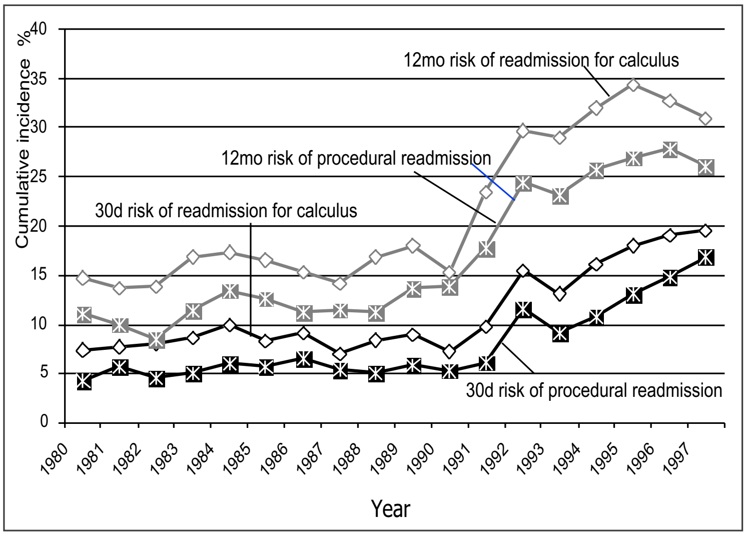

Figure 2 Cumulative incidence of a hospital readmission, including a procedural readmission, within 30 days and 12 months of index separation for renal or ureteral calculi in Western Australia 1980 to 1997

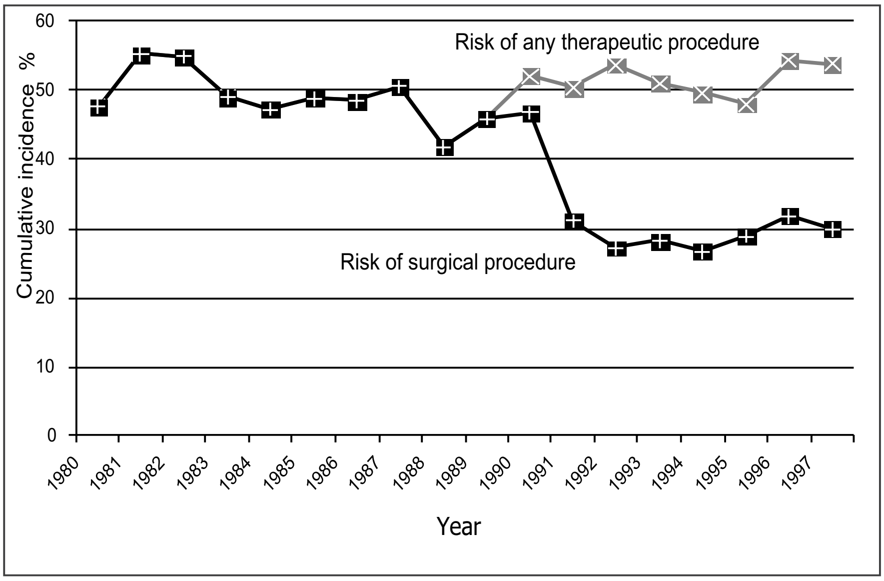

Figure 3 Cumulative incidence of any procedural intervention, including a surgical procedures, within 12 months of index admission for renal or ureteral calculi in Western Australia 1980 to 1997

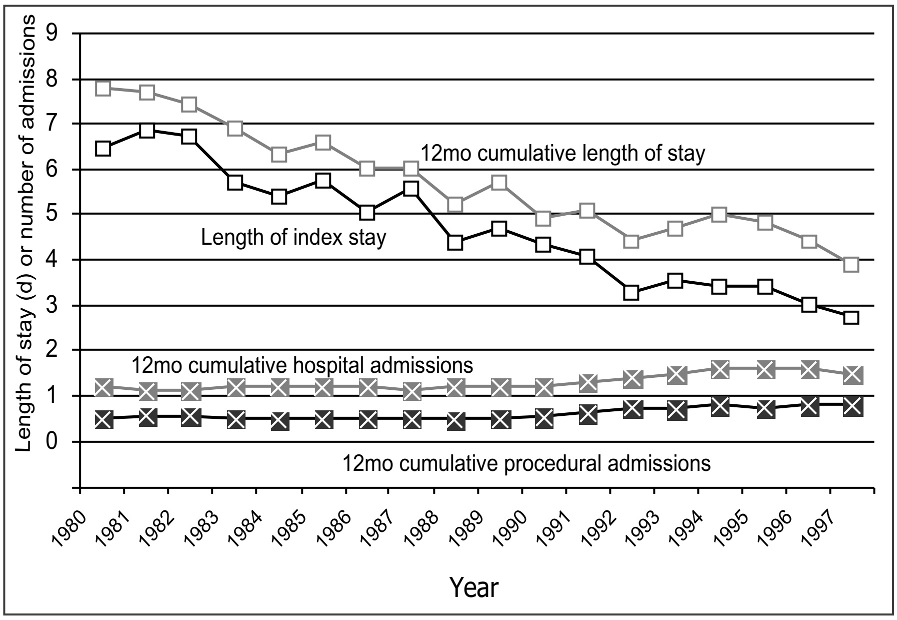

Figure 4 Average length of index stay, cumulative length of stay, total and procedural hospital admissions within 12 months of index admission for renal or ureteral calculi in Western Australia 1980 to 1997

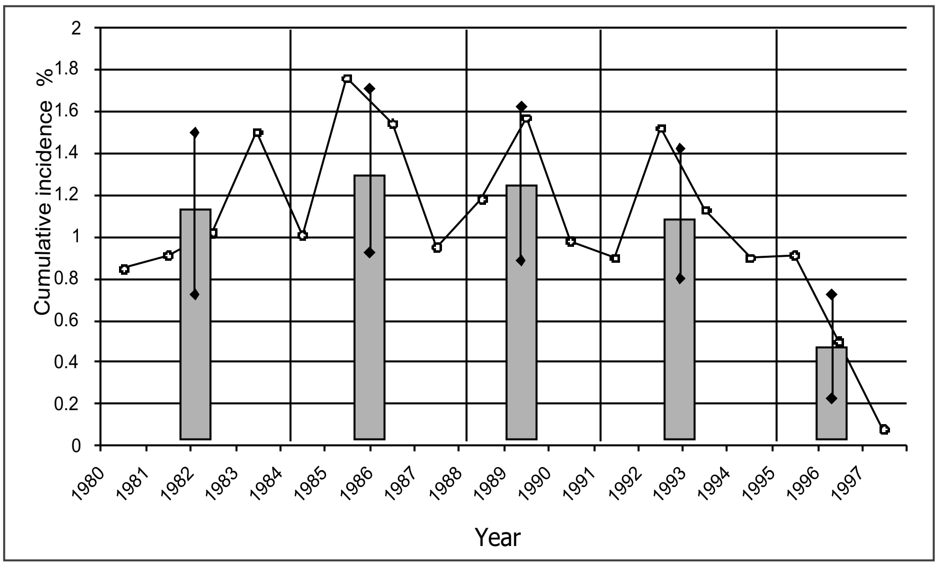

Figure 5 Cumulative incidence of total or partial nephrectomy within 12 months of index admission for renal or ureteral calculi in Western Australia 1980 to 1997, showing period averages with 95% confidence intervals

Appendix

The procedural codes used is this study were as follows: open procedures (ICPM 1–651, 5–550, 5–551, 5–562 [21]; ICD–9-CM 55.01, 55.02, 55.1X, 55.21, 55.22, 56.2 [20]); transurethral clearance via ureteroscopy or its antecedents (ICPM 5–560; ICD–9-CM 56.0); PCN (ICD–9-CM 55.03, 55.04), ESWL (ICD–9-CM 98.51); ancillary endourological procedures including insertion of a ureteral stent (ICPM 1–650, 1–654, 5–561; ICD–9-CM 56.1, 56.31, 59.8); and partial or total nephrectomy, including ureterectomy (ICPM 5–552, 5–553, 5–554, 5–563; ICD–9-CM 55.3X, 55.4, 55.51, 55.52, 56.4X).

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