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Original Article

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Urinary tract stone deaths: data from the Australian and New Zealand Audits of Surgical Mortality

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Objectives

To analyse all mortalities related to surgery for urinary tract calculi in Australia from 1 January 2009 to 31 December 2018, and identify common causes, clinical management issues (CMIs), and areas for improvement.

Patients and Methods

All urological-related deaths reported to the Australian and New Zealand Audit of Surgical Mortality (ANZASM) from 2009 to 2017 were analysed. The Bi-National Audit of Surgical Mortality (BAS) database was interrogated for any involvement with renal, ureteric or bladder stones and all relevant associated data analysed. Any CMIs documented by the peer reviewers were recorded and compared to those in urology and all of surgery ANZASM data.

Results

Of 1034 total urological deaths, 100 (9.7%) were related to stones. The mean (range) age of patients was 74.4 (21–97) years; 95% of the patients underwent at least one procedure, with 45 (47.4%) of these being elective. Urinary sepsis was responsible for 49.5% of the deaths, with 20% dying of cardiac events. In all, 39% (37/95) of deaths were associated with CMIs, the most common considerations being delays in diagnosis or treatment, perioperative management and inadequate preoperative evaluation. This is a considerably higher percentage than the 26% recorded for the general urology and all surgery national data. Ureterorenoscopy at 54% (12/22) had the highest rate of CMIs.

Conclusion

Death related to stone surgery represents only a small proportion of all urological surgical deaths, but generates more CMIs amongst ANZASM peer assessors. Results could be improved with more rapid diagnosis and treatment. Careful case selection and access to all treatment options are recommended.

Keywords

urinary tract, calculus, stone, death, mortality, sepsis, #KidneyStones, #UroStone

Introduction

Nephrolithiasis is common with the incidence rising around the world and a lifetime risk of developing the condition in 10% globally [1]. Treatments vary depending on the size and location of the stone, and the presence or absence of infection. The standard treatments include extracorporeal shockwave lithotripsy (SWL), semi-rigid ureteroscopy, flexible ureterorenoscopy (URS), and percutaneous nephrolithotomy (PCNL) [2].

Nephrolithiasis is rarely a life-limiting condition, and mortality rates for treatments are thought to be low but, as always, depend on patient and disease factors. There have been limited studies that report on mortality rates of the various surgical treatments. The present study aimed to describe in detail the largest series of peer-reviewed renal tract stone-related deaths, the causes of death, and, uniquely, identify clinical management issues (CMIs) as assessed by peer reviewers with potential areas for improvement.

Patients and Methods

The Australian and New Zealand Audit of Surgical Mortality (ANZASM) is a collection of State-based audits overseen by the Royal Australasian College of Surgeons (RACS). They collect data on all surgical deaths (both in the public and private sectors) in their jurisdictions and provide feedback to individual surgeons, in addition to using aggregated data to report on mortality trends [3]. Data have been collected nationwide since 2009, with reporting for Continuing Professional Development commencing in 2012. The

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processes have been reported previously [3]; following is a brief summary. Deaths are reported either from hospitals, self-reporting surgeons or the coroner. The involved surgeon is asked to complete a surgical case report form on the events leading up to death, which is then reviewed by a surgical peer from the same specialty but different hospital. In most cases no concerns are raised but if there could be any CMIs, or there is inadequate information, a second-line assessment by a different peer is conducted using the hospital patient medical notes. The ANZASM uses three grades for CMIs (in increasing severity): an area of consideration, where there could be some debate about the management; an area of concern, where patient care could have better; or, an adverse event. These can be further classified by preventability and whether they were considered directly contributing to the patient's death.

All data are entered into the Bi-national Audits of Surgical Mortality (BAS) database, which allows interrogation using multiple data points collected. All information provided to the audit, including the operating surgeon's and assessor's views and criticisms, is protected in Australian Commonwealth law by Qualified Privilege. Only de-identified patient information can be used for aggregate reports, case note reviews or research projects.

For the present review, all urological deaths entered into the BAS from 1 January 2009 to 31 December 2017 were extracted and classified for any involvement with renal, ureteric or bladder stones. All CMIs were recorded, analysed and compared with the results for urology and all surgery death data in the ANZASM.

Results

Of 1034 total urological deaths, 100 were related to stones (9.7%). The mean (range) age of patients was 74.4 (21–97) years with males representing 54%. In all, 95 patients underwent at least one surgical procedure as documented in Table 1, with 50 (52.6%) of these being performed as emergencies either for sepsis or an obstructed system. All the ureteric stent procedures and nephrostomies were inserted for urgent indications. Nine (50%) of the 18 ureteroscopic procedures were performed urgently for obstructed systems, including a 96-year-old with an obstructing 16-mm stone and a 97-year-old with a small stone. Of the remaining nine ureteroscopies, five had preoperative ureteric stents. One (4.5%) of the 22 URS procedures was performed as an emergency for an obstructed system. Only five of the remaining URS cases had documented preoperative ureteric stents.

Five patients did not have any procedures, all presenting as emergencies with three dying of cardiac events that prevented intervention, one dying from chronic renal failure secondary to bilateral staghorn calculi, and a 34-year-old female presenting with ureteric colic and an underlying terminal metastatic leiomyosarcoma. These cases were excluded from further analysis.

Table 1 Deaths related to stone operations and CMIs.

Procedure	Quantity, *n* (%)	CMIs, *n* (%)
Ureteric stent insertion	30 (0)	10 (0)
URS	22 (21)	12 (12)
Ureteroscopy	18 (9)	6 (3)
Nephrostomy	10 (0)	3 (0)
PCNL	6 (6)	3 (3)
Cystolitholapaxy	4 (4)	1(1)
No procedure	5	0
SWL	2 (2)	1 (1)
Cystoscopy	1 (1)	0
Stent removal	1 (1)	1 (1)
Open cystolithotomy	1 (1)	0 (0)
Total	100	37
Total elective	45	21 (56.8)

The causes of death for operative cases are shown in Figs 1 and 2, with sepsis (47/95, 49.5%) being the most common cause followed by cardiac events with 19 deaths (20%).

Of the 95 patients undergoing some urological intervention for stone disease, 37 (39.9%) were assessed to have a CMI. The case details are shown in Table 2. This compares poorly to the 26% for both urology as a specialty and all surgical specialties reported to the ANZASM [4]. A total of 17 of the CMIs (45.9%) were the least serious classification of an area of consideration, whereas 14 (37.8%) were areas of concern and there were six (16.2%) adverse events. Again, these results are higher compared to the latest all specialty ANZASM national data, where 7% of all cases were reported to be areas of concern and 4% had adverse events [4].

In all, 21 (56.8%) of the 37 CMI cases were in elective patients (Table 2). Overall, the most common considerations were delay to surgery (18.9%, seven of 37), issues with perioperative management (16.2%, six of 37), issues with antibiotics (10.8%, four of 37), and inappropriate procedures or timing of procedures (24.3%, nine of 37). There were three (8.1%) intraoperative iatrogenic injuries, two of which were associated with PCNL. URS, often with stent insertion or removal, had the highest rate of CMIs (54.5%), the majority of which (66.7%, eight of 12) were areas of consideration (Table 2). The mean age of patients with elective CMIs was 67.5 years, and emergency CMIs was 77.4 years.

Discussion

Surgery in Australia and New Zealand is safe with perioperative mortality rates ranging between two and three per 1000 operations [5]. Most of these deaths are from emergency operations in already unwell patients. The aim of the ANZASM is to investigate all surgical deaths and provide both feedback to individual surgeons and aggregated surgeon

Fig. 1 Causes of death.

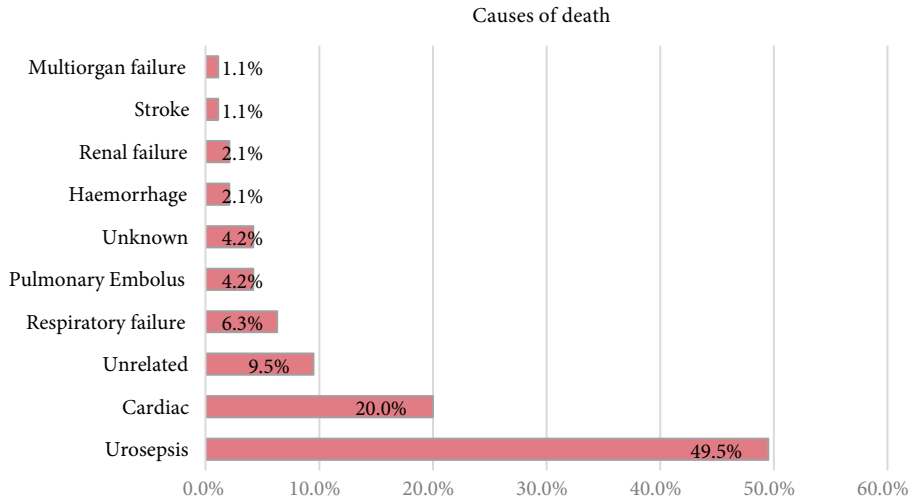
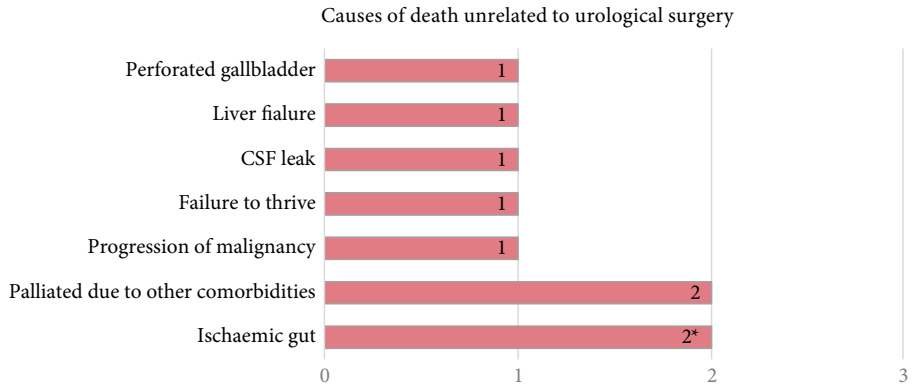


Fig. 2 Causes of death unrelated to urological surgery. *one of these cases had a CMI.



and hospital performance reports to help prevent further deaths. There is some evidence that the latter is occurring [3,6].

Death involving stone disease is thought to be very rare, although there is little published evidence. Quoted mortality rates for the common procedures are: PCNL 0.2–0.4% [1,7,8], URS 0.05% [9] with only 21 cases reported [10]. Very few deaths have been reported after emergency ureteric stenting or percutaneous nephrostomy placement for infective urolithiasis [11,12]. Mortality from SWL is extremely rare, with only case report of post-procedure haemorrhage [13–15].

The ANZASM dataset is the largest reported, which includes peer review and preventability status of each death. Limitations of the audit include that only hospital deaths are routinely reported, so it is possible that postoperative deaths in the community are missed, and that the number of procedures that did not cause death is unknown, so rates of death for each of the treatments cannot be calculated. It is concerning that 56.8% (21/37) of the cases with CMIs were elective and that patients as young as 21 years have died from planned procedures.

As with previous studies the most common cause of death was urosepsis [1,16]. This is a well-recognised, frightening complication possible in any urological intervention and despite best efforts, some may be unavoidable. In many emergency cases, the patient may have succumbed from the disease regardless of intervention, which will account for the assessors having no issues with 27 (67.5%) of the 40 emergency stent and nephrostomy procedures. It is worrying that the significant failures regarding documentation were identified, that prophylactic antibiotics were not prescribed, inappropriate antibiotics were used, and there were concerns with perioperative management. There is no excuse for not documenting urine cultures and adhering to antibiotic guidelines for elective stone cases.

There is always a debate about the best way of decompressing obstructed, infected systems [17], and some assessors have queried whether a nephrostomy may have been less traumatic

Table 2 Details of CMIs.

Procedure	Age, years	Elective/ Emergency	Cause of death	CMI	Details
URS	21	Elective	Sepsis	Concern	Postoperative management
URS	68	Elective	Sepsis	Adverse event	No prophylactic antibiotics
URS	80	Elective	Sepsis	Consideration	Operation could have been delayed
URS	52	Elective	Sepsis	Consideration	Preoperative evaluation
URS	64	Elective	Sepsis	Consideration	Should operation have been performed?
URS	63	Elective	Sepsis	Consideration	Wrong prophylactic antibiotic
URS	46	Elective	Sepsis	Concern	Lost stent/preoperative management
URS	89	Elective	Pneumonia	Consideration	Inadequate antibiotics
URS	76	Elective	Sepsis	Adverse event	Inadequate preoperative management
URS	79	Elective	IHD	Consideration	Postoperative management
URS	84	Elective	? DIC	Consideration	Inappropriate antibiotics
URS*	70	Elective	MI	Consideration	Perioperative assessment/ communication
Stent insertion	93	Emergency	MI/sepsis	Consideration	Consider nephrostomy
Stent insertion	79	Emergency	Respiratory Failure	Adverse event	Sepsis
Stent insertion	59	Emergency	Sepsis	Adverse event	Aspiration
Stent insertion	43	Emergency	Cardiac event	Concern	No MSU performed
Stent insertion	78	Emergency	Cardiac event	Concern	Delay in treatment
Stent insertion	88	Emergency	Respiratory failure	Consideration	Delay in treatment
Stent insertion	87	Emergency	Sepsis	Consideration	Consider Nephrostomy
Stent insertion	76	Emergency	Sepsis	Consideration	Delay in treatment
Stent insertion	69	Emergency	Ischaemic bowel	Consideration	Delay in treatment
Stent insertion/ nephrostomy	87	Emergency	Sepsis	Concern	Failure to confirm preoperative infection
Ureteroscopy/ stent change	43	Elective	Sepsis	Concern	6-month delay in removing stent
Ureteroscopy/ stent change	58	Elective	Sepsis	Consideration	Surgery could have been delayed
Ureteroscopy	87	Elective	Sepsis	Concern	Delay in treatment
Ureteroscopy	73	Emergency	Sepsis	Consideration	Immunocompromised patient
Ureteroscopy	84	Emergency	Sepsis	Concern	Stent rather than treatment
Ureteroscopy	88	Emergency	MI	Concern	Stent rather than treatment
Nephrostomy	79	Emergency	Sepsis	Concern	Failed to confirm infection
Nephrostomy	69	Emergency	Sepsis	Concern	Delay in treatment
Nephrostomy	87	Emergency	Sepsis	Concern	Delay in treatment
PCNL	66	Elective	MI	Concern	Post mortem 2 L intraperitoneal blood
PCNL	79	Elective	Sepsis	Consideration	Consider nephrostomy instead of operation
PCNL	43	Elective	Cardio-respiratory arrest	Adverse event	Tension pneumothorax/sepsis
Stent removal	85	Elective	Cardiac event	Concern	Stent removed, stone untreated
Cystolitholapaxy	94	Elective	Respiratory failure	Adverse event	Bladder perforation
SWL	70	Elective	MI	Consideration	No DVT prophylaxis

**Planned procedure – patient arrested during cystoscopy. DIC, disseminated intravascular coagulation; DVT, deep vein thrombosis; IHD, ischaemic heart disease; MI, myocardial infarction; MSU, mid-stream urine.*

than a ureteric stent. Not every hospital will have access to interventional radiology and it is not always appropriate to transfer patients to those centres that have those facilities, with distances between sites in Australasia often being vast. These criticisms were in the least serious category – an area of consideration.

The assessors noted a number of cases where delay played a part in the death. This may be due to delay in diagnosis, delay in decompression, which is known to increase mortality [18], and delay to definitive treatment. Two cases involved ureteric stents being left in for too long a period, which increases the risk of encrustation, meaning longer operations to remove the stent and an increased risk of sepsis [19]. Stent registries [20,21] have been reported for many years and 'lost' ureteric stents should not feature in developed nations.

PCNL is often considered the most technically difficult of the common stone procedures and has the highest reported mortality rate [1]. Accordingly, it is often reserved for the largest stones, although there has been a reduced use in recent years largely attributed to the increased uptake of URS [22,23]. Only 6.3% (six of 95) of the deaths in the present report were related to PCNL; with half of these reporting a CMI, and two of six having significant iatrogenic injuries (which are well-recognised) that caused death. Increased vigilance for the known complications may improve outcomes, although the operation will probably still remain in the hands of the relatively few experts who perform large numbers of these procedures.

URS contributed to over one in five of the deaths in the present series, with over half of these cases associated with a CMI. There has been a rapid increase in the uptake of the operation due to the improvement in digital flexible scopes, and the availability and reliability of lasers for stone fragmentation/dusting [24]. There is some evidence that URS

is being used for large renal stones that may be better cleared with PCNL [25], and the results published here and elsewhere [16,25] demonstrate that the procedure may not achieve acceptable results and is not risk-free [10]. Careful patient selection and preoperative evaluation are required to avoid unnecessary complications and death. In particular, consideration must be made for preoperative ureteric stents. Only five (23.8%) of the 21 elective patients with CMIs in this series were recorded to have preoperative stents, which if true (as it may just be a limitation of the reports) could increase the risk of ureteric trauma [26].

Ureteroscopy for stone disease has been available for >30 years. Developments in telescope design and the stone breaking technology have made it a standard, generally safe procedure but it was still involved in 18 deaths, a third of which caused some criticism from the assessors. In particular, those cases where a ureteric stone was removed as an emergency in elderly patients were classed as areas of concern. Whilst removing an acute ureteric stone in one sitting is attractive to patient and surgeon alike, thus avoiding additional anaesthesia and possibly a stent, it should only be considered for small, distal stones with no suggestion of underlying sepsis in expert hands. The safer procedure will always be to de-obstruct the system with nephrostomy or a stent and electively remove the stone later.

Death related to SWL is extremely rare and often related to renal trauma [13–15]. It is concerning that two Australasian cases have been reported. However, in this case series, both deaths were related to cardiac events with one possibly precipitated by a peri-renal haematoma, a rare but recognised complication. During this reporting period, virtually all SWL in Australasia was performed using general anaesthesia, despite the latest generation of lithotripters being designed for use without general anaesthesia, which is both acceptable to patients and will reduce the risks of anaesthesia-related complications [27].

Cystolitholapaxy was involved in 4.2% (four of 95) of the deaths with only one CMI. This was an iatrogenic bladder perforation that required laparotomy. This is a well-recognised risk of the procedure, particularly when using the older stone punches, which will hopefully be seen less in the future with the use of high-powered lasers.

Open surgery for urinary tract stone disease is now rarely performed in the developing world and it is reassuring that no deaths have been reported to the ANZASM.

Death related to stone surgery represents only a small proportion of all urological deaths and these incidents generated more CMIs amongst the ANZASM peer assessors. The most common cause of death is due to overwhelming sepsis, often in an emergency setting. Results can be improved in these cases with more rapid diagnosis and treatment. Over 50% of deaths related to elective surgery for renal stones were associated with assessor CMIs, with most of these cases involving the rapidly increased use of URS. Careful case selection and access to all treatment options are recommended.

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Conflict of Interest

The authors have no conflicts of interest to disclose.

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Abbreviations: ANZASM, Australian and New Zealand Audit of Surgical Mortality; BAS, Bi-National Audit of Surgical Mortality; CMI, clinical management issue; PCNL, percutaneous nephrolithotomy; SWL, extracorporeal shockwave lithotripsy; URS, ureterorenoscopy.