Centre for Clinical Effectiveness
Enhancing patient outcomes through clinical application of the best available evidence

EVIDENCE CENTRE
EVIDENCE REPORT

Management of renal colic in the emergency department

Wendy Allen, BA(Hons) MA MBA
Elmer V Villanueva, MD ScM
Associate Professor Jeremy Anderson MBChB MSc(Epi) MD FRANZCP

Centre for Clinical Effectiveness
Monash Medical Centre
Locked Bag 29
Clayton VIC 3168
Australia

Telephone: +61 3 9594 2726
Fax: +61 3 9594 6970

July 31, 2001

Southern Health

MONASH UNIVERSITY

SUMMARY

Task

The Centre for Clinical Effectiveness was asked to review research literature, focusing primarily on clinical guidelines, relevant to diagnosis and treatment of renal colic in emergency department settings.

Conclusions and recommendations

The literature review identified a single authoritative clinical guideline about the treatment of renal colic, produced by the American Urological Association in 1997. Unfortunately the guideline concerns almost exclusively the indications and options for surgical management of renal calculi, which is not the major issue in an emergency department setting. In this context screening and diagnosis of renal colic are more relevant.

The review also identified fifty relevant primary research reports published since 1997. Although a critical appraisal of these reports in a specific clinical context was beyond the scope of this document, several possible approaches stand out. Unenhanced spiral computerised tomography appears from the recent literature to be the single screening procedure of choice. This technique has impressive sensitivity and specificity as a diagnostic test and appears to offer advantages over ultrasonography. Data on the economic implications of this technique are not conclusive.

Feasibility

The identified clinical guideline for management of renal colic provides little assistance in the emergency department context. The primary research literature offers strong suggestions of possible advances in screening and diagnosis but would require a moderately large-scale critical appraisal of the identified literature before reliable management recommendations could be made. Developing clinical guidelines from this material would also require multidisciplinary clinician involvement.

METHODOLOGY

Search Strategy

The Centre for Clinical Effectiveness defined the 'best available evidence' as that research we can identify that is least susceptible to bias. We determine this according to predefined NHMRC criteria (see Appendix 1).

First we search for systematic reviews, evidence-based clinical practice guidelines, or health technology assessments, and randomized controlled trials. If we identify sound, relevant material of this type, the search stops. Otherwise, our search strategy broadens to include studies that are more prone to bias, less generalizable, or have other methodologic difficulties. We include case-control and longitudinal cohort studies in our critical appraisal reports. While we cite observational and case series studies, and narrative reviews and consensus statements, in our reports we do not critically appraise them. Some studies can produce accurate results but they are generally too prone to bias to allow determination of their validity beyond their immediate setting.

The CCE was tasked to examine the evidence for the various strategies in the management of renal colic in the emergency department setting.

Resources Searched

We searched the following databases and Internet websites:

.

- Cochrane Library CD-ROM
- Medline (OVID)
- CINAHL (OVID)
- SumSearch
- National Guidelines Clearinghouse
- NHS Centre for Reviews and Dissemination (NHS CRD)

Refinements, Searching & Reporting Constraints:

We only included articles published since 1997, and applied the following inclusion and exclusion criteria:

Inclusion Criteria

- Focus on adult patients with renal colic in the emergency department;
- Published primary studies;
- Published clinical practice guidelines (whether generated through evidence-based methods or through consensus)

Exclusion Criteria

- Study examined less than five patients
- Study was published in a language other than English
- Study presented data included in another published report

RESULTS

Clinical Practice Guidelines

The search identified one relevant clinical guideline meeting the entry criteria (AUA 1997). The descriptive characteristics of the guideline are shown in Table 1. We include a brief summary of this guideline in Appendix 1.

Table 1. Description of guidelines.

Characteristic	AUA 1997
Developers	American Urological Association, Inc.
Category	Treatment
Intended Users	Physicians
Target Population	Nonpregnant adults with a solitary ureteral stone composed of material other than cystine or uric acid; not been previously treated for this stone; whose medical condition, including renal function, body habitus and urinary tract anatomy, permits performance of any of the accepted active treatment modalities including use of anesthesia; and whose situation is such that all accepted modalities are available.
Endorsers	Not stated
Outcomes Considered	Outcomes stratified by stone location (upper or lower ureter); spontaneous passage; stone-free rates (stratified by size); acute complication rates; long-term complication rates; number of primary and secondary procedures
Methods to Collect Evidence	Searches of electronic databases
Methods to Analyse Evidence	Systematic review with evidence tables, meta-analysis of summarized patient data
Length	72 pages

Health Technology Assessments

There were no health technology assessment reports available on the topic of renal colic.

Citations for clinical practice guidelines and health technology assessments

AUA (1997). *The management of ureteral calculi*. American Urological Association, Baltimore, MD, USA.

Published Primary Literature

Fifty identified articles met the entry criteria. Critical appraisal was not performed on these articles. Citations and abstracts are listed in Appendix 2 arranged according to topic area.

.

APPENDIX 1 Clinical practice guideline identified through the literature search

Introduction

The following summary draws heavily on that provided by the National Guidelines Clearinghouse <www.guidelines.org>. It is intended to illustrate only the main recommendations of the guideline. Readers are advised to consult the full document for detailed findings.

Brief Summary

TITLE: The management of ureteral calculi.

TABLE 1 CITATION: AUA 1997

SOURCE: Baltimore (MD): American Urological Association, Inc; 1997 Sep. 72 (Clinical practice guidelines; no. 9/97).[72 references]

RELEASE DATE: 1997 Sep

SUMMARY RECOMMENDATIONS:
These recommendations were graded into three groups determined by strength of evidence and the expected amount of variation in patient preferences:

- **Standard**: A treatment policy is considered a standard if the health and economic outcomes of the alternative interventions are sufficiently well-known to permit meaningful decisions and there is virtual unanimity about which intervention is preferred.
- **Guideline**: A policy is considered a guideline if (1) the health and economic outcomes of the interventions are sufficiently well-known to permit meaningful decisions and (2) an appreciable but not unanimous majority agrees on which intervention is preferred.
- **Option**: A policy is considered an option if (1) the health and economic outcomes of the interventions are not sufficiently well-known to permit meaningful decisions, (2) preferences among the outcomes are not known, (3) patients' preferences are divided among the alternative interventions, and/or (4) patients are indifferent about the alternative interventions.

Recommendations
The first 3 recommendations below apply to proximal and distal ureteral stones. Subsequent recommendations are categorized as to whether the stone is located in the proximal or distal ureter and whether the stone is 1 cm. or less, or greater than 1 cm. in diameter.

Standard.

A patient who has a ureteral stone with a low probability of spontaneous passage must be informed about the existing active treatment modalities, including the relative benefits and risks associated with each modality. The decision that a stone has a low probability of spontaneous passage is based on the facts of the case and professional experience. Factors that weigh in the decision are the size of the stone, the shape of the stone, internal anatomy and history of stone

passage. In general patients whose stones are 0.5 cm. or less in diameter have a good chance of spontaneous passage, whereas the chance of spontaneous passage for larger stones diminishes considerably. Although, as a practical matter, it is evident that the availability of equipment and the expertise of an individual practitioner may impact the choice of a treatment intervention, it is unacceptable to withhold certain treatments from the patient and not offer them as alternatives because of personal inexperience or unfamiliarity with one of the accepted treatment modalities, or because of the local unavailability of equipment or expertise.

Guideline.

In a patient who has a newly diagnosed proximal or distal ureteral stone with a high probability of spontaneous passage, and whose symptoms are controlled observation with periodic evaluation is recommended for initial treatment. Up to 98% of stones less than 0.5 cm. in diameter, especially in the distal ureter, may be expected to pass spontaneously. How long until passage occurs, when passage takes place and the degree of colic or other symptoms are all unpredictable and often bear heavily on the decision to intervene in such patients. In the opinion of the panel for most such patients the high probability of spontaneous passage justifies observation as the initial treatment. However, difficulties in tolerating pain, multiple trips to the emergency room or other factors may mandate treatment in a patient whose stone might otherwise be expected to pass.

Guideline.

Routine stenting to increase efficiency of fragmentation is not recommended as part of shock wave lithotripsy. It has become common practice to place a ureteral stent, usually a Double-J* stent, for more efficient fragmentation of ureteral stones using shock wave lithotripsy. The data analyzed by the panel did not support the routine use of such stents when the goal is to improve the stone-free results of shock wave lithotripsy. The data showed no improved fragmentation with stenting. Routine stenting may be justifiable for other purposes such as management of symptoms associated with the passage of stones.

Recommendations for stones 1 cm. or less in the proximal ureter.

As a standard open surgery should not be the first line active treatment. As a guideline shock wave lithotripsy is recommended as first line treatment for most patients. Although open surgery will usually be successful, relatively longer hospitalization and greater postoperative morbidity with open surgery mean that shock wave lithotripsy should be the first line treatment for most patients. Ureteroscopy and percutaneous nephrolithotomy are acceptable choices in situations when shock wave lithotripsy may not be appropriate or as salvage procedures for failed lithotripsy.

Recommendations for stones greater than 1 cm. in the proximal ureter.

As a guideline open surgery should not be the first line treatment for most patients. As an option shock wave lithotripsy, percutaneous nephrolithotomy and ureteroscopy are all acceptable treatment choices. Treatment results for large stones in the upper ureter are less predictable than for small stones. Shock wave lithotripsy, percutaneous nephrolithotomy and ureteroscopy are all acceptable options in the upper ureter but ureteroscopy may become less appropriate as the stones encountered become larger. Open surgery, despite the excellent stone-free results, should not be the first line treatment in most patients with large stones. The reasons are the same as for patients with small stones, that is relatively greater postoperative morbidity and longer hospitalization. Open surgery may well

.

be appropriate for nonstandard cases and is certainly an acceptable alternative as a salvage measure.

Recommendations for stones 1 cm. or less in the distal ureter.

As a standard, open surgery should not be the first line treatment.

As a guideline blind basketing without fluoroscopy and guide wire cannot be encouraged as a treatment choice.

As an option shock wave lithotripsy and ureteroscopy are acceptable treatment choices.

Blind basketing refers to basket manipulation of distal ureteral stones as practiced before the advent of ureteroscopy and fluoroscopy around 1981. The high success rates attending ureteroscopic stone removal using fluoroscopic control, the availability of fluoroscopy as an adjunctive measure and lack of training in the vast majority of programs in the technique of blind basket extraction mean that blind basketing without fluoroscopy and safety guide wire cannot be encouraged as a treatment choice. The data from the literature suggest that blind basketing can achieve a 73% success rate. Nevertheless, the panel's expert opinion is that guided stone manipulation, concomitant use of fluoroscopy and safety guide wire, or ureteroscopic basketing would be a considerably safer and more efficacious option.

Shock wave lithotripsy and ureteroscopy are effective for management of distal ureteral stones. Each has advantages and disadvantages. Shock wave lithotripsy is minimally invasive and can often be performed without anesthesia or under intravenous sedation but it may require multiple primary treatments for adequate fragmentation and is more likely to require ancillary treatment. Ureteroscopy has a higher success rate, with the least risk of requiring multiple treatments and the least risk of an ancillary procedure, but it is more invasive than shock wave lithotripsy. Although not studied by the panel, cost issues will bear on patient decision as to which treatment method is more appropriate. Availability is also a factor. Ureteroscopy is widely available in the current era as is shock wave lithotripsy, although the availability of lithotripsy will vary according to whether a practitioner is dependent on a mobile machine.

Recommendations for stones greater than 1 cm. in the distal ureter.

As a standard blind basketing is not recommended as a treatment choice.

As a guideline open surgery should not be the first line treatment for most patients.

As an option shock wave lithotripsy and ureteroscopy are acceptable treatment choices. Large stones in the ureter must be fragmented before ureteroscopic extraction, and shock wave lithotripsy must fragment large stones into passable fragments. Such stones will likely require more shock wave lithotripsy treatments than will smaller stones, and ureteroscopy may be preferable when such cases are anticipated. Given the high success rates using shock wave lithotripsy and ureteroscopy, open surgery should not be the first line treatment in most patients, although open surgery may be preferable for certain large ureteral stones or in nonstandard situations.

CLINICAL ALGORITHM(S):
None provided

DEVELOPER(S):
American Urological Association, Inc. (AUA) - Medical Specialty Society

COMMITTEE:
Ureteral Stones Clinical Guidelines Panel Members and Consultants

GROUP COMPOSITION:
Names of Panel Members: Joseph W. Segura, MD, Chair; Glenn M. Preminger, MD, Facilitator; Dean G. Assimos, MD; Stephen P. Dretler, MD; Robert I. Kahn, MD; James E. Lingeman, MD; Joseph N. Macaluso, Jr., MD
Consultants: Hanan S. Bell, PhD; Patrick M. Florer; Curtis Colby

GUIDELINE STATUS:
This is the current release of the guideline. No update is in progress at this time. The AUA will assess the need to an update 2-3 years after release.

GUIDELINE AVAILABILITY:
Electronic copies: Available to physicians from the American Urological Association (AUA) Web site.
Print copies: Available to physicians from the American Urological Association, Inc., Health Policy Department, 1120 N. Charles Street, Baltimore, MD 21201; telephone (410) 223-4367.

COMPANION DOCUMENTS:
The following are available:

Segura JW, Preminger GM, Assimos DG, Dretler SP, Kahn RI, Lingeman JE, Macaluso JN Jr. Special communication. Ureteral Stones Clinical Guidelines Panel summary report on the management of ureteral calculi. J Urol 1997 Nov;158(5):1915-21.

Print copies: Available to physicians from the American Urological Association, Inc., Health Policy Department, 1120 N. Charles Street, Baltimore, MD 21201; telephone (410) 223-4367.

PATIENT RESOURCES:
The following is available for physicians to distribute to patients:

The management of ureteral stones. A doctor's guide for patients. Baltimore, MD: AUA, 1997. 9 p.

Print copies: Available to physicians by contacting AUA, Health Policy Dept, 1120 N. Charles St, Baltimore, MD 21201-5559; 410-223-4310; fax, 410-223-4375; e-mail: guidelines@auanet.org..

APPENDIX 2 Published primary literature identified through the literature search

Diagnostic tests on arrival in ED

Doppler Ultrasonography

Shokeir, A. A. and M. Abdulmaaboud (1999). "Resistive index in renal colic: a prospective study." BJU International 83(4): 378-82.

OBJECTIVE: To study the role of Doppler ultrasonography (DU) in the diagnosis of acute unilateral renal obstruction. PATIENTS AND METHODS: In all, 117 patients with suspected renal colic were evaluated by intravenous urography (IVU) and DU, with determination of the resistive index (RI) and the difference between the RI of ipsilateral and contralateral kidneys (deltaRI). RI and deltaRI were considered positive with values of > or = 0.70 and > or = 0.06, respectively. IVU results were considered the 'gold standard' with which renal DU findings were compared. CONCLUSIONS: Renal DU is a sensitive and highly specific test that can contribute significantly to the diagnosis of acute unilateral renal obstruction. It can replace the IVU, particularly in situations where IVU is undesirable.

de Toledo, L. S., T. Martinez-Berganza Asensio, et al. (1996). "Doppler-duplex ultrasound in renal colic." European Journal of Radiology 23(2): 143-8.

OBJECTIVE: To determine the role of intrarenal Doppler ultrasound (US) in patients with renal colic and to establish the usefulness of this diagnostic method. CONCLUSION: Color Doppler US is useful to fundamentally evaluate the consequences of the obstruction on renal function. Other factors such as evolution time of the symptomology, obstruction level, or existence of pyelonephritis can alter the US-Doppler values

Shokeir, A. A. and M. Abdulmaaboud (2001). "Prospective comparison of nonenhanced helical computerized tomography and Doppler ultrasonography for the diagnosis of renal colic." Journal of Urology 165(4): 1082-4.

PURPOSE: We evaluate the accuracy of nonenhanced helical computerized tomography (CT) and Doppler ultrasonography for the diagnosis of renal colic. CONCLUSIONS: Nonenhanced helical CT and change in resistive index are sensitive and specific tests that can contribute significantly to the diagnosis of acute unilateral renal obstruction. They can replace IVP, particularly in situations in which it is undesirable.

Intravenous Urography

Richards, J. R. and C. A. Christman (1999). "Intravenous urography in the emergency department: when do we need it?" European Journal of Emergency Medicine **6**(2): 129-33.

Intravenous urography (IVU) is a useful radiographic study in the detection of renal and ureteral calculi. However, it is time consuming, expensive, and exposes the patient to i.v. contrast and radiation. To determine the impact of utilizing IVU less for the detection of renal calculi, criteria for ordering IVU in the emergency department (ED) were evaluated, and patients with high probability of positive IVU were identified. IVU is a useful study in the ED but may be overutilized, leading to lengthy patient stays. The combined objective findings of acute flank pain and haematuria are sensitive, and prior history is specific in identifying patients with renal calculi. Degree of haematuria was not useful in predicting renal calculi. By utilizing the criteria of acute flank pain and haematuria as a decision aid, 66% of all IVUs ordered could have been avoided.

Sourtzis, S., J. F. Thibeau, et al. (1999). "Radiologic investigation of renal colic: unenhanced helical CT compared with excretory urography." AJR. American Journal of Roentgenology **172**(6): 1491-4.
OBJECTIVE: Our aim was to compare unenhanced helical CT and excretory urography in the assessment of patients with renal colic. CONCLUSION: Compared with excretory urography, unenhanced helical CT is better for identifying ureteral stones in patients with acute ureterolithiasis. Secondary CT signs of obstruction, including renal sinus fat blurring, were frequently present even when the stone was eliminated before imaging.

Renal Resistive index

Shokeir, A. A., M. R. Mahran, et al. (2000). "Renal colic in pregnant women: role of renal resistive index." Urology **55**(3): 344-7.
OBJECTIVES: To investigate the value of the renal resistive index (RI) in the identification of acute renal obstruction in pregnant women. METHODS: The study included 22 pregnant women with acute unilateral ureteral obstruction due to a stone disease (group A), 71 normotensive pregnant patients without loin pain (group B), and 20 nonpregnant women of child-bearing age with both kidneys normal (group C). All patients underwent Doppler ultrasound (DUS) with determination of the RI and the difference between the RI of the corresponding and contralateral kidney (DeltaRI). CONCLUSIONS: The DeltaRI is a sensitive and specific test that can replace intravenous urography in the diagnosis of acute unilateral ureteral obstruction in pregnant women.

Single stone risk analysis

Pak, C. Y., R. Peterson, et al. (2001). "Adequacy of a single stone risk analysis in the medical evaluation of urolithiasis." Journal of Urology **165**(2): 378-81.
We tested the hypothesis that a single 24-hour urine sample for stone risk analysis would be sufficient for the simplified medical evaluation of urolithiasis. CONCLUSIONS: The reproducibility of urinary stone risk factors is satisfactory in repeat urine samples. A single stone risk analysis is sufficient for the simplified medical evaluation of urolithiasis.

Computerized Tomography (CT)

Abramson, S., N. Walders, et al. (2000). "Impact in the emergency department of unenhanced CT on diagnostic confidence and therapeutic efficacy in patients with suspected renal colic: a prospective survey. 2000 ARRS President's Award. American Roentgen Ray Society." AJR. American Journal of Roentgenology **175**(6): 1689-95
OBJECTIVE: Our objective was to evaluate the impact of unenhanced CT on clinician diagnostic confidence and therapeutic efficacy in emergency department patients with clinically suspected renal colic. CONCLUSION: CT significantly increased emergency department clinician diagnostic confidence and altered initial treatment decisions in patients with suspected renal colic. Most often, CT confirmed a ureteral stone and allowed appropriate discharge or urologic intervention. In a smaller subset of patients, CT established a significant alternative diagnosis that allowed the prompt initiation of appropriate treatment.

Assi, Z., J. F. Platt, et al. (2000). "Sensitivity of CT scout radiography and abdominal radiography for revealing ureteral calculi on helical CT: implications for radiologic follow-up." AJR. American Journal of Roentgenology **175**(2): 333-7
OBJECTIVE: We compared the sensitivity of CT scout radiography with that of abdominal radiography in revealing ureteral calculi on unenhanced helical CT. CONCLUSION: Abdominal radiography is more sensitive than CT scout radiography in revealing ureteral

.

calculi; however, some calculi revealed on unenhanced helical CT cannot be seen on either abdominal radiography or CT scout radiography. Ureteral calculi not visible on either study can only be followed, when necessary, with unenhanced helical CT.

Chen, M. Y. and R. J. Zagoria (1999). "Can noncontrast helical computed tomography replace intravenous urography for evaluation of patients with acute urinary tract colic?" Journal of Emergency Medicine **17**(2): 299-303.
The objective of this study was to determine whether helical computed tomography (CT) performed without oral or intravenous contrast agents is accurate in the evaluation of patients with suspected acute renal colic. One hundred consecutive patients with suspected renal colic or ureteral colic were referred by our institution's emergency department for unenhanced helical CT scans. The sensitivity and specificity of helical CT in evaluating ureteral calculi were 100% and 94%, respectively. Sixteen extraurinary lesions were detected in 34 patients who had no urinary calculi. Most extraurinary lesions (81%) were deemed the cause of acute flank pain. The room time for CT averaged 26 min, compared to 69 min for intravenous urography (IVU). The charge for CT was $600 compared to $400 for IVU in our institution. Unenhanced helical CT was fast and accurate in determining the cause of colic and proved to be highly accurate for emergency situations.

Chu, G., A. T. Rosenfield, et al. (1999). "Sensitivity and value of digital CT scout radiography for detecting ureteral stones in patients with ureterolithiasis diagnosed on unenhanced CT." AJR. American Journal of Roentgenology **173**(2): 417-23
OBJECTIVE: When unenhanced CT reveals ureterolithiasis, some patients will require baseline or follow-up conventional radiography to help guide clinical management. We sought to determine the sensitivity of routinely obtained scout radiographs for revealing stones to determine if the scout view can be used in place of baseline conventional radiography. CONCLUSION: In our series, 49% of ureteral stones were visible on the often-overlooked routine CT scout radiograph. Imaging of phantoms showed that stone visualization can be optimized by using the lowest kilovoltage settings. Therefore, the CT scout view can be used as a baseline study in patients requiring follow-up radiography and for planning treatment of patients requiring lithotripsy or other intervention. Finally, large stones not visible on scout radiographs are likely composed of uric acid or xanthine

Dalla Palma, L., R. Pozzi-Mucelli, et al. (2001). "Present-day imaging of patients with renal colic." European Radiology **11**(1): 4-17.
In the past decade alternatives to urography have been proposed for the study of patients with renal colic. In 1992 it was suggested to replace urography with KUB and ultrasonography. In 1993 the combination of KUB and ultrasonography followed by urography in unresolved cases was proposed and, in 1995, it was suggested to replace urography with unenhanced helical CT (UHCT). This article illustrates the contribution of UHCT to the study of patients with renal colic and analyses advantages and shortcomings of the technique compared with other diagnostic approaches. Many authors consider UHCT to be a valuable tool for suggesting the best therapeutic approach. Among these there are also urologists. The evaluation is based on the stone detection, its size and level in the urinary tract. Cost analysis shows that the cost of UHCT is equal to or inferior to the cost of urography. If helical CT is not available, plain film plus ultrasonography should be considered. This approach does not solve all the cases; in unresolved cases urography is indicated. It should also be noted that US has a good sensitivity in detecting other conditions such as biliary lithiasis, acute pancreatitis, acute appendicitis and abdomino-pelvic masses which are responsible for pain that mimics renal colic. In conclusion, IVU should not have any more the priority in investigating the patients with renal colic. Helical CT should be the first choice in imaging a patient with renal colic. If this technique is not available, plain film and ultrasonography should be considered adding urography in unresolved cases.

.

Dalrymple, N. C., M. Verga, et al. (1998). “The value of unenhanced helical computerized tomography in the management of acute flank pain.” Journal of Urology **159**(3): 735-40.
PURPOSE: We developed an algorithm using unenhanced computerized tomography (CT) for the management of acute flank pain and suspected ureteral obstruction. CONCLUSIONS: Unenhanced helical CT accurately determines the presence or absence of ureterolithiasis in patients with acute flank pain. CT precisely identifies stone size and location. When ureterolithiasis is absent, other causes of acute flank pain can be identified. In most cases additional imaging is not required.

Fielding, J. R., S. G. Silverman, et al. (1998). “Unenhanced helical CT of ureteral stones: a replacement for excretory urography in planning treatment.” AJR. American Journal of Roentgenology **171**(4): 1051-3.
OBJECTIVE: The purpose of this study was to determine whether unenhanced helical CT alone can be used for diagnosis and treatment planning of patients with obstructing ureteral stones. CONCLUSION: Helical CT can be used in place of excretory urography to plan treatment of patients with flank pain caused by obstructing ureteral stones. Stones that are larger than 5 mm, located within the proximal two thirds of the ureter, and seen on two or more consecutive CT images are more likely to require endoscopic removal, lithotripsy, or both.

Fielding, J. R., G. Steele, et al. (1997). “Spiral computerized tomography in the evaluation of acute flank pain: a replacement for excretory urography.” Journal of Urology **157**(6): 2071-3.
PURPOSE: We determined the value of noncontrast enhanced spiral computerized tomography (CT) in the evaluation of suspected renal colic. CONCLUSIONS: Noncontrast enhanced spiral CT was accurate and reliable in detecting obstructing ureteral calculi in patients with flank pain.

Fielding, J. R., L. A. Fox, et al. (1997). “Spiral CT in the evaluation of flank pain: overall accuracy and feature analysis.” Journal of Computer Assisted Tomography **21**(4): 635-8.
PURPOSE: Our goal was to assess test reliability and identify those features that have the strongest positive and negative predictive values in the diagnosis of renal colic using spiral CT. CONCLUSION: Absence of hydroureter and hydronephrosis on spiral CT images should prompt a search for a diagnosis other than an obstructing ureteral stone.

Greenwell, T. J., S. Woodhams, et al. (2000). “One year's clinical experience with unenhanced spiral computed tomography for the assessment of acute loin pain suggestive of renal colic.” BJU International **85**(6): 632-6
OBJECTIVE: To assess the use of unenhanced spiral computed tomography (CT) as the primary investigation of choice for suspected acute renal colic in clinical urological practice. CONCLUSIONS: Unenhanced spiral CT allows a rapid, contrast-medium-free, anatomically accurate diagnosis of urinary tract calculi and in the present series had a sensitivity of 98% and a specificity of 97%. CT provided an alternative diagnosis in 6% of patients. These advantages must be weighed against the threefold greater radiation dose of unenhanced spiral CT than with three-film IVU, and in practice the requirement for a radiologist to interpret routine axial scans

Haq, A., B. Drake, et al. (2001). “One year's clinical experience with unenhanced spiral computed tomography for the assessment of acute loin pain suggestive of renal colic.” BJU International **87**(3): 280-1.

Jackman, S. V., S. R. Potter, et al. (2000). “Plain abdominal x-ray versus computerized tomography screening: sensitivity for stone localization after nonenhanced spiral computerized tomography.” Journal of Urology **164**(2): 308-10.
Urolithiasis followup with plain abdominal x-ray requires adequate visualization of the calculus on the initial x-ray or computerized tomography (CT) study. We compared the

sensitivity of plain abdominal x-ray versus CT for stone localization after positive nonenhanced spiral CT. CONCLUSIONS: Plain abdominal x-ray is more sensitive than scout CT for detecting radiopaque nephrolithiasis. Of the stones visible on plain abdominal x-ray 51% were not seen on CT. To facilitate outpatient clinic follow-up of patients with calculi plain abdominal x-ray should be performed when a stone is not clearly visible on scout CT.

Heneghan, J. P., N. C. Dalrymple, et al. (1997). “Soft-tissue "rim" sign in the diagnosis of ureteral calculi with use of unenhanced helical CT.” Radiology **202**(3): 709-11.
PURPOSE: To determine the value of the ureteric soft-tissue "rim" sign for differentiation of ureteral calculi from phleboliths on unenhanced helical computed tomographic (CT) scans and to identify factors that are associated with the presence of the rim sign. CONCLUSION: In patients with flank pain, the presence of a rim sign is a strong indicator that a calcification along the course of the ureter is a stone. Absence of the rim sign indicates that a calcification remains indeterminate

Hubert, J., A. Blum, et al. (1997). “Three-dimensional CT-scan reconstruction of renal calculi. A new tool for mapping-out staghorn calculi and follow-up of radiolucent stones.” European Urology **31**(3): 297-301.
OBJECTIVES: The development of CT scanners (CT scan) with continuous rapid spiral acquisition now allows three-dimensional reconstructions of mobile organs such as kidneys. The aim of this study was to appreciate the merits of this new technique in the field of renal lithiasis. CONCLUSION: 3D CT scan reconstruction is a noninvasive, cost-effective method which offers high quality 3D images of renal calculi. These results should spur the more widespread use of this technique.

Levine, J. A., J. Neitlich, et al. (1997). “Ureteral calculi in patients with flank pain: correlation of plain radiography with unenhanced helical CT.” Radiology **204**(1): 27-31.
PURPOSE: To determine the sensitivity and specificity of plain radiography for the detection of ureteral calculi with use of unenhanced helical computed tomography (CT) as the standard of reference. CONCLUSION: Plain radiography is of limited value for aiding the diagnosis of ureteral stones. All patients with acute flank pain for whom radiologic imaging is recommended can directly undergo unenhanced helical CT; plain radiographs need not be obtained first.

Liu, W., S. J. Esler, et al. (2000). “Low-dose nonenhanced helical CT of renal colic: assessment of ureteric stone detection and measurement of effective dose equivalent.” Radiology **215**(1): 51-4.

PURPOSE: To evaluate a low-dose, nonenhanced helical computed tomographic (CT) protocol in the detection of ureteric stones and measure the associated effective dose equivalent (H(E)) of radiation. CONCLUSION: Our low-dose CT protocol is superior to IVU and clinically adequate for diagnosis of renal colic.

Miller, O. F., S. K. Rineer, et al. (1998). “Prospective comparison of unenhanced spiral computed tomography and intravenous urogram in the evaluation of acute flank pain.” Urology **52**(6): 982-7.

OBJECTIVES: To prospectively compare the diagnostic ability of unenhanced spiral computed tomography (NCCT) and intravenous urogram (IVU) in the evaluation of adults with acute flank pain. CONCLUSIONS: NCCT accurately diagnoses ureterolithiasis in patients presenting with acute flank pain. NCCT is significantly better than IVU in determining the presence of urolithiasis.

Mindelzun, R. E. and R. B. Jeffrey (1997). “Unenhanced helical CT for evaluating acute abdominal pain: a little more cost, a lot more information.” Radiology **205**(1): 43-5.

Nakada, S. Y., D. G. Hoff, et al. (2000). “Determination of stone composition by noncontrast spiral computed tomography in the clinical setting.” Urology **55**(6): 816-9.
OBJECTIVES: Several investigators have evaluated noncontrast computed tomography (NCCT) in predicting stone composition in vitro. We assessed NCCT in predicting stone composition in patients presenting to our emergency room with flank pain and stone disease. CONCLUSIONS: Using peak attenuation measurements and the attenuation/size ratio of urinary calculi from NCCT, we were able to differentiate between uric acid and calcium oxalate stones.

Olcott, E. W., F. G. Sommer, et al. (1997). “Accuracy of detection and measurement of renal calculi: in vitro comparison of three-dimensional spiral CT, radiography, and nephrotomography.” Radiology **204**(1): 19-25.
PURPOSE: To compare accuracy of three-dimensional (3D) spiral computed tomography (CT) performed without administration of contrast material with that of radiography and linear nephrotomography in detection and measurement of renal calculi. CONCLUSION: 3D spiral CT enabled highly accurate determination of the volumes and all three linear dimensions of renal calculi. In addition, 3D spiral CT depicted calculi more sensitively than traditional techniques and provided new information and improved accuracy in the evaluation of nephrolithiasis.

Patel, M., S. S. Han, et al. (2000). “A protocol of early spiral computed tomography for the detection of stones in patients with renal colic has reduced the time to diagnosis and overall management costs.” ANZ Journal of Surgery **70**(1): 39-42.
BACKGROUND: The recent use of spiral computed tomography (CT) without contrast for the diagnosis of acute flank pain has been shown to be highly sensitive and specific for the detection of urolithiasis. This method has not, however, been evaluated for its contribution to savings in management costs. The present study aims to evaluate the cost savings gained by instituting a protocol of early spiral CT to investigate these patients. CONCLUSIONS: The implementation of a protocol of early spiral CT for patients with suspected renal colic has led to earlier definitive diagnosis and shorter hospital stays. This is associated with a significant reduction in costs associated with managing this condition.

Sheafor, D. H., B. S. Hertzberg, et al. (2000). “Nonenhanced helical CT and US in the emergency evaluation of patients with renal colic: prospective comparison.” Radiology **217**(3): 792-7.

PURPOSE: To compare nonenhanced helical computed tomography (CT) with ultrasonography (US) for the depiction of urolithiasis. CONCLUSION: Nonenhanced CT has a higher sensitivity for the detection of ureteral calculi compared with US.

Sheley, R. C., K. G. Semonsen, et al. (1999). “Helical CT in the evaluation of renal colic.” American Journal of Emergency Medicine **17**(3): 279-82

This study assessed the clinical effectiveness of unenhanced helical (spiral) computed tomography (CT) for evaluation of patients presenting with symptoms of renal colic. Two hundred patients with symptoms and signs of renal colic (flank or groin pain, hematuria) were imaged. Unenhanced CT was performed using 5-mm collimation with a pitch of 1.5 to 1.8. Image reconstruction was performed at 3-mm intervals. Exam time was approximately 5 minutes. The financial charge at the study institution was the same as

for an intravenous urogram. Clinical follow-up was performed by review of available medical records and patient interviews. The sensitivity for detecting clinically relevant ureteral and bladder calculi was 0.862 (0.95 confidence interval [CI] 0.771 to 0.927), the specificity was 0.914 (0.95 CI 0.837 to 0.962), and the accuracy was 0.89 (0.95 CI 0.833 to 0.931). Helical CT is an effective technique in the evaluation of suspected acute urinary tract obstruction.

Yilmaz, S., T. Sindel, et al. (1998). "Renal colic: comparison of spiral CT, US and IVU in the detection of ureteral calculi." European Radiology **8**(2): 212-7.

The aim of our study was to compare non-contrast spiral CT, US and intravenous urography (IVU) in the evaluation of patients with renal colic for the diagnosis of ureteral calculi. During a period of 17 months, 112 patients with renal colic were examined with spiral CT, US and IVU. Spiral CT was found to be the best modality for depicting ureteral stones with a sensitivity of 94 % and a specificity of 97 %. For US and IVU, these figures were 19, 97, 52, and 94 %, respectively. Spiral CT is superior to US and IVU in the demonstration of ureteral calculi in patients with renal colic, but because of its high cost, higher radiation dose and high workload, it should be reserved for cases where US and IVU do not show the cause of symptoms.

Other diagnostic tests used. Which are recommended?

Plain film radiography (PFR)

Anyanwu, A. C. and S. M. Moalypour (1998). "Are abdominal radiographs still overutilized in the assessment of acute abdominal pain? A district general hospital audit." Journal of the Royal College of Surgeons of Edinburgh **43**(4): 267-70.
Several studies have shown that plain film radiography (PFR) is unnecessary for most patients with abdominal pain. Most patients with non-specific abdominal pain had radiographs (62%, 31/50), suggesting that PFR was being used as a routine investigation. Plain film radiography has little in the diagnosis of most causes of abdominal pain and should therefore not be used routinely. Confining radiography to patients with suspected gastrointestinal obstruction, perforation or ischaemia, unexplained peritonism, or renal colic would have included all our diagnostic films and reduced the utilization of PFR to 20.5%.

Boyd, R. and A. J. Gray (1996). "Role of the plain radiograph and urinalysis in acute ureteric colic." Emergency Medicine Journal **13**(6): 390-1.
The objective was to determine the accuracy of accident and emergency (A&E) doctors' diagnosis of radio-opaque ureteric calculi on plain abdominal radiographs; (2) to study the predictive value of haematuria with a history suggestive of ureteric colic. The conclusion was that A&E doctors are poor at identifying radio-opaque ureteric calculi on plain abdominal radiographs. If haematuria is absent on urinalysis then ureteric colic is an unlikely diagnosis.

Gorelik, U., Y. Ulish, et al. (1996). "The use of standard imaging techniques and their diagnostic value in the workup of renal colic in the setting of intractable flank pain." Urology **47**(5): 637-42.
OBJECTIVES. This study reviews the rate at which diagnostic imaging techniques are used in patients with intractable flank pain attributed to renal colic who are admitted to the hospital through the emergency room and determines the diagnostic values of plain film of the abdomen, kidney, ureter, bladder [KUB] and of ultrasonography (US) of the urinary tract, using intravenous urography (IVU) as the gold standard for establishing the presence of a calculus. CONCLUSIONS. Our data indicate that combining US with KUB provides the best diagnostic algorithm that approaches the yield of IVU in excluding the

presence of a calculus in the renal-urinary tract in patients who present with intractable flank pain.

Ramakumar, S., D. E. Patterson, et al. (1999). "Prediction of stone composition from plain radiographs: a prospective study." Journal of Endourology **13**(6): 397-401
Stone composition, as reflected in radiographic appearance, is important to help choose between SWL and percutaneous/endoscopic procedures. Predicting a stone's composition accurately from a plain radiograph would be a useful tool in clinical decision-making. However, the ability of physicians to predict composition has not been adequately assessed. A prospective study was designed to quantify the accuracy of a panel of physicians who routinely deal with stones in classifying stone composition solely from radiographs. CONCLUSIONS: With a random sampling of plain radiographs, a panel of physicians specializing in stone disease correctly diagnosed the composition of renal calculi less than half of the time without being given clinical information.

Digital radiography

Averch, T. D., D. O'Sullivan, et al. (1997). "Digital radiographic imaging transfer: comparison with plain radiographs." Journal of Endourology **11**(2): 99-101.
Advances in digital imaging and computer display technology have allowed development of clinical teleradiographic systems. There are limited data assessing the effectiveness of such systems when applied to urologic pathology. In an effort to appraise the effectiveness of teleradiology in identifying renal calculi, the accuracy of findings on transmitted radiographic images were compared with those made when viewing the actual plain film. Overall, no statistical difference between the interpretations of the plain film and the digital image was revealed ($p = 0.21$). Using available technology, KUB images can be transmitted to a remote site, and the location of a stone can be determined correctly. Higher accuracy is demonstrated by experienced surgeons.

Nephroscopy

Pearle, M. S., L. M. Watamull, et al. (1999). "Sensitivity of noncontrast helical computerized tomography and plain film radiography compared to flexible nephroscopy for detecting residual fragments after percutaneous nephrostolithotomy." Journal of Urology **162**(1): 23-6.
We prospectively compared plain film radiography and noncontrast, thin cut helical computerized tomography (CT) to flexible nephroscopy for detecting residual stones after percutaneous nephrostolithotomy. CONCLUSIONS: Selective use of flexible nephroscopy after percutaneous nephrostolithotomy based on positive CT findings will avoid an unnecessary operation in 20% of patients. The rate of unnecessary procedures is 32% if all patients undergo flexible nephroscopy, regardless of radiographic findings. At our institution this strategy will result in a cost savings of $109,687 per 100 patients.

Recommended treatments/management for renal colic

ESWL, PCNL

Rassweiler, J. J., C. Renner, et al. (2000). "The management of complex renal stones." BJU International **86**(8): 919-28.
Discusses minimally invasive techniques and remaining current indications for open surgery.

Kosar, A., K. Sarica, et al. (1999). "Comparative study of long-term stone recurrence after extracorporeal shock wave lithotripsy and open stone surgery for kidney stones." International Journal of Urology **6**(3): 125-9.

BACKGROUND: Extracorporeal shock wave lithotripsy (ESWL) has become the treatment of choice for most calculi of upper urinary tract and the need for open stone surgery (OSS) have considerably reduced. However, stone recurrence is often encountered as a long-term problem requiring re-treatment. CONCLUSIONS: The results of the present study demonstrate that stone burden may be the primary risk factor for stone recurrence after ESWL and OSS

Mattelaer, P., J. M. Wolff, et al. (1997). "Long-term follow-up after primary extracorporeal shockwave lithotripsy monotherapy of staghorn calculi: results after more than 6 years." Acta Urologica Belgica **65**(3): 41-5.
OBJECTIVE: We retrospectively investigated 58 patients suffering from 60 staghorn calculi, who were treated with primary extracorporeal shockwave lithotripsy (ESWL) monotherapy, in order to determine long-term results and the fate of the residual stones. CONCLUSIONS: Primary ESWL monotherapy of staghorn calculi is justified because of the comparable results with open surgery and percutaneous nephrolithotomy (PCNL). Prognostic good factors are small stone mass with most of the stone mass in the upper and middle calices, the absence of dilatation and the absence of anatomical anomalies.

Renal stone tracking

Orkisz, M., T. Farchtchian, et al. (1998). "Image based renal stone tracking to improve efficacy in extracorporeal lithotripsy." Journal of Urology **160**(4): 1237-40.
We describe a method to reduce the number of shocks necessary to fragment renal stones during extracorporeal shock wave lithotripsy by automatically taking into account stone movements. CONCLUSIONS: Image based renal stone tracking software that automatically adjusts the shock wave generator position according to the displacement of renal stones is useful during extracorporeal shock wave lithotripsy. Treatment time was significantly shorter with this software.

Guidelines

Baggio, B. (2000). "Drawing up guidelines for the management of kidney stones in Italy." Journal of Nephrology **13**(Suppl 3): S61-4.
The Italian Society of Nephrology recently proposed and published guidelines for the management of nephrolithiasis. This review reconsiders some aspects, and presents the scientific background and clinical-scientific evidence that suggested the guidelines for some of the more controversial and debated issues in the clinical-diagnostic approach to the disease, i.e., medical management of renal colic and the first episode of nephrolithiasis. [References: 26]

Craig, S., (2001). Renal Calculi. eMedicine Journal, May 19 Volume 2, Number 5, <www.emedicine.com/emerg/topic499.htm>

Intrarenal surgery

Rocco, F., M. Casu, et al. (1998). "Long-term results of intrarenal surgery for branched calculi: is such surgery still valid?" British Journal of Urology **81**(6): 796-800
OBJECTIVE: To evaluate whether intrarenal surgery for branched calculi remains valid in the light of current new techniques, e.g. percutaneous nephrolithotomy and extracorporeal shockwave lithotripsy. CONCLUSIONS: Intrarenal surgery, conducted using modern anatomical guidelines, was an effective treatment for renal branched stones. The long-term results are satisfactory after appropriate correction of the urinary tract, with the consequent prevention of stasis and chronic infection. The definitive comparison between surgical and combined endoscopic/extracorporeal methods will only become clear when there is a comparable follow-up. Currently, surgery remains preferable in patients with giant calculi, a small pelvis and prevalent calyceal development.

.

Sodium potassium citrate

Jendle-Bengten, C. and H. G. Tiselius (2000). "Long-term follow-up of stone formers treated with a low dose of sodium potassium citrate." Scandinavian Journal of Urology & Nephrology **34**(1): 36-41.
We evaluated the clinical efficacy of long-term preventive treatment with a single evening dose of alkaline citrate. Information was collected from the files of 52 recurrent stone formers prescribed a daily intake of 3.75-5 g of sodium potassium citrate (SPC; 14-18 mmol of citrate). The annual and cumulative rates of stone formation and the rate of recurrence were compared before and during the treatment. A comparison was also made between the patients with (Group R) and without (Group NR) recurrent stone formation during treatment in terms of urine composition and previous history of the disease. Although the number of patients in this study was small, our results indicate poor long-term protection from recurrent calcium stone formation when a single evening dose of only 3.75-5 g of SPC was taken. The rate of stone formation was apparently slightly reduced, but the fraction of patients free of recurrence was no different from that in patients without medical treatment.

Pain management regimens

NSAIDS

Laerum, E. and J. Murtagh (2001). "Renal colic and recurrent urinary calculi. Management and prevention." Australian Family Physician **30**(1): 36-41.
BACKGROUND: Urinary calculi are a relatively common problem and up to 80% of patients with calculi who are untreated will experience one or more recurrences within five years. OBJECTIVE: This paper outlines the causes of urinary calculi and presents evidence for the less conventional treatment of renal colic with NSAIDs such as intramuscular diclofenac in preference to traditional pethidine injections. The paper also deals with ways to prevent recurrence of stone formation. DISCUSSION: Effective treatment requires a clear understanding of the cause, and investigations need to be directed toward establishing this. Prevention is the cornerstone of management and requires patients to have a clear understanding of the problem. Follow up of these patients is essential. [References: 35]

Lopes, T., J. S. Dias, et al. (2001). "An assessment of the clinical efficacy of intranasal desmopressin spray in the treatment of renal colic." BJU International **87**(4): 322-5.
OBJECTIVES: To assess the efficacy of desmopressin nasal spray compared with diclofenac given intramuscularly in patients with acute renal colic caused by urolithiasis. CONCLUSIONS: Desmopressin has several advantages, e.g. ease of administration, simplicity of delivery and apparent lack of side-effects, which makes it suitable for ambulatory use. Desmopressin acts rapidly and seems to be effective in both single and combined therapy with diclofenac; it decreases the need for a second treatment and increases the analgesic effect of diclofenac. Some patients responded well to desmopressin, with rapid and complete pain relief. These results indicate that desmopressin may be used to treat renal colic either alone or combined, increasing the analgesic effect of other drugs. More studies are needed to validate and confirm the results; it would also be useful to determine factors that may identify the subgroup of patients who respond quickly and with almost complete pain relief.

Criteria for providing inpatient treatment/admission

Gettman, M. T. and J. W. Segura (2001). "Current evaluation and management of renal and ureteral stones." Saudi Medical Journal **22**(4): 306-14.

A systematic clinical approach is required for the diagnosis and management of renal and ureteral stones. The presenting symptoms, past medical history, medications, and physical examination all provide clues to the diagnosis of urinary stones. In the acute setting, noncontrast helical computerized tomography has emerged as the first line imaging test for renal colic. More traditional imaging tests are also important in the management of stone disease. After making the diagnosis of a urinary stone, the urologist should discuss the advantages and disadvantages of all treatment options with the patient. For most stone patients today, many equally effective treatment approaches can exist for the same problem. To help direct surgical management, guidelines for stone management have been devised. With technologic advances, stone treatment has improved and complications have decreased. While patient care has been significantly impacted by use of effective endourologic techniques, patients should complete imaging tests following surgery to assure a stone-free state. In addition, recurrent stone formers should complete a medical stone evaluation to identify treatable causes of their stones.

Recommended follow-up, treatment and discharge education for patient returning to the home (i.e. not admitted)

Chow, W. H., P. Lindblad, et al. (1997). "Risk of urinary tract cancers following kidney or ureter stones." Journal of the National Cancer Institute **89**(19): 1453-7.
BACKGROUND: A relationship has been suggested between kidney or ureter stones and the development of urinary tract cancers. In this study, a population-based cohort of patients hospitalized for kidney or ureter stones in Sweden was followed for up to 25 years to examine subsequent risks for developing renal cell, renal pelvis/ureter, or bladder cancer. CONCLUSIONS: Individuals hospitalized for kidney or ureter stones are at increased risk of developing renal pelvis/ureter or bladder cancer, even beyond 10 years of follow-up. Chronic irritation and infection may play a role, since kidney or ureter stones were located on the same side of the body as the tumors in most patients with renal pelvis/ureter cancer evaluated in our study.

Gettman, M. T. and J. W. Segura (1999). "Struvite stones: diagnosis and current treatment concepts." Journal of Endourology **13**(9): 653-8.
Effective management of struvite calculi requires a comprehensive approach to eliminate the stone burden and prevent stone recurrence. These stones occur more frequently in women, infants, and the elderly, as these patients are at greater risk for urinary tract infections. All patients should have routine laboratory testing as well as an excretory urogram. Appropriate urine cultures should be completed. Definitive management should promptly follow diagnosis. Percutaneous nephrolithotomy with or without SWL is the usual treatment. Appropriate antibiotic use is helpful; magnesium and phosphorus restriction and administration of urease inhibitors are less valuable.

APPENDIX 3

Copyright

Disclaimer

The information in this report is a summary of that available and is primarily designed to give readers a starting point to consider currently available research evidence. Whilst appreciable care has been taken in the preparation of the materials included in this publication, the authors and Southern Health do not warrant the accuracy of this document and deny any representation, implied or expressed, concerning the efficacy, appropriateness or suitability of any treatment or product. In view of the possibility of human error or advances of medical knowledge the authors and Southern Health cannot and do not warrant that the information contained in these pages is in every aspect accurate or complete. Accordingly, they are not and will not be held responsible or liable for any errors of omissions that may be found in this publication. You are therefore encouraged to consult other sources in order to confirm the information contained in this publication and, in the event that medical treatment is required, to take professional expert advice from a legally qualified and appropriately experienced medical practitioner.

Levels of Evidence

As Defined By "How to use the evidence: assessment and application of scientific evidence" (National Health & Medical Research Council, Canberra, 2000):

Level I		Evidence obtained from a systematic review (or meta-analysis) of all relevant randomised controlled trials.
Level II		Evidence obtained from at least one randomised controlled trial.
Level III	1	Evidence obtained from pseudorandomised controlled trials (alternate allocation or some other method).
	2	Evidence obtained from comparative studies (including systematic reviews of such studies) with concurrent controls and allocation not randomised, cohort studies, case control studies or interrupted time series with a control group.
	3	Evidence obtained from comparative studies with historical control, two or more single-arm studies or interrupted time series without a parallel control group.
Level IV		Evidence obtained from case series, either post-test or pretest/post-test.