*The Turkish Journal of Pediatrics*
*Volume 26, Nos 1-4, 1984*

# RENAL STONES: SCREENING TESTS*

*Geoffrey D. Chisholm ChM, FRCS***

*Key words: screening tests, urolithiasis*

The purpose of stone screening tests is to find an abnormality that can be treated and so prevent further stone formation.

*History.* The history from a patient with a stone should be systematically detailed with regard to stone related disorders. Thus the frequency of stone problems, a family history of stone disease or a history of conditions suggesting parathyroid disease (peptic ulcer or bone disorders) must be determined. A history of bowel disease or previous bowel surgery may give a clue to the etiology of uric acid or calcium oxalate stones. A dietary history is a most important requirement since many of the stones occurring in the Western world are associated with a regular high intake of animal proteins; some patients may have peculiar dietary habits such as an exceptional intake of milk or dairy products, or excessive intake of high oxalate content foods or excessive vitamin C. Drugs such as steroids and antacids may lead to chronic metabolic disorders with stone formation.

*Plain abdominal X-rays.* The first investigation for a patient suspected of a stone in the kidney will be a plain abdominal X-ray. If there is doubt that the opacity is within the kidney then an oblique view of the kidney will help to confirm its location. Radiological calcification in the kidney may range from a small discrete stone to a large staghorn stone. There may be a pattern of stones clustered in the areas corresponding to the renal medullae (Figure 1) or a number of calcifications apparently scattered throughout the kidneys including the cortex (Figure 2). This latter condition of nephrocalcinosis is uncommon but can be a valuable clue to the diagnosis since 95% of patients with radiological nephrocalcinosis will be found to have a cause. A classification of nephrocalcinosis is given in Table I.

Poorly opacified rounded stones may be due to an abnormality of cystine metabolism (Figure 3). The commonest non-opaque stones are uric acid and they may be identified as negative shadows on excretion urography (Figure 4).

## *Stone classification*

Stones may be classified according to their etiology or their chemical composition. Because an exact composition may not always be available it is convenient to continue to use the two broad etiological groups of infected and metabolic stones.

---

* From the Department of Surgery/Urology, Western General Hospital, Edinburgh, United Kingdom.
** Professor of Surgery/Urology, Western General Hospital, Edinburgh.

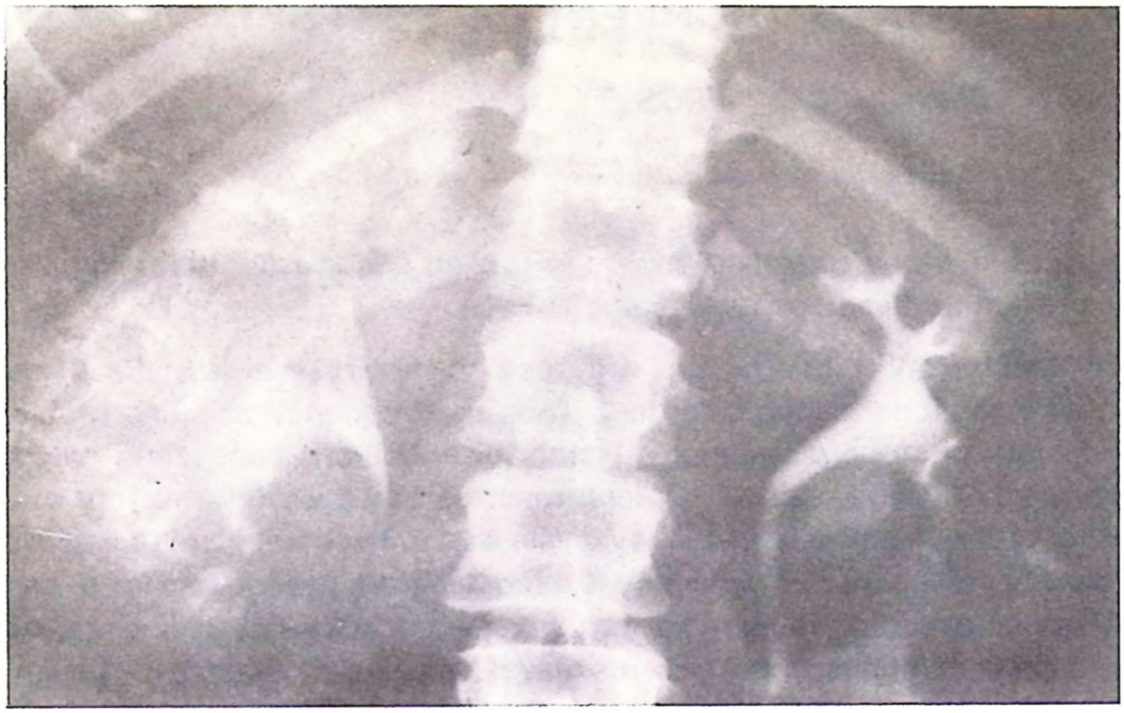


Figure 1

**Medullary sponge kidney. This example is unusual since the abnormality affected only the right kidney.**

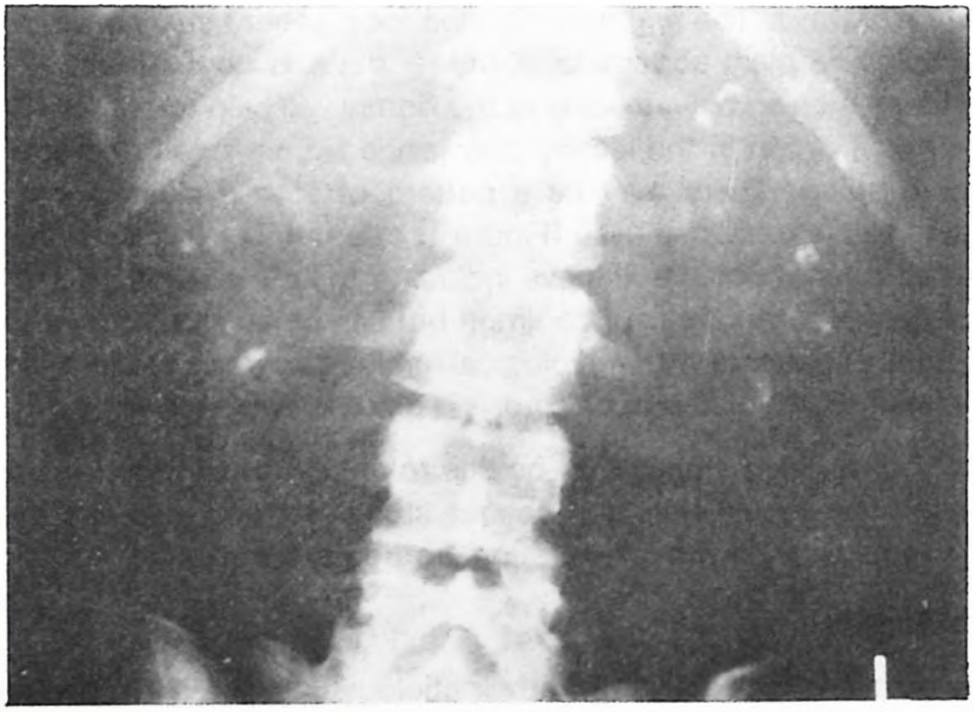


Figure 2

**Renal tubular acidosis. This petient passed many small stones over a period of 15 years.**

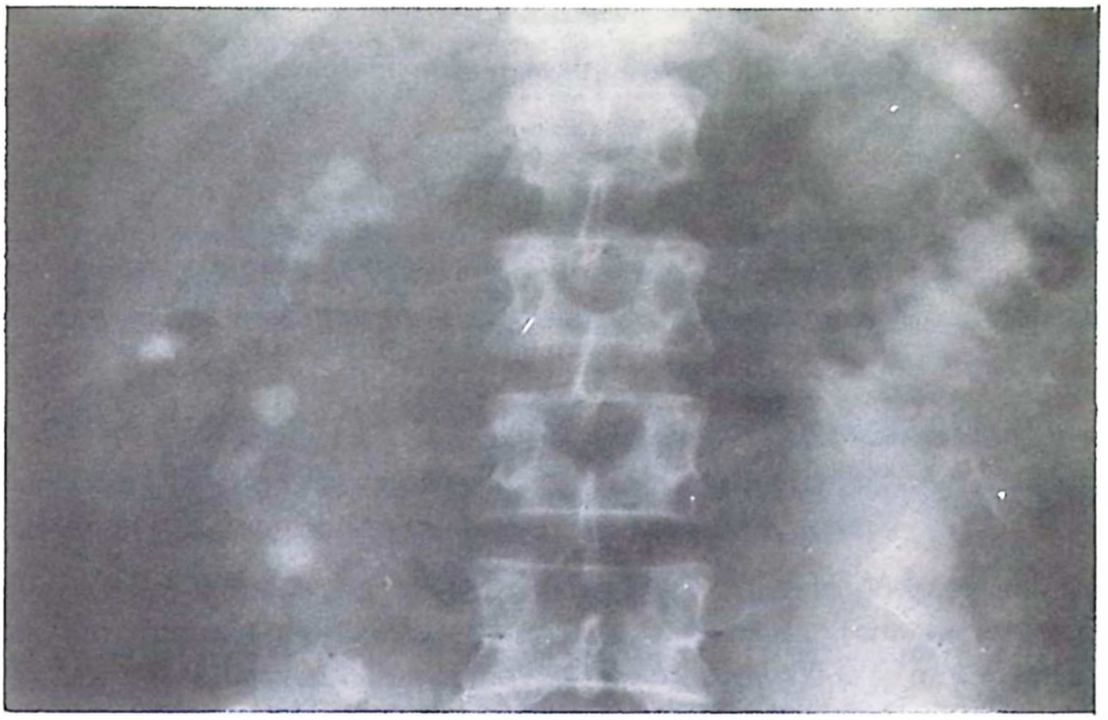


Figure 3

**Cystine stones. These stones were mobile in a dilated collecting system and hydroureter.**

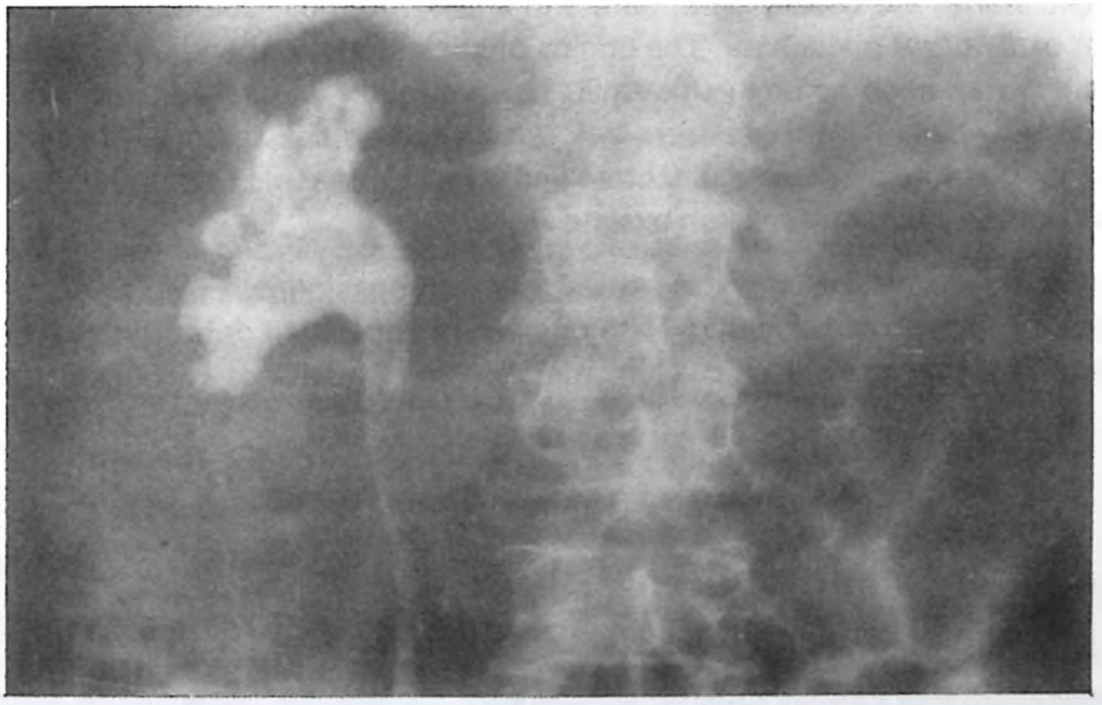
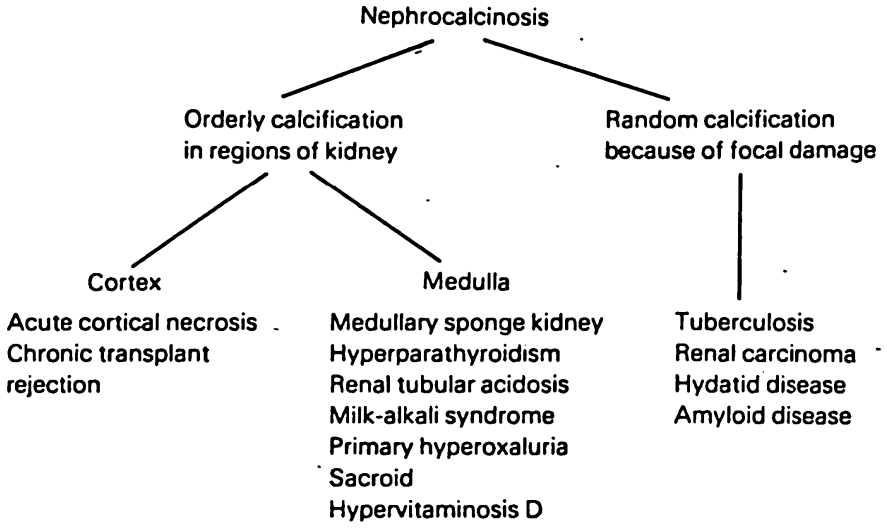


Figure 4

**Uric acid stones. These stones were not visible on a rotinc Intravenous urogram, they were best seen on the retrograde pyelogram when the patient was prone.**

TABLE I

**Causes of Radiological Nephrocalcinosis**[7]




An *infective* stone is usually whitish, chalky and crumbly. The main constituents are calcium, ammonium, magnesium and phosphate. The presence of stagnant urine in the urinary tract, due to some obstruction or deformity, is a major predisposing factor. Urea-splitting organisms commonly grow in stagnant urine and the increase in ammonia, which raises the pH, accelerates the development of a stone.

*Metabolic stones* are usually dark, hard and sharp and most commonly consist of calcium oxalate and phosphate. The origins of such stones depend on a number of factors such as urine volume, urine pH, concentration of oxalate, uric acid and glycosaminoglycans and these have been described as risk factors.[1] There is no doubt that diet affects these risk factor[2] and a low urinary pH favors the development of both uric acid and calcium oxalate stones.

If a stone is available for chemical analysis, its composition can help to determine the etiology. Stones of calcium oxalate or calcium phosphate or both may indicate disorders of either oxalate or calcium metabolism. Struvite or carbonate apatite

TABLE II

**Frequency of Urinary Stone Types**

| Type of stone | Frequency |
|---|---|
| Calcium oxalate/phosphate | Up to 80% |
| Magnesium ammonium phosphate ± calcium | 6 - 14% |
| Uric acid | 5% |
| Cystine | 1 - 4% |
| Xanthine | none |

indicate infection with urea-splitting organisms. Cystine stones are pathognomonic of cystinuria and urate stones suggest a problem of uric acid metabolism. The frequency of the different chemical types is summarized in Table II.

*Stone screening*

*New patient.* The extent of screening depends upon the facilities that are available. Special stone clinics or physicians interested in the metabolism of stones will usually carry out more detailed investigations because they have the appropriate laboratory support.

The minimum assessment of a new patient consists of the following:

1. Plain X-ray of abdomen and intravenous urogram: to determine the size and location of the stone and to exclude a structural abnormality
2. Urea, serum electrolytes, calcium, phosphate, alkaline phosphatase and uric acid. An abnormal plasma bicarbonate may be a clue to renal tubular acidosis[3]. Because the serum calcium may be raised after a meal due to prolonged stasis at the time of the venepuncture, a fasting sample taken without a tourniquet is preferred. In many centers a "routine biochemical screen" includes calcium, and this has become the commonest way in which hyperparathyroidism presents. This is in contrast to the previously common presentations of urinary stones, bone disease or abdominal "groans" (e.g. peptic ulcer or pancreatitis). The main causes of hypercalcemia are shown in Table III.

TABLE III

**Causes of Hypercalcemia**

Primary hyperparathyroidism

Malignancy (especially breast, bronchus, multiple myeloma, kidney and squamous carcinoma of lung)

Vitamin D overdose

Vitamin D hypersensitivity (sacroid, hypercalcemia of infancy)

Thyrotoxicosis

Paget's disease

Immobolization (especially in children)

Milk-alkali syndrome

3. Urine examination. Hematuria may be caused by a stone. Crystals in the urine may indicate an underlying metabolic abnormality. The urinary pH should be checked and a specimen of urine sent for culture and sensitivity. The sodium nitroprusside test is a qualitative test on the urine for cystine.

4. Stone analysis. This may be done either by gross chemical analysis or by X-ray diffraction[4].

*High risk patients.* If a patient has recurrent stones, nephrocalcinosis or a history suggestive of a metabolic stone, then the stone screen should be extended in order to define the cause more clearly. Ideally, two 24-hour urine collections for calcium, urate and oxalate are obtained. These samples are best collected by the patient while on his or her normal diet. Unfortunately there may be inaccuracies over the collection of these samples and precise instructions must be given to the patient. A reliable measurement of oxalate is often difficult to obtain and in general, the main emphasis is on calcium abnormalities (Table IV).

TABLE IV

**Causes of hypercalciuria[8]**

1. Always accompanied by hypercalcemia
   - Primary hyperparathyroidism
2. Never accompanied by hypercalcemia
   - Idiopathic hypercalciuria
   - Medullary sponge kidney
   - Renal tubular acidosis
   - Corticosteroids
   - Cushing's syndrome
3. May or may not show hypercalcemia
   - High calcium intake
   - Immobilization
   - Vitamin D overdose
   - Sarcoidosis
   - Paget's disease
   - Malignancy
   - Milk-alkali syndrome

If there is a suspicion of a metabolic cause for the stone, the patient may require further tests, either as an in-patient in a metabolic unit or an outpatient, provided that the patient is able to assist reliably in urine sample collection[5]. In particular, fasting and calcium loading tests may be necessary to distinguish between resorptive, renal and absorptive hypercalciuria[6]. If the pH of the fasting urine is about 5.3. then an acid loading test using ammonium chloride may be required.

*Value of stone screening* It has been estimated that after the initial stone has formed, a patient has approximately a 60 per cent chance of forming a second stone within about 7 years. It follows that if any cause can be detected then this recur-

rence rate can be reduced. Approximately 60% of patients will be found to have hypercalciuria. Primary hyperparathyroidism occurs in about 5% of patients in most series. Though less easy to diagnose, renal tubular acidosis may be found in up to 20% of patients. The proportion of patients found to have a metabolic abnormality depends upon the detail and care with which these tests are pursued. Thus Pak et al[5] found only 10% with no abnormality after a very detailed outpatient screen of 241 patients.

It is concluded that stone screening is of benefit to the patient and that the more detailed the investigation, the larger the number of patients will be found to have a metabolic disorder. Based on these findings it should be possible to give the patient advice about fluid intake, diet and possibly specific medication.

**REFERENCES**


1. Robertson WG, Peacock M, Heyburn PJ, et al. Risk factors in calcium stone disease of the urinary tract. *Br J Urol* 50:449, 1978.
2. Robertson WG, Peacock M, Heyburn PJ, et al. Should recurrent calcium oxalate stone formers become vegetarians? *Br J Urol* 51:427, 1979.
3. Williams G, Chisholm GD. Stone screening and follow - up are necessary. *Br J Urol* **47**: 745, 1976.
4. Sutor DJ. Crystallographic analysis of urinary calculi. In Williams DI, Chisholm GD (eds). *Scientific Foundations of Urology* (2nd ed). London: Heinemann Medical, 1982.
5. Pak CY, Britton F, Peterson R, et al. Ambulatory evaluation of nephrolithiasis. Classification, clinical presentation and diagnostic criteria. *Am J Med* 69: 19, 1980.
6. Pak CY. The spectrum and pathogenesis of hypercalciuria. *Urol Clin North Am* **8**: 245, 1981.
7. Sherwood T. *Uroradiology.* Oxford: Blackwell Scientific Pub, 1980.
8. Rose GA. *Urinary stones, clinical and laboratory aspects.* Lancaster: MTP Press Ltd, 1982.


## DİSCUSSION

**Chisholm:** May I ask what percentage of urologic operations are for stones?

**Bakkaloğlu:** With us it has been 37%.

**Tellaloğlu:** According to our latest figures in the Istanbul Faculty of Medicine it is 20.8%.

**Khalifa:** The questionnaire, I remember didn't stress meat consumption.

**Bakkaloğlu:** Meat? No, actually we didn't ask. We know, roughly, our feeding system level, if you are a medical doctor you have a proper diet. So we didn't ask.

**Blandy:** I'd like to ask Professor Bakkaloğlu two questions. First of all, when you asked your doctors to fill in the questionnaire, did they actually measure how much tea and coffee they drank, or did they tell you what they said they drank?

**Bakkaloğlu:** Actually they put the figures on the form. Maybe they gave an estimate because we left the forms with them and collected them later on.

**Blandy:** There was a very significant difference between the amount of water which the people with stones *said* they drank and that which the other people drank. I think it's because people with stones are told by their doctors that they have to drink. When you ask them to come and see you in the clinic, they always say, "Oh yes, doctor I drink three liters of water a day", but they do not drink three liters of water a day. And you can tell when you measure their 24 hours urine output.

**Bakkaloğlu:** Some of these figures depend purely on the information provided by the doctors.

**Blandy:** The other very interesting point you made was that 16% of your surgeons had stones, is that correct?

**Bakkaloğlu:** Yes.

**Blandy:** This exactly correlates with what was found in a Scottish study. They found that 17.6% of surgeons had stones in a given group they looked at and 15% of anesthetists.

**Dajani:** Professor Chisholm raised the question of follow-ups. I think in my part of the world, Jordan, it's very important, especially since our people are not very health-conscious. We follow them up regularly doing routine urine tests, and so on; every 6 - 8 months we do a KUB and prolong the period. If they have had a stone operation, we follow them up for the first year regularly every 2 to 3 months. I think it is very important to follow them up in this part of the world. I don't know how my colleagues feel about it.

**Chisholm:** Well I think it's a good question because what I'm going to say to you is really by way of a challenge. I think there are some advantages but it's very difficult to be certain that you influence the course of the disease by that regular follow-up.

If you simply waited until they came back with symptoms, would it be different? I wonder if you actually do anything to the patient, by way of management, earlier, because of your follow-up.

**Dajani:** I'm afraid there are some of them who have virtually no symptoms. I can quote you a story. A man, who had a kidney out, came to say goodbye to me in Saudi Arabia. At 10 o'clock I told him to go have his urine checked. We found lots of RBC's in the urine; we took an X-ray and there was a big stone in his ureter. I operated on him that very day at 2 o'clock in the afternoon, but there had been no signs prior to that of any problem.

**Chisholm:** I'm sure we've all seen cases like that, but again if you take a hundred patients or a thousand patients, it's a lot of work. Though I agree, if it was my stone, I would quite like a KUB, just to make sure.

**Wickham:** Our attitude at the Institute of Urology is that you have to do a primary screening on all these stone patients to make sure there is no metabolic disease. And the vast majority as you know, will reveal no metabolic disease and these stones are probably dehydration phenomenon; if you can get a patient to drink, all will be well. That's up to him. A portion of the people that you do diagnose with a metabolic disease will require medical therapy. These are the ones that you have to follow, the ones you put on chlorothiazide.

**Chisholm:** Once you've got that out of the way, though..

**Wickham:** But they are a small proportion of the whole group. These are the ones you follow. But like you I think there is no point in having vast follow-up stone clinics. They don't contribute, they are not preventative.

**Chisholm:** They don't actually achieve anything.

**Wickham:** I think that most follow-up stone clinics are run by doctors for their own amusement. Not for the patient at all.

**Chisholm:** Who has a stone clinic?

**Khalifa:** I do.

**Chisholm:** For follow-up?

**Khalifa:** It is a preliminary sort of stone clinic. I really want to know whether it's worthwhile or not. There are some enormous follow-up clinics and it is claimed that they do, in fact, change the course of the disease. Whether this applies everywhere or not I really don't know. I wanted to ask you about fast and load tests.

**Chisholm:** I think we're back to hypercalcemia. And the point I want to make is that, with hypercalcemia you must be able to rely on your laboratory; if they say the upper limit is 2.67 and you have a patient with 2.67, you must believe it; and I think most people feel that probably is significant. And then you do a PTH just to confirm.

**Smith:** Two years ago I had the opportunity of going round the wards at Hacettepe, and my feeling was that there are two quite different populations. There's the one that you've been talking about, producing small oxalate stones, at intervals, and there's the people who you get at Hacettepe University who are often not in very good health, not very wealthy and have large stones, which are, I would have thought, often associated with infection. And the question I wanted to ask is, it's all very well for us in England to be worried about oxalate stones and hypercalciuria, but is the problem in Turkey not more related to infection and dehydration than to metabolic abnormality?

**Chisholm:** I'm sure you're right.

**Bakkaloğlu:** If you look at the stone analysis results, we can see over all,nearly 15% of the stones are infective stones. And the remaining calcium oxalate.

**Smith:** Only 15% ?

**Chisholm:** That is surprising isn't it?

**Bakkaloğlu:** This study was done by X-ray diffraction technique which is quite reliable.

**Tellaloğlu:** Well in my study of stones in children, out of 334 cases, we found infection significant in 64.7%.

**Chisholm:** That's a bit more what I think Mr. Smith was expecting.

**Tellaloğlu:** That's the primary problem in Turkey.

**Blandy:** Apropos infection, I think it's worth remembering that looking for infection in people with stones is harder than it might appear. In looking retrospectively over my own staghorn cases, I was astonished to see how much wound infection we had, and it was always due to proteus, though the urine was in fact either sterile or nearly so. And it was only when we started routinely grinding the stones out and sending them for culture, that we found every single one of them had proteus in it. I think there are more infective stones than we appreciate.

**Tellaloğlu:** Matrix of the stone.

**Blandy:** Yes, I think so.

**Chisholm:** Can I just ask how many of you do 24-hour urine checks routinely?

**Bakkaloğlu:** We try to, but we have problems with the labs or biochemists.

**Chisholm:** Of course you're in the hands of two groups, you're in the hands of your patients. If they can't be relied on to collect 24 hours urine for the lab, then it's a waste of time; and of course in the lab, if they don't like doing the tests, they have every excuse if they don't think the urine has been properly collected.

**Türkyılmaz:** I would like to ask a question my patients usually ask me. We were talking about water consumption. We tell the patient to drink a lot of water. Two liters, three liters, fifteen glasses, or twenty glasses; and they ask, "What kind of water?" A long time ago, I read an article about a study carried out in England, about the stone forming patient in the city in relation to the quality of the water of the city. The results were interesting: the harder the water the fewer the stone-forming patients. So I keep telling patients, "Drink any kind of water, whatever you find". But is this good advice?

**Chisholm:** Well that's what I tell mine, but I'm really not sure if I have a view on whether the kind of water really influences stone incidence. London's water is hard isn't it?

**Blandy:** We have three main sources of water in our part of London, and we looked at the incidence of stone formation with respect to all three. There was no difference in the incidence of stones whether they drank water out of this tap, that tap, or the other. There is a striking difference in the calcium content, however.

**Bakkaloğlu:** May I say something about water in Turkey? According to the law here, the water in the water supplies is of a limited hardness. All such water in Turkey is analysed at least every 6 months, to check the hardness and if the water is pronounced usable this means the degree of hardness is less than 20 French Grade. So, in Turkey, all tap water is drinkable.

**Türkyılmaz:** Well in my hometown, in the South of Turkey, the water is rather hard. A kettle for boiling water will have heavy calcium deposits within a month. But we still get a lot of stone cases there even though they drink lots of hard water.

**Wickham:** Have you demonstrated hypercalciuria in these patients? Have you measured their 24 hour urine?

**Türkyılmaz:** No we don't have facilities for that.

**Barlas:** It's very hot there. They drink and sweat.

**Wickham:** Well the point I wanted to make is that people with stones have got to drink enough to pass at least a liter and a half of urine a day.

**Chisholm:** That's what I tell my patients. One-point-five liters a day.

**Türkyılmaz:** We tell them the same because it's a hot climate and they sweat a lot, and the concentration gets stronger. Some of my patients who've had repeated stones, want to drink distilled water without any minerals in it, and really I don't know what to recommend.

**Chisholm:** I think that really is obsessive, and I don't think it would help the patient.