The Diagnostic Evaluation of Risk Factors for Urinary Tract Stones: An Analysis of Care Patterns in Five Hospitals

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Medical records of hospitalized primary urolithiasis patients in five Connecticut hospitals were studied to determine the aggressiveness of the diagnostic search for metabolic and other renal stone risk factors. A total of 924 patients over three years were analyzed. Routine serum, urine, and X-ray tests were generally performed according to accepted criteria. However, medical histories were generally inadequate, and 24-hour urine studies for calcium and uric acid were performed on less than half of the patients for whom they were indicated. Neither the complexity of the stone problem nor the stone event number appeared to influence the intensity of the diagnostic search in any important way. Other deficiencies included the lack of follow-up of abnormal test findings and the lack of treatment of problems discovered. The diagnostic approach in each hospital was stable over time.

In the fall of 1977 the Yale–New Haven Medical Center (YNHMC) established a specialized urolithiasis research center with the assistance of a grant from the National Institutes of Health. The Renal Stone Center (RSC) was to contribute to the increasingly close teaching and research relationship which exists between Yale and its affiliated hospitals [1] and to enhance the regions’ consultation capabilities. One of its objectives was to improve the quality of diagnosis of risk factors for renal stones at the medical center and at the affiliated hospitals. Included in the grant was a commitment to study the intensity of the search for risk factors in hospitalized patients with renal and ureteral stones before the RSC began and to describe the extent of improvement in quality following the implementation of the RSC program. This paper describes the diagnostic care patterns in five Connecticut hospitals before the RSC was established (1974–1976); a subsequent paper will address the changes found in the quality of diagnostic efforts that can be attributed to the educational impact of the RSC.

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REVIEW OF LITERATURE

There is a large literature that describes the metabolic basis of renal stone disease as well as other known risk factors for stone formation. The importance of a thorough diagnostic investigation of patients with urolithiasis has been emphasized because there is evidence that the elimination or modification of one or more risk factors may prevent stones [4–12]. The diagnostic search for risk factors associated with renal stone disease should include a comprehensive history, confirmation of the stone by radiology, analysis of the stone if it has passed, examination of the urine pH and sediment, and the serum calcium and uric acid levels. There has been a widespread belief that when these preliminary examinations do not reveal abnormalities, and the stone event is the patient’s first, no further work-up is needed, because intensive work-ups in these patients do not produce a high yield of treatable risk factors. Although recent studies have suggested that a majority of patients may experience recurrent stones [2,3], for this study, a more extensive work-up was expected only if abnormalities were present in the initial screen, or if the stone was not the patient’s first or was a complicated stone (such as nephrocalcinosis, bilateral stones, staghorn calculus, or stones occurring in a child or adolescent).

The following items of information are important in the search for risk factors:

The stone event number is important, both to guide the intensity of the work-up, and also to enable data obtained from previous stone events to be used in diagnostic and therapeutic decisions.

A positive family history is often noted in patients with renal stone disease; the presence of a positive family history is thought to increase the likelihood of underlying risk factors being present in a given patient.

A historical search for low fluid intake or abnormally high dietary intake of calcium, oxalate, or purine is recommended, because dehydration facilitates renal stone formation and hypercalciuria, hyperoxaluria, and hyperuricosuria are known risk factors for stone formation. These dietary factors are also important because the level of their intake influences the amounts absorbed and excreted and must be used in the interpretation of 24-hour urinary excretion findings.

Patients should also be screened for abnormally high doses of vitamins A, D, and C. Excessive intake of vitamins A and D can cause hypercalcemia, medullary nephrocalcinosis, and renal tract stones. Excess vitamin C intake may be associated with hyperoxaluria, which increases the risk of calcium nephrolithiasis.

Evaluation of urine pH is important because acidic urine decreases the solubility of uric acid and therefore promotes formation of these stones. An alkaline urine decreases the solubility of calcium phosphate and increases the likelihood of these stones, as, for example, in complete renal tubular acidosis. The urine pH is a useful screening test for renal tubular acidosis (RTA); an acid urine (pH of 5.3 or less) effectively rules out this diagnosis.

Examination of the urine sediment and urine culture are important because infection, particularly chronic infection with Proteus organisms, is associated with the formation of magnesium ammonium phosphate stones.

It is impossible to design an appropriate therapeutic regimen in nephrolithiasis unless the cause of stone formation is understood. Thus clarification of the pathogenesis is an essential step toward proper treatment [4–12].
Our search of the literature did not reveal how frequently physicians actually performed a comprehensive search for urolithiasis risk factors, nor did the literature report findings about the impact of educational efforts to maintain or improve the thoroughness of diagnostic work-ups on urinary stone patients. However, a variety of methods for quality of care assessments are described in the literature. For example, "physician performance indexes" have been designed so that the actual care patterns of a group of physicians could be compared with pre-set criteria that represented expected care patterns [13,14]. This approach to quality of care assessment provides an objective evaluation of care, especially when refined by the use of weighted criteria [14–17]. Although Brook et al. [16] found this approach valuable, they comment that when actual care patterns are obtained from medical chart review, the judgments of physician performance may be harsh because all of the data may not have been recorded. The use of medical records as the only source of data in research remains controversial; some researchers, such as Brook et al., believe that much of what physicians do is undocumented [22,23]. Others maintain that medical records are valid indicators of care quality because accurate and informative recording is an essential element of good care [19–21].

OBJECTIVES

The purpose of the overall study was to determine the impact of the Renal Stone Center (RSC) on the extent to which physicians and surgeons at Connecticut hospitals search for stone risk factors in hospitalized patients with renal and ureteral stones. The objectives of this report are to establish the criteria for a satisfactory clinical search for risk factors in patients with renal or ureteral stone, to develop and demonstrate a method for analyzing the quality of diagnostic care patterns for hospitalized patients with urolithiasis, and to describe baseline patterns of inpatient care at Connecticut hospitals before the development of the Renal Stone Center.

METHODS

The initial task of this project was to develop an index for measuring the thoroughness of diagnostic evaluations performed by physicians. Specific criteria for good quality were identified by physicians at the Renal Stone Center and reviewed by two urologists and four internists, two of whom were specialists in calcium metabolism. The criteria which were determined to constitute the acceptable minimum risk factor work-up for urolithiasis patients were included in the Physician Performance Index and are presented in Table 1. It is believed that these standards are realistic with respect to the diverse patients and problems encountered in normal clinical practice and true to the scientific knowledge commonly available to community practitioners.

The percentage of patients for which each criterion was fulfilled was determined, as was the percentage for whom all items of a given type of test were performed (e.g., serum tests). In order to measure the adequacy of diagnostic work-ups for a patient, each care item was assigned a certain number of points depending on performance and adequacy of performance (refer to Table 1), and the total number of care points received by each patient was determined. This sum, called the Physicians' Performance Index (PPI) is expressed as a percentage of the total number of care points which were recommended in the standards of Table 1. As is apparent from Table 1, the sum of the care points recommended for patients with "first event, uncomplicated" stones is 11, while the sum of care points for patients with "complex or recurrent" stones is 16.
A. **Physician Performance Index for First Event Uncomplicated Patients**

| Potential Points |
|------------------|
| 5                |

1. Comprehensive History
   a. History of stone event number
   b. Family history of stones or stone risk factors
   c. Diet history
   d. Vitamin use history
   e. Urinary tract infection history
2. X-Ray Test (KUB)
   1
3. Urinalysis (with pH)
   1
4. Serum Calcium and Serum Uric Acid
   2
5. RTA Screen (urine pH ≤ 5.5 or CO₂ ≥ 24)
   1
6. Stone Analysis
   1

**Total Points 11**

B. **Physician Performance Index for First or Recurrent Event Complicated Patients**

| Potential Points |
|------------------|
| 5                |

1. Comprehensive History
   a. History of stone event number
   b. Family history of stones or stone risk factors
   c. Diet history
   d. Vitamin use history
   e. Urinary tract infection history
2. X-Ray Test (Intravenous Pyelogram — unless contraindicated)
   1
3. Urine Tests
   a. Urinalysis (with pH)
   b. Urine culture
   c. 24-hour urine (for calcium, uric acid, indicated others, and adequate collection)
4. Serum Tests
   a. Calcium and Uric Acid
   b. CO₂
   c. Creatinine or BUN
5. RTA Screen (urine pH ≤ 5.5 or CO₂ ≥ 24)
   1
6. Stone Analysis
   1
7. Cystine Screen (if patient is under age 20)
   −1 if omitted

**Total Points 16**

A retrospective medical chart review was conducted at the Yale-New Haven Medical Center (MC) and four affiliated community hospitals (Hospitals A, B, D, and E) for all hospitalized patients in calendar years 1974 and 1976 who had had a primary discharge diagnosis of ureteral or renal stone. A specially designed medical abstraction sheet was used for the data collection, which was carried out by a trained medical abstractor under the supervision of the principal investigator. Data were transferred to a coding sheet, keypunched, stored on-line at the Yale Computer Center, and analyzed using the Statistical Analysis System (SAS). The distribution of the study subjects is presented in Table 2 by year and hospital. For most of the analyses, the data from 1974 and 1976 were pooled because patterns of care remained relatively constant over the two-year period (Table 2).
**TABLE 2**

| Hospital | Number of Patients | 1974 | 1976 | Total |
|----------|--------------------|------|------|-------|
| A        | 114                | 138  |      | 252   |
| B        | 85                 | 95   |      | 180   |
| MC       | 101                | 109  |      | 210   |
| D        | 61                 | 89   |      | 150   |
| E        | 70                 | 62   |      | 132   |
| Total    | 431                | 493  |      | 924   |

**FINDINGS**

*Medical History of Stones and Stone Risk Factors*

The historical information considered useful for a diagnostic work-up for all patients with stones included the stone event number, family history for stones and stone risk factors, vitamin use, diet history, and urinary tract infection history. Point credit was given for a history item if the item appeared in the chart and its relevance to renal stone disease was apparent; point credit was not given if there was no evidence that there had been a historical search specifically for stone risk factors. For example, if a physician recorded “Family History negative for stones” or “—negative for renal disease,” point credit was gained. However, if a physician recorded “Family History non-contributory” or “—negative” no point was earned. Point credit was allotted in this way in order to minimize the error of accepting a nonspecific statement as having specific implications.

The “Stone Number” is important because it should guide the intensity of the subsequent work-up for underlying risk factors, which are much more likely to be present in a patient with recurrent stones. The stone number was recorded clearly for 74 percent (682/924) of stone patients; it was the only historical item adequately recorded in a majority of patients' hospital medical records. Patients with recurrent stone events were more likely to have a clear stone number recorded than were patients with first stone events. “Family History” for stones and stone risk factors, “Vitamin Use,” and “Diet History” were adequately recorded on less than 40 percent of patient medical records at each of the five hospitals (Table 3).

**Serum Tests**

Serum “Calcium” and serum “Uric Acid” tests were recommended for evaluation

**TABLE 3**

| History Item     | Hosp A N = 252 | Hosp B N = 180 | Hosp MC N = 210 | Hosp D N = 150 | Hosp E N = 132 | Total N = 924 |
|------------------|---------------|---------------|----------------|----------------|----------------|---------------|
| Stone No. Clear  | 183(73)       | 154(86)       | 169(80)        | 84(56)         | 84(64)         | 674(73)       |
| Family History   | 55(22)        | 68(38)        | 79(38)         | 19(13)         | 52(39)         | 273(30)       |
| Vitamin History  | 11(4)         | 29(16)        | 9(4)           | 0(0)           | 0(0)           | 49(5)         |
| Diet History     | 15(6)         | 49(27)        | 21(10)         | 14(9)          | 26(20)         | 125(14)       |
of all stone patients. For recurrent or complex stone patients, a serum “Bicarbonate” and blood urea nitrogen or serum creatinine test also were required by the study's criteria. However, only the calcium, uric acid, and bicarbonate serum tests were included in the procedure-related group “Serum Tests”; the blood urea nitrogen and creatinine tests were considered “Urine Tests,” because they evaluated kidney function rather than stone risk factors.

The “Serum Tests” were considered adequate, and therefore given full point credit, if all tests were completed; partial credit was given if only one of the recommended tests was missing. “Serum Tests” were fully adequate for 74 percent (682/924) of all patients and partially adequate for another 15 percent (136/924) (Table 4).

Ninety-two percent (548/595) of patients with either a recurrent or complex stone had a BUN or a creatinine test performed. Although the study's criteria did not require these tests for uncomplicated patients, approximately the same proportion of uncomplicated patients also had at least one of the two tests done.

**X-Ray Examinations**

A patient’s chart met the study's criteria of adequacy for X-ray if, for a first stone patient, any radiographic attempt was made to localize the stone (e.g., a KUB film), and for a recurrent stone patient if an intravenous pyelogram (IVP) or retrograde pyelogram was performed. If an allergy to IVP dye was reported for a patient with recurrent or complex stones, an adequacy point was allotted if only a KUB was done.

X-rays were taken for 97 percent (897/924) of all patients, and 98 percent (875/897) of those done were judged adequate. The percentage of X-rays taken, as well as the percentage of X-rays considered adequate, did not vary significantly between patients with uncomplicated and complicated stones. Ninety-six percent (316/329) of patients with uncomplicated stones had an X-ray; 12 percent (39/315) of these were KUBs and 88 percent (276/315) were IVPs. Ninety-seven percent (561/580) of patients with recurrent or complex stones underwent X-ray examination, 95 percent (552/580) of which were IVPs (or were KUBs with IVP dye allergy noted).

**Routine Urine Tests**

All patients were required by the study's criteria to have an adequate “Urinalysis” performed (i.e., one which included a numerical pH value and an examination of the urine sediment). Urinalyses were performed for almost all patients; 96 percent (887/924). At Hospitals B, MC, D, and E almost all patients with stones had an adequate urinalysis. In Hospital A, however, pH was reported only as “acid,” “neutral,”

| Serum Tests  | Hosp A No. (%) | Hosp B No. (%) | Hosp MC No. (%) | Hosp D No. (%) | Hosp E No. (%) | Total No. (%) |
|--------------|----------------|----------------|-----------------|---------------|---------------|---------------|
| Adequate     | 183(73)        | 153(85)        | 158(75)         | 99(67)        | 89(68)        | 682(74)       |
| Partially adequate | 43(17) | 19(11) | 27(13) | 22(15) | 25(19) | 136(15) |
| Inadequate   | 26(10)         | 8(4)           | 25(12)          | 29(19)        | 18(14)        | 106(11)       |
| Total        | 252(100)       | 180(100)       | 210(100)        | 150(100)      | 132(100)      | 924(100)      |
or "alkaline" in all 1974 charts and most of those from 1976; therefore only 8 percent of the urinalysis done at Hospital A during 1974 and 1976 were adequate by the study's criteria.

Patients with recurrent or complex stones were required to have a "Urine Culture" that resulted in a complete culture report (positive or negative); credit was not given if the culture report was reported to be contaminated. Cultures were performed for 73 percent (679/924) of stone patients; most of the cultures that were performed were complete, adequate cultures (Table 5).

Although urine cultures were recommended by the study's criteria only for patients with recurrent or complex stone disease, little difference was found in the percentage of cultures collected, or in the percentage of those collected that were complete, for patients with uncomplicated and complicated stones.

**Twenty-Four-Hour Urine Tests**

Twenty-four-hour urines were indicated by the study criteria for all patients with recurrent or complex stone events but not for patients with first, uncomplicated stone events. It was surprising that only 28 percent (167/596) of patients with recurrent or complex stone disease had twenty-four-hour urines collected since the evaluation of 24-hour urines were considered to be the most useful test for determining the underlying cause of the disorder; 68 percent (80/117) of complicated patients at Hospital B had 24-hour urines collected but only 18 percent (87/479) of such patients at the remaining hospitals had them collected (Table 6). The number of 24-hour urine evaluations noted here may be an underestimate since some physicians prefer to have patients collect these specimens on an outpatient basis. However, there was little evidence that 24-hour urines were collected on an outpatient basis; because in subsequent admissions, except at the MC, there was almost never reference to studies done on the outside.

For the PPI, full point credit for a 24-hour urine evaluation required both adequate preparation (e.g., an adequate diet, an adequate collection as shown by a sufficient 24-hour creatinine result or a urine volume ≥ 1,000 ml, and no renografin interference) and the completion of all relevant tests (e.g., calcium and uric acid, and, if less than twenty years old, a cystine test). Partial credit was given if the prep-

### Table 5

| Urine Culture     | Hosp A No. (%) | Hosp B No. (%) | Hosp MC No. (%) | Hosp D No. (%) | Hosp E No. (%) | Total No. (%) |
|-------------------|----------------|----------------|-----------------|----------------|----------------|---------------|
| Complete          | 128(51)        | 117(65)        | 168(80)         | 104(69)        | 100(76)        | 617(67)       |
| Contaminated      | 7(3)           | 34(19)         | 9(4)            | 8(5)           | 4(3)           | 62(7)         |
| Not Done          | 117(46)        | 29(16)         | 33(16)          | 38(25)         | 28(21)         | 245(27)       |
| Total             | 252(100)       | 180(100)       | 210(100)        | 150(100)       | 132(100)       | 924(100)      |

### Table 6

| Complexity of Stone Disease | Hosp A No. (%) | Hosp B No. (%) | Hosp MC No. (%) | Hosp D No. (%) | Hosp E No. (%) | Total No. (%) |
|-----------------------------|----------------|----------------|-----------------|----------------|----------------|---------------|
| Uncomplex                   | 2/91(2)        | 33/63(52)      | 6/59(10)        | 1/60(2)        | 0/55(0)        | 42/328(13)    |
| Complex                     | 32/161(20)     | 80/117(68)     | 37/151(25)      | 17/90(19)      | 1/77(1)        | 167/596(28)   |
paration was adequate but all relevant tests were not done or if the appropriate tests were done but the preparation was not complete. Forty-five percent (51/113) of the 24-hour urines performed at Hospital B received full credit, but only 19 percent (18/96) of those performed at the other hospitals were fully adequate. Partial credit was earned for 55 percent (18/33) of patients at Hospital A, 42 percent (48/113) at Hospital B, 56 percent (24/43) at Hospital MC, 79 percent (15/19) at Hospital D, and 100 percent (1/1) at Hospital E (Table 7).

**Stone Analysis**

The study's criteria required that if the patient's renal or ureteral stone was retrieved in the course of treatment, crystallographic analysis of its content was to be performed. If an analysis was not done because a stone was not passed or a recent stone analysis was available, point credit was also given. No credit was allotted if either a stone was retrieved and no analysis was done, or if a stone was passed but not retrieved. "Stone Analysis" was done on 86 percent (273/316) of stones retrieved at Hospitals A, B, MC, and D but on only 53 percent (31/58) of stones retrieved at Hospital E.

**Cystine Screen**

In this study a cystine screen (e.g., spot or 24-hour urine cystine) was considered necessary for any patient less than twenty years of age who had stones. Out of the sample population, 7 percent (64/924) required a cystine screen and 5 percent (45/924) were subjected to the appropriate screen; therefore 70 percent (45/64) of those at risk were adequately tested for abnormal cystine metabolism.

**Renal Tubular Acidosis**

The presence of either one urine pH of 5.5 or less, or one serum bicarbonate reading of 24 mEq/L or greater, was considered necessary by the study's criteria to rule out complete renal tubular acidosis. Renal tubular acidosis was ruled out for 81 percent (746/924) of patients; 62 percent of patients at Hospital A had RTA ruled out, 88 percent at Hospital B, 89 percent at Hospital MC, 97 percent at Hospital D, and 76 percent at Hospital E. None of the patients who were inadequately tested for RTA were given a confirmed diagnosis; some therefore may have had undiagnosed RTA.

| Status of 24-Hour Urine | Hosp A No. (%) | Hosp B No. (%) | Hosp MC No. (%) | Hosp D No. (%) | Hosp E No. (%) | Total No. (%) |
|-------------------------|----------------|----------------|-----------------|----------------|----------------|---------------|
| Prep Ok — All Tests Done| 6(18)          | 51(45)         | 9(21)           | 3(16)          |                | 69(33)        |
| Prep Ok — Not All Tests Done| 11(33)       | 14(12)         | 9(21)           | 2(11)          |                | 36(17)        |
| Prep Not Ok — All Tests Done| 7(21)         | 34(30)         | 15(35)          | 13(68)         | 1(100)         | 70(33)        |
| Prep Not Ok-Not All Tests Done| 9(27)        | 15(13)         | 10(23)          | 1(5)           |                | 35(17)        |
| Total                   | 33(100)       | 114(100)       | 43(100)         | 19(100)        | 1(100)         | 210(100)      |
Follow-Up Evaluation for Abnormal Laboratory Values

Though the study's criteria did not address the issue of follow-up for abnormal laboratory values, patients who had either an abnormal serum or 24-hour urine uric acid or calcium value were examined to determine whether relevant follow-up tests had been done. Forty percent (367/924) of the sample population had at least one abnormal uric acid or calcium value and 54 percent (197/367) of those with an abnormal value had at least one repeat test following the abnormal value. Sixty-five percent of patients at Hospitals A and B had a repeat test following an abnormal laboratory value, as did 56 percent at Hospital MC, 33 percent at Hospital D, and 34 percent at Hospital B.

Patients were also studied to determine whether additional recommended laboratory tests had been performed (e.g., a 24-hour urine with a uric acid or calcium test was recommended as a follow-up for an elevated serum uric acid or calcium value; a serum PTH was recommended when a patient had two elevated serum calciums; a urine culture was expected following a urinalysis with a WBC count in the sediment greater than ten, and a 24-hour urine cystine was required following a positive spot cystine screen). Additional laboratory tests were recommended for 38 percent (355/924) of the patients evaluated, but only 17 percent (62/355) of patients with abnormal laboratory values had the relevant additional test. The percentage of patients who had the recommended additional tests varied greatly from hospital to hospital: 10 percent (8/83) of patients at Hospital A had an additional test when recommended, 51 percent (40/79) at Hospital B, 13 percent (12/89) at Hospital MC, 3 percent (2/60) at Hospital D, and 0 percent (0/44) at Hospital E.

Follow-Up Plans

Data were collected concerning physicians' plans for post-discharge "Diagnostic and Treatment Follow-Up." For a majority of patients plans were documented but often these were vague. For 64 percent (589/924) of patients, physicians indicated intended diagnostic follow-up plans, and for 49 percent (453/924) they indicated intended treatment follow-up plans. Among these plans, however, only 25 percent (146/589) of the diagnostic follow-up plans were "Specific" (e.g., "repeat IVP" or "24-hour urine at 6 weeks"), and only 21 percent (93/453) of the treatment follow-up plans were specific (e.g., "discharged on Allopurinol"). "General" follow-up diagnostic procedures (e.g., "strain urine") and general follow-up therapeutic procedures (e.g., "push fluids" or "reduce calcium intake") were also seldom found in patients' medical records; 6 percent (38/589) of recorded follow-up diagnostic plans and 18 percent (83/453) of recorded follow-up treatment plans were general. In a majority of cases, physicians recorded "Non-Specific" follow-up plans (e.g., "to be followed in the office"); 69 percent (405/589) of diagnostic follow-up plans were non-specific and 61 percent (277/453) of therapeutic follow-up plans were non-specific.

Physicians Performance Index

The Physicians Performance Index (PPI) is a weighted index that describes an expected level of physicians' performance during their diagnostic evaluation of patients with stone disease. Because some of the physicians who were evaluated by the index were involved in approving the criteria items included in the index and the weighting of each item, it was hypothesized that conformance would be relatively good.
Two basic forms of the PPI were developed. The eleven-point PPI included all of the criteria points required for the work-up of patients with first event, uncomplicated stones. The sixteen-point PPI included an additional five points and, therefore, all criteria points recommended for the work-up of patients with complex or recurrent stones.

The diagnostic thoroughness for all patients with renal stones could be evaluated using the eleven-point PPI; physician performance was expected to be similar for all patients, regardless of their stone complexity, since all criteria included in the eleven-point PPI were recommended for evaluation of all patients with stones. There was no important difference in care patterns at each of the five hospitals between patients with uncomplicated and complicated first event stones when evaluated by the eleven-point PPI. However, there was a significant difference between the eleven-point PPI for first uncomplicated stones when compared with first complicated and recurrent complex stones at Hospitals A, B, and D (Table 8). The difference can be primarily attributed to one criterion: physicians recorded a clear stone history for recurrent patients more frequently than they did for first event stone patients.

Only patients with complicated first event stones or recurrent event stones required a work-up that included all of the criteria items in the sixteen-point PPI. Therefore it was hypothesized that there would be a significant difference between the diagnostic scores on the sixteen-point PPI for patients with uncomplicated and complicated stones. Also the difference should have been most notable in the criteria that make up the difference between the eleven- and sixteen-point PPI, since these items (equivalent to five points) were recommended only for evaluation of patients with complex stones. However, when the five additional points were evaluated independently, no significant difference in diagnostic scores by stone number and complexity was found (Table 9). (Because of the problem of multiple comparisons,
we used an alpha level of 0.01, rather than the more traditional 0.05. This was obtained by dividing the traditional 0.05 by the number of comparisons in the table—i.e., 0.05/5 = 0.01.

**DISCUSSION**

The data from this study suggest four principal conclusions. First, patients with stone disease often are managed by rote, regardless of the complexity and/or severity of their disease. Second, the single most informative evaluation, the collection of 24-hour urine specimens, is woefully underutilized in the hospital. Third, abnormal serum and urine laboratory values are not always followed up during a patient’s hospitalization to determine whether the abnormality persists. Fourth, among most of the patients there was little evidence that there were therapeutic attempts to alter risk factors to reduce the risk of stones.

Physicians’ actual diagnostic investigations for patients with recurrent or complicated stone disease were not significantly more thorough than their evaluations of patients with uncomplicated stone disease. Physicians did not appear to use the stone event number (e.g., recurrent vs. first event), the stone “burden” (e.g., bilateral vs. unilateral stone) or the patients’ age (e.g., 21 years of age or older vs. less than 20 years of age) to guide the intensity of their diagnostic work-ups. Most diagnostic work-ups appeared to be done “automatically” and without careful case-by-case analysis of the intensity of the work-up needed.

Twenty-four-hour urines were evaluated for less than one-fourth of the hospitalized patients included in this study. Although the percentage of 24-hour urines collected did not vary significantly between patients with uncomplicated stone disease and those with complicated stone disease, it did vary significantly between hospitals. Abnormal 24-hour urine values can direct medical therapy, and they are essential for effective management of patients with renal stone disease, especially for those who have recurrent stone disease.

Nearly half of the hospitalized renal stone patients had at least one abnormal serum or urine laboratory value. However, only half of those with abnormal laboratory values were tested to see whether the abnormality persisted during their hospitalization, or to see if there was other evidence for that abnormality.

Indications of intended follow-up diagnostic evaluation and treatment after discharge from the hospital were recorded clearly in very few charts. This may reflect a deficiency in recording intended follow-up plans, or it may reflect infrequent follow-up care of urolithiasis patients. Renal stone disease is considered a lifelong disease for which elimination or modification of known risk factors can be beneficial [2,4]; therefore, follow-up is an important aspect of care.

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