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Excretory Urogram

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UTILIZATION, COSTS, AND CONTROVERSIES

Excretory urogram (ExU) refers to any procedure that provides for X-ray delineation of the urinary tract using an opaque contrast medium injected (or occasionally infused) into the blood (123). * As the contrast medium is excreted by the kidneys through the urinary tract, usually within 15 to 20 minutes of injection, the anatomy of the urinary tract organs can be delineated by X-ray films. Special types of ExU examinations, such as cystography (bladder studies) or urethorography, focus on particular sections of the urinary tract. The examination "must be tailored to meet the needs of the individual patient or clinical problem" (123).

The primary purpose of ExU is to detect obstructions (calcifications, tumors, etc.) and other diseases in the urinary tract. ExU is also a diagnostic tool for detection of renovascular disease, an underlying cause of hypertension in about 10 percent of hypertensive cases (13).

In 1970, approximately 3.9 million ExU examinations were performed, representing about 3 percent of the radiographic examinations performed in the United States that year. Over 85 percent of these procedures took place in hospitals, and the average number of films used per examination was 5.3. The ExU procedure subjects the patient to a relatively high gonad dose, and this dose is higher for women (448 millirads per exam) than for men (20 millirads per exam) (28).

Not only does ExU involve high radiation exposure to vulnerable organs, but the injection of the contrast medium can cause acute reactions. In a study of almost 33,000 consecutive patients receiving ExUS, 1.72 percent had acute reactions; 5 percent of these developed severe or life-threatening reactions, and one patient died

(123). Patients with heart disease and diabetes are at higher risk for the development of undesirable side effects such as rapid heart beat or cardiac arrest (10,123).

As with the BE examination, radiologists perform most ExUS. According to California physicians' medicaid claims records for 1978,** radiologists performed 93 percent of all ExU exams on these patients. In hospitals (both inpatient and outpatient settings), radiologists performed 100 percent of these exams, compared to 88 percent in physicians' offices.

In comparing the relative frequency of ExUS, hypertensive urograms, and drip infusion urograms, the standard procedure accounts for a large proportion of all urograms. Tables 13 and 14 present summaries of physicians' medicaid claims for ExU in 1978. California medicaid data indicated that from 1973 to 1976, the standard ExU comprised an average of 84.5 percent of the ExUs performed in physicians' offices. In outpatient settings, the proportion was similar, at an average of 84.1 percent, and slightly lower for inpatient examinations (81.7 percent). The data do not reveal any *trends* toward increases or decreases in the proportion of standard urograms performed during these 4 years.

The ExU examination is uncomfortable for the patient, and it requires some preparation, including prior dehydration and catharsis. Considered together with the morbidity, risk, and radiation exposure inherent in the procedure, and its cost, ExU is in little danger of becoming a routine or screening examination. Nevertheless, questions have arisen about the appropriateness of its use in certain patient groups such as women with urinary tract infections and about the potential for simplifying radiologic methods

*The term excretory urogram is generally used interchangeably with intravenous pyelography (IVP) but the latter term is a misnomer and is avoided in modern texts (123)

**These are claims for physicians' services only. When the hospital bills directly for both technical and professional services, the claims are not included.

Table 13.—Medicaid Excretory Urogram Claims in California Submitted by Physicians in First Quarter of 1978, by Location of Service

	In patienta	Outpatient ^a	Office	Other	Total
74400 Excretory urogram.	789 (77.1 O/.)	1,011 (71.0 ^o /O)	4,105 (82.20/.)	16 (84.2 ^o /O)	5,921 (79.20/o)
74405 Excretory urogram: hypertensive.	19 (01 .90/o)	143 (10.0 ^o /O)	290 (05.80/.)	—	452 (06.0 ^o /O)
74406 Excretory urogram: extended.	139 (13.6 ^o /O)	128 (09.0%)	286 (05.7%)	3 (05.8 ^o 4)	556 (07.5 ^o /O)
74410 Excretory urogram: infusion	76 (07.4%)	142 (10.0 ^o /~)	313 (06.0 ^o /O)	—	531 (07.1 ^o /O)
Total	1,023	1,424	4,994	19	7,460

^aRecorded only when hospital and physician bill separately for the service (split billing arrangement)

SOURCE: Urban Institute, 1980 Sample of 5,000 sole practitioners, including 177 radiologists

Table 14.—Medicaid Excretory Urogram Claims in California Submitted by Radiologists in First Quarter of 1978, by Location of Service

	Inpatient ^a	Outpatient ^a	Office	Other	Total
74400 Excretory urogram.	706 (88.30/.)	1,003 (77.9 ^o /O)	2,031 (87.5%)	16 (100 ^o /o)	3,756 (84.9 ^o /O)
74405 Hypertensive ('69 RVS).	18 (02.3%)	143 (11 .1%)	186 (08.0%)	—	347 (07.80/.)
74410 Infusion ('60 RVS).	76 (09.5 ^o /O)	142 (1 1.0%)	103 (04.40/o)	—	321 (07.3 ^o /O)
Total	800	1,288	2,320	16	4,424

^aRecorded only when hospital and physician bill separately for the service (split billing arrangement)

SOURCE: Urban Institute, 1980 Sample of 177 sole radiologists (326 percent of sole radiologists in California)

in order to save cost and reduce radiation exposure. A few clinical evaluative studies have addressed these issues.

The evaluative literature follows the following broad categories: 1) studies of diagnostic yield and high-yield criteria for ordering ExU, 2) studies of appropriate radiologic method, 3) studies of the role of ExU in screening for renovascular disease, and 4) studies of the information content of the ExU. Each is discussed below.

Diagnostic Yield and High= Yield Criteria

Van Woert and associates reported on a review of 200 consecutive hospital and clinic patients who had received ExUs during a 4-month period in 1955-56 (120). Fifty-five examinations (27.5 percent) were abnormal. The investigation correlated ExU results with prior signs, symptoms, or findings. In 50 percent of patients with a history of colicky pain, ExU was positive. Other signs or symptoms found to be important predictors of abnormality were palpable renal mass (5o percent); hematuria (40 percent); white

blood cells in urine (25 percent); and costovertebral angle tenderness (20 percent). Moreover, combinations of these symptoms increased the probability of an abnormal ExU. Using this list as a starting point, the authors constructed a set of 10 indications for ordering an ExU. Use of the criteria constructed in this arbitrary fashion would have eliminated 25 percent of the 200 ExU examinations while at the same time missing 4 of the 55 abnormal ExU findings. In the opinion of the authors, none of the 4 was clinically significant. It must be noted, however, that the performance of the criteria was not tested on independent patient samples.

More recently, Mellins and associates studied over **1,622 patients** referred to a major teaching hospital for ExU (89). Referring physicians were asked to complete a questionnaire giving information on signs, symptoms, and laboratory findings in each patient. These attributes were then associated with ExU findings by constructing attribute likelihood ratios. Those with likelihood ratios suggesting a significant relationship between the attribute and ExU results were con-

sidered high-yield criteria. In patients without known prior genitourinary disease, these high-yield findings included gross hematuria (visible blood in urine); nocturia (excessive urination at night); elevated creatinine level; proteinuria (excess of serum proteins in urine); and elevated BUN (urea nitrogen) levels. Had these findings been used as referral criteria in the patient sample studied, 65 percent of ExU examinations would have been avoided, but 55 percent of abnormal ExU examinations would have been missed. The authors concluded that the use of the high-yield criteria so constructed would provide an unacceptably high false-negative rate (low sensitivity) and therefore offered no improvement over current referral processes.

An example of the potential benefits to be derived from further studies of the contribution of particular indications to diagnostic yield is given in two recent studies of diagnostic yield of ExU in women with recurrent urinary tract infection (37, 46). In the first, a review of 164 cases in which an ExU was performed at a university-affiliated hospital on women whose major indication for the examination was a history of recurrent urinary tract infection showed a diagnostic yield of 5.5 percent. Only one positive examination (0.6 percent) revealed a potentially significant abnormality, but it was considered unrelated to the symptoms of urinary tract infection. These results were supported by those of a similar study of **104 patients** referred for excretory urography (46). Although it is unknown how frequently ExU examinations are performed for this indication, promulgation of better criteria for ordering the procedure is likely to make some difference to total ExU volume.

Studies of Appropriate Radiologic Method

New variations in radiologic method are frequently tested and reported. Here, one element of radiological method with significant implications for the cost of medical care is reviewed: the number of films taken as part of the examination. In ExU, X-ray films are taken both before and at specific intervals after the injection of the contrast materials. Although these intervals

vary with the clinical problem (e. g., the sequence of films is more rapid for hypertensive patients than for other patients), there is wide variation in the number and timing of films used in standard examinations,

Van Woert and colleagues addressed the question of film sequence in 1958 in a study whose purpose was to search for ways of decreasing gonadal radiation (120). In 87 positive ExU examinations for ureteral abnormalities, films were exposed at 5-, 10-, and 15-minute intervals after injection of the contrast. In only 3 of the 87 cases could the pathology be demonstrated on the early films but not on the 15-minute or subsequent films; the 3 cases involved clinically insignificant conditions. Thus, in none of the 87 cases was the 5- or 10-minute film essential to diagnosis of lower urinary tract disease. Gonadal shielding on the early films was recommended. It should be noted that the study was a review of past urograms, probably with reviewer knowledge of the original findings. It is not clear how an independent blind review of these cases in a larger sample containing both normal and abnormal urograms would have fared in detecting ureteral abnormalities on only the 15-minute film.

More recently Hillman and his associates investigated the sensitivity, specificity, and accuracy of ExU exams using different film sequences (61). Four experienced staff radiologists viewed 45 urograms, 21 normal and 24 abnormal, with abnormal cases representing a broad spectrum of diseases. The radiologists first reviewed a one-film examination (15 minutes); a three-film examination (1, 10, and 15 minutes); and a six-film examination (1, 5, 10, 10, 10, and 15 minutes). Mean sensitivity (true-positive rate) was 93, 88, and 91 percent on the one-, three-, and six-film urograms, respectively. Mean specificity (true-negative rate) was 67, 77, and 80 percent, respectively. Accuracy was 82, 83, and 85 percent. Thus, while specificity increased with additional films, sensitivity was not affected. However, the definitiveness of disease diagnosis (i. e., ability to correctly differentiate among possible

*The six-film examination involved three different views at 10 minutes.

diseases) did increase as the number of films increased (75, 85, and 84 percent, respectively). On the basis of these findings, the authors recommended a policy of a one-film postinjection examination (at 10 minutes) followed by reinjection of contrast if the film indicates an abnormal. The authors made a rough estimate of national annual savings of \$368 million if this policy were followed. Better estimation procedures would probably reduce this value substantially. Nevertheless, the authors have demonstrated that economies are possible through changes in radiographic method without significant changes in diagnostic efficiency.

Studies of the Role of ExU in Screening for Renovascular Hypertension

It has been estimated that about 10 percent of persons with hypertension have the condition as a consequence of underlying renovascular disease (13). In particular, stenosis (narrowing) of the renal artery is often present, and in some cases, surgery can correct the resulting hypertension. Thus, differentiation of patients with essential hypertension (i. e., not secondary to another condition) from those with renovascular hypertension has been of interest to clinicians and researchers alike. In 1961, a cooperative study of renovascular hypertension was initiated, with the purpose of improving understanding of the disease, its detection, and therapy (13). Consequently, a great deal of information exists on the efficiency of alternative diagnostic methods and outcome of therapies.

ExUs show features suggestive of renovascular disease. The major features are a significant difference in length of the kidneys; a significant difference in the time until contrast appears at the calyx on each side; and a difference in concentration of contrast medium on each side (13). The difference-in-appearance time mandates a large number of early postcontrast films. A fairly uniform technique is to take X-ray films at intervals of 1, 2, 3, 4, 5, 10, 15 and 30 minutes after the rapid injection of contrast (13). The urogram does not provide definitive diagnosis, however. Angiography, an invasive, difficult, and expensive procedure can be used to prove

renovascular disease. * Urography is one of several signs, symptoms, and laboratory findings potentially useful in screening for the disease. The central question involving the use of urography is whether it should be used as a general or selective screening tool for detection of renovascular disease in hypertensive patients.

Bookstein and colleagues reported on a study of diagnostic efficiency of ExU in 198 patients with proved unilateral renovascular hypertension and 771 cases of essential hypertension in the Cooperative Study (12,13). The ExU false-positive rate in essential hypertension was 11.4 percent. In patients with serious unilateral renovascular disease, the true-positive rate was 78.2 percent.

The information generated by the Cooperative Study enabled McNeil and her colleagues (80) to perform a cost-effectiveness analysis of two issues: 1) the relative merits of screening hypertensives with ExU v. the renogram, a radionuclide procedure; and 2) the relative merits of screening v. no screening for renovascular diseases in hypertensive patients. In the former study, the evaluative measure chosen was the cost per surgical cure of each screening alternative. In the latter, the authors calculated the cost of keeping a patient from incurring a morbid event associated with hypertension for 16 years.

In the study of the ExU v. the renogram, the cost per surgical cure was found to be \$15,000 for ExU, \$14,000 for the renogram, and \$20,000 if both are performed. These estimates, while based on some rather heroic assumptions about the cost of diagnosis and treatment,** would suggest that the renogram be considered the primary screening technique.

The more germane issue is whether a general screening program in hypertensives is worthwhile at all. Here, the alternative strategies are: 1) screening for renovascular disease by ExU, with surgical intervention in those renovascular

* Recent advances in angiographic techniques that allow for direct visualization of the renal arteries with less invasive methods may make the ExU obsolete in the future.

** See Wagner (121) for a discussion of problem of cost measurement.

hypertensive found to be amenable to surgery; and 2) no screening and medical management of all patients. The cost of providing an additional well patient by the route of screening and surgery was \$56,000. The cost of protecting women is higher. Cost also increases with decreasing diastolic blood pressures and with the rate of compliance with medical regimens.

The success of the authors in examining the impact of alternative diagnostic strategies on outcomes is due largely to the availability of a rich data base emanating from large-scale epidemiological and clinical studies. It might have been useful to know how the morbid and mortal events under the alternative strategies were dispersed through time, since bad outcomes that occur later are preferred to those that occur sooner. Nevertheless, information sufficient to make a decision about the usefulness of screening, and the appropriate diagnostic tools for screening, is present. Whether \$56,000 per additional well person is too high or too low a price to pay for hypertensive screening is a political decision fraught with questions of equity and ethics. Should society pay to screen hypertensive in groups with historically low rates of compliance with medical regimens? These questions can be posed only because information is available to frame existing tradeoffs.

Studies of the Diagnostic Information From ExU

Thornbury, Fryback, and Edwards attempted to determine the extent to which ExU is useful in changing physicians' levels of uncertainty about the correct diagnosis (117). Their study was premised on the assumption that if a test substantially alters physicians' subjective probability assessments, then it has diagnostic value. In a

prospective study of 67 patients referred to two outpatient clinics for ExU, the referring physicians were asked to estimate the probability of the most likely diagnosis prior to the test. After the results of the ExU were received, the physicians' ratio of posttest to pretest odds was constructed, and a logarithmic index of this ratio was used to measure the degree of change (either positive or negative) in these odds. An index value of zero would denote no effect of ExU on physicians' probabilities. Successively higher values would suggest larger impacts of the ExU on diagnostic certainty. Thirty-five of the sixty-seven patients had an index value of less than 0.5, indicating little or no change in probability estimates resulting from the information provided by the ExU. These results contrast with those of the American College of Radiology study, where only 34 percent of ExU examinations performed in participating emergency rooms received an index value of less than 0.75 (76). The differences in the two studies could result from inconsistencies in study designs or differences in the patient mix.

In any case, it is difficult to draw inferences for medical practice for these studies. The study sample had various presenting signs and symptoms; whether the ExU is useful for some of these and not for others was not explored. Thornbury and his associates (117) noted that about one-half of the cases in which no change in probabilities was recorded were ultimately diagnosed as essential hypertension, indicating that these tests were performed to screen for renovascular hypertension. Without information on the findings from all hypertension patients in the study and separate analysis of those with other presenting conditions, these studies are virtually meaningless.