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A Cost-effectiveness Analysis of Screening Urine Dipsticks in Well-Child Care

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WHAT'S KNOWN ON THIS SUBJECT: Data suggest that routine urine screening for chronic kidney disease has low diagnostic yield. In 2007, the American Academy of Pediatrics issued a new recommendation to discontinue this screening.

WHAT THIS STUDY ADDS: In support of the new guidelines, this analysis demonstrates that urine dipstick is inexpensive, but it is a poor screening test for chronic kidney disease and a cost-ineffective procedure for the primary care provider.

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KEY WORDS
urinalysis, cost-effectiveness analysis, chronic kidney disease, screening

ABBREVIATIONS
AAP—American Academy of Pediatrics
CKD—chronic kidney disease
ICER—incremental cost-effectiveness ratio
ESRD—end stage renal disease

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abstract

OBJECTIVE: Despite data suggesting that routine urine screening for chronic kidney disease (CKD) has low diagnostic yield and the American Academy of Pediatrics 2007 recommendation to discontinue this screening, pediatricians may not have recognized this change. Because the new recommendation marks a major alteration in the practice guidelines, we sought to evaluate the cost-effectiveness of dipstick urinalysis for detection of CKD from the primary care practitioner's perspective.

METHODS: Decision analysis was used to model a screening dipstick urinalysis strategy relative to a no-screening strategy. Data on the incidence of hematuria and proteinuria in children were derived from published reports of large cohorts of school-aged children. Direct costs were estimated from the perspective of the primary care practitioner. The measure of effectiveness was the rate of diagnoses of CKD. Cost-effectiveness was evaluated by using an incremental cost-effectiveness ratio.

RESULTS: Expected costs and effectiveness for the no-screening strategy were $0 because no resources were used and no cases of CKD were diagnosed. The screening strategy involved a cost per dipstick of $3.05. Accounting for both true-positive and false-positive initial screens, 14.2% of the patients required a second dipstick as per typical clinical care, bringing the expected cost of the screening strategy to $3.47 per patient. In the screening strategy, 1 case of CKD was diagnosed per 800 screened, and the incremental cost-effectiveness ratio was $2779.50 per case diagnosed.

CONCLUSIONS: Urine dipstick is inexpensive, but it is a poor screening test for CKD and a cost-ineffective procedure for the primary care provider. These data support the change in the American Academy of Pediatrics guidelines on the use of screening dipstick urinalysis. Clinicians must consider the cost-effectiveness of preventive care procedures to make better use of available resources . *Pediatrics* 2010;125: 660–663

Screening dipstick urinalyses are still being performed on school-aged children, although this practice is no longer recommended by the American Academy of Pediatrics (AAP).[1,2] Supporting this recommendation, multiple large-scale studies of healthy schoolchildren have demonstrated the low incidence of chronic kidney disease (CKD) in children.[3–6] At present, the early detection of CKD in asymptomatic children does not seem to alter ultimate disease outcome, making dipstick urinalysis an unbeneficial screening tool. The high rate of false-positive and true-positive screens for benign conditions (eg, orthostatic proteinuria) result in additional tests that generate increased costs and anxiety for patients and families.

The decision to perform routine dipstick urinalysis, however, rests with the primary care practitioner. Thus, the direct costs of this screening test were calculated from the primary provider perspective to determine the cost-effectiveness of this procedure. Our hypothesis was that routine urine dipstick is cost-ineffective, which concurs with the updated AAP guidelines.

METHODS

Design

Decision analysis was used to model a screening dipstick urinalysis strategy relative to a no-screening strategy. The screening strategy involved the use of office urine dipstick during routine well-child care. Consistent with typical care, the dipstick was repeated after abnormal results.

Abnormal urinalyses included the following: (1) ≥1+ proteinuria and (2) ≥1+ hematuria. Although glucosuria and bacteriuria are also considered abnormal, most pediatricians do not intend to diagnose diabetes or urinary tract infections in otherwise healthy children by urine dipstick; the main purpose is the detection of occult renal disease.

The primary analysis outcomes were (1) the screening cost per patient and (2) the incremental cost-effectiveness ratio (ICER) per case of CKD diagnosed. Costs are rounded and reported to 2 significant digits.

Probabilities

Probabilities in the decision tree were calculated from the published reports of Vehaskari and collegues,[3,4] who performed dipstick urinalyses on 8954 schoolchildren aged 8 to 15 years followed by systematic clinical evaluation of children with persistent abnormalities. These studies involved the collection of 4 urine specimens before examination. These data were extrapolated to the well-child check in which a single urine sample is collected.[3,4] Children with blood or protein in 1 sample were placed in the group who tested positive initially but were negative on repeat testing (dipstick 2). Those with blood or protein in ≥2 samples received additional evaluation, which led to de novo diagnosis of some form of CKD in 11 of 8954 children.[3,4] This translates to an incidence of CKD of ~0.1%.[3,4] Although epidemiologic information on the incidence and prevalence of CKD in the pediatric population is lacking, this incidence is consistent with published data.[7,8]

Costs

We assumed $0 cost in the no-intervention arm because no routine screening dipsticks were used. Cases of CKD would have to present with overt clinical symptoms that prompted an evaluation. For the screening strategy, direct hospital costs of a dipstick urinalysis at our center were calculated (Table 1). The total came to $3.05 for dipstick urinalysis performed by a licensed practical nurse assuming 3 minutes to complete the test. Administrative and institutional overhead were not included. A practitioner in the screening arm was assumed to perform 1 screening dipstick per healthy child with a single repeat for an abnormal result. Subsequent laboratory work and imaging were not judged to be a direct practitioner cost. For comparison, we examined Pennsylvania Medicaid reimbursement figures. This was a comparable $3.10 for a urine dipstick in 2008.

TABLE 1 Cost Composition of Dipstick Urinalysis

Components	Price
Supply items	$1.80
Specimen container 4.5 oz	
Nitrile gloves	
Nice wipes	
Benzoin tincture 3.5 oz	
Urine dipstick	
Labor expense/time	
LPN salary (3 min)	$0.98
LPN fringe benefits (3 min)	$0.27
Total supplies and labor	$3.05

LPN indicates licensed practical nurse.

Effectiveness

The measure of effectiveness was the rate of diagnoses of CKD. Cost-effectiveness was summarized by using an ICER. This was calculated as the additional expected cost incurred by having urine dipstick versus no urine dipstick for each additional unit of effectiveness:

$$\text{ICER} = (\text{Cost}_{\text{urine dip}} - \text{Cost}_{\text{no urine dip}})/(\text{Effect}_{\text{urine dip}} - \text{Effect}_{\text{no urine dip}})$$

The ICER is the additional cost that must be incurred for each additional case of CKD diagnosed if all patients receive the urine dipstick.

Decision Tree Analysis

TreeAge 3.5 software (Williamstown, MA) was used to create the decision tree and solve the model (Fig 1). Outcomes of a positive dipstick are based on Vehaskari's cohort. For example, no child with initial proteinuria subsequently developed hematuria, so this is not a potential branch of the tree.

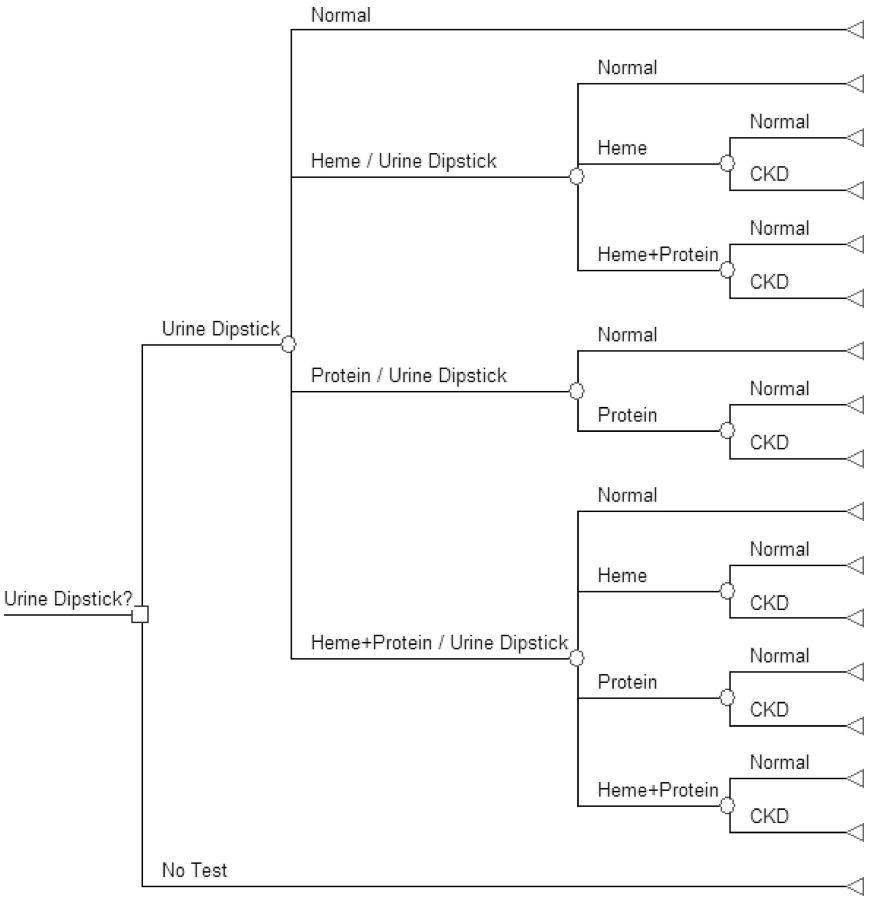

FIGURE 1
Decision tree for use of screening urine dipsticks for detection of CKD.

RESULTS

On the basis of previously published data, 1264 (14.2%) of 8954 patients initially had an abnormal urinalysis. On retesting, only 319 (3.6%) had a persistent abnormality.[3,4] Specific abnormalities were as follows: 88 with hematuria, 217 with proteinuria and 14 with both. Workup for persistent abnormalities led to a diagnosis of CKD in only 11 (0.1%) children, with diagnoses including focal segmental sclerosis, collagen vascular disease, immunoglobulin A–immunoglobulin G nephropathy, hereditary nephritis, anatomic abnormalities, chronic urinary tract infection with vesicoureteral reflux, and resolving acute glomerulonephritis.[3,4]

Applying our cost model to this population, expected costs and effectiveness for the no-screening strategy were $0 because no resources were used and no cases of CKD were diagnosed. The screening strategy involved a cost per screen of $3.05. With 100% of children receiving a screen as part of standard clinical care and 14.2% requiring retesting for an abnormal initial screen, the expected cost of the screening strategy became $3.47 per patient, with a rate of 1 case of CKD diagnosed per 800 screened. The ICER was $2779.50 per case of CKD diagnosed.

DISCUSSION

Although screening urinalysis is a relatively inexpensive test, it is a poor screening test for CKD. Building on the results of a 1997 cost-analysis study,[9] the current data further demonstrate that screening dipstick urinalysis is not a cost-effective endeavor at $2779.50 per case of CKD diagnosed.

A screening test should be inexpensive and widely available, and a positive result should prompt timely evaluation. Most important, early detection should lead to an intervention that prevents morbidity and/or mortality.[10] Screening urine dipstick meets the first 3 requirements but fails to satisfy the last. It remains unproven that early detection of microscopic hematuria and/or proteinuria through screening by office urine dipstick significantly alters the course of a child who is destined to progress from CKD to end-stage renal disease (ESRD). In addition, good pediatric data are lacking on mitigation of other end-organ effects (eg, growth, anemia) by early detection of asymptomatic patients.

The likely variability in current provider practice may be related to income generated from reimbursement as well as the numerous changes in the urine screening recommendation in the past several decades. In 1977 and 1992, the AAP recommended a screening urinalysis at 4 periods during a child's life.[1] In 2000, the pediatric health care guidelines were revised to recommend a screening urinalysis at 5 years of age and during adolescence.[1,11] In 2007, the screening urinalysis was removed altogether, which provided clear guidance for this screening test.[2] This change was not based on new evidence but a consensus on the lack of existing data to support this practice (J. Hagan, Jr, MD, and J. Swanson, MD, Bright Futures Steering Committee, written communication, September 2008). Given the current state of knowledge and treatment of CKD in children, our study lends support to the removal of the screening dipstick urinalysis from the preventive pediatric health care guidelines.

Because screening dipstick urinalysis is relatively inexpensive, the cost-

effectiveness of this procedure may change if the benefits of early treatment alter outcomes. For example, angiotensin-converting enzyme inhibitors slow progression to ESRD in adults; in time, their benefits may be proven for children. Pediatric studies are just starting to emerge.[12–16] Alternatively, a targeted screen for children at high risk may be cost-effective, as suggested for adults.[12]

This analysis was limited by several factors. First, we relied on retrospective published data on a non-American cohort of children to populate our decision tree. The study involved the collection of 4 urine specimens, which was extrapolated to an office setting where a single urine dipstick is obtained. Several patients were lost to follow-up. The missing patients were distributed according to the percentage of normal and abnormal results in the study, but their true outcome is unknown. We assumed 100% negative predictive value of the urine dipstick, because office practitioners equate a normal test with no disease. Last, the use of this study population does not account for racial or ethnic factors that affect the incidence of CKD.

CONCLUSIONS

Screening dipstick urinalyses are inexpensive but are not cost-effective on the basis of our current treatments and knowledge of CKD in children. As early intervention treatments are developed for CKD, reexamination of screening dipstick urinalyses and perhaps targeted screening for high-risk populations may be warranted.

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