
Vesicoureteral Reflux and Ureterocele

Hans G. Pohl,* Geoffrey F. Joyce, Matthew Wise and Bartley G. Cilento, Jr.

From the Department of Urology, George Washington University, Children's National Medical Center, Washington, D. C., RAND Health, Santa Monica, California, and Children's Hospital, Boston, Massachusetts

Purpose: We quantified the burden of vesicoureteral reflux and ureteroceles in the United States by identifying trends in the use of health care resources and estimating the economic impact of the diseases.

Materials and Methods: The analytical methods used to generate these results were described previously.

Results: Annual inpatient hospitalizations for vesicoureteral reflux increased slightly between 1994 and 2000 from 6.4/100,000 to 7.0/100,000 children, although this trend did not attain statistical significance. Inpatient hospitalization for ureteroceles remained relatively stable between 1994 and 2000 at an average of approximately 2,818 cases annually (1.0/100,000 to 1.1/100,000 children). The rates of visits to physician offices doubled during the 1990s for commercially insured children (12/100,000 in 1994 and 26/100,000 in 2002) and children covered by Medicaid (43/100,000 in 1996 and 85/100,000 in 2000). Overall the rate of ambulatory surgery visits by commercially insured children increased from 3.4/100,000 in 1998 to 4.8/100,000 in 2002. Similar estimates were not available for children covered by Medicaid. Emergency room use by children with a primary diagnosis of vesicoureteral reflux was rare, reflecting the trend toward delivery of care at physician offices, ambulatory surgery centers and inpatient hospitals. No reliable data could be obtained on outpatient visits or ambulatory surgery for ureteroceles. In 2000 total expenditures for inpatient pediatric vesicoureteral reflux were \$47 million, an increase of more than \$10 million since 1997. Based on data from 2000 the yearly national inpatient expenditures from ureterocele treatment were an estimated \$4 million.

Conclusions: The economic impact of inpatient treatment for pediatric vesicoureteral reflux is considerable. If other service types such as pharmaceuticals, and outpatient and ambulatory services were considered, the observed impact of this condition would certainly be greater. Importantly the costs of prophylactic medical therapy and emerging therapies such as Deflux® are not accounted for in this estimate. Furthermore, indirect economic costs, such as work loss to parents of children with pediatric vesicoureteral reflux, were not considered, causing an even greater underestimation of the true costs associated with the condition. Although the National Association of Children's Hospitals and Related Institutions, and the Health Care Cost and Utilization Project Kids' Inpatient Database include data on ureteroceles, the data were limited and, thus, they could not be used to determine reliable cost trends. Available data indicate that the mean cost per ureterocele case was almost \$8,000 with little variation observed across ages, regions or sexes.

Key Words: vesico-ureteral reflux, ureterocele, health care costs, health services research, pediatrics

The advent of routine prenatal screening ultrasonography has facilitated the detection of many causes of hydronephrosis, such as VUR and ureteroceles. Overall the incidence of VUR in all children is estimated at approximately 10%, although the prevalence is largely determined by the mode of presentation, for instance prenatally or following evaluation for UTI and whether there are coexisting urinary tract abnormalities.¹ Thus, VUR has been identified in 17.2% of children without UTI, 40% to 70% with UTI and up to 37% with prenatally detected hydronephrosis.²⁻⁷

When evaluation is performed in infancy in response to prenatal hydronephrosis, a preponderance of the patients with VUR is male. In contrast, females predominate when VUR is diagnosed at evaluation for UTIs later in develop-

ment.⁸ Affected infant boys also often present with more severe degrees of VUR, especially if diagnosed in infancy or during postnatal evaluation for prenatal hydronephrosis.⁹ Although 85% of VUR diagnosed in older children occurs in girls, boys who present with UTIs have a higher likelihood of having the anomaly.¹⁰ Since circumcision status influences the predisposition to infection, this propensity toward UTI also affects the detection of VUR.¹¹ The prevalence of VUR in black children with UTI is less than that in white children up to age 10 years.¹² However, after reflux is discovered its grade and chance of spontaneous resolution are similar in female children of the 2 races.¹³

Reflux is a concern because of its association with renal scarring, which may result in high blood pressure and renal insufficiency. The severity of each condition is related to the proportion of kidney tissue that is scarred. In the 1970s VUR was identified as the underlying cause in up to 50% of children with high blood pressure and it was reported to be present in up to 40% at renal failure clinics.^{14,15} Recently only 6% of children with high blood pressure and renal insufficiency had VUR as the underlying cause, perhaps because improved diagnosis of VUR and treatment algo-

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* Correspondence: Department of Urology, George Washington University, Children's National Medical Center, Washington, D. C. (telephone: 202-884-5042; FAX: 202-884-4739; e-mail: Hpohl@cnmc.org).

TABLE 1. Inpatient hospital stays for VUR as primary diagnosis

	1994			1996			1998			2000		
	Count	Rate (95% CI)	Age Adjusted Rate	Count	Rate (95% CI)	Age Adjusted Rate	Count	Rate (95% CI)	Age Adjusted Rate	Count	Rate (95% CI)	Age Adjusted Rate
Totals	4,913	1.9 (1.5–2.4)	1.9	5,105	1.9 (1.4–2.4)	1.9	6,469	2.4 (1.3–3.6)	2.4	5,675	2.1 (1.5–2.7)	2.1
Age:												
Younger than 18	4,328	6.4 (4.8–7.8)		4,442	6.2 (4.5–8.0)		5,907	8.2 (4.2–12)		5,047	7.0 (4.9–9.1)	
18–24	173	0.7 (0.5–0.9)		155	0.6 (0.4–0.8)		165	0.7 (0.4–0.9)		203	0.8 (0.5–1.0)	
25–34	153	0.4 (0.2–0.5)		167	0.4 (0.2–0.6)		*	*		186	0.5 (0.3–0.7)	
35–54	*	*		193	0.3 (0.2–0.4)		*	*		*	*	
55 or Older*												
Sex:												
M	1,335	1.1 (0.8–1.4)	1.0	1,163	0.9 (0.7–1.1)	0.9	1,574	1.2 (0.6–1.8)	1.2	1,454	1.1 (0.8–1.4)	1.0
F	3,578	2.8 (2.1–3.4)	2.9	3,942	2.9 (2.1–3.7)	3.0	4,895	3.6 (1.8–5.3)	3.7	4,222	3.0 (2.1–3.9)	3.2
Race/ethnicity:												
White	3,279	1.8 (1.3–2.2)	1.9	2,892	1.5 (1.1–1.9)	1.7	4,075	2.1 (0.9–3.4)	2.4	3,488	1.8 (1.2–2.4)	2.0
Hispanic	402	*	1.2	483	*	1.3	574	*	1.5	520	1.6 (0.8–2.4)	1.3
Region:												
Midwest	1,369	2.3 (1.5–3.0)	2.2	1,319	2.1 (1.2–3.1)	2.1	1,037	1.7 (1.1–2.2)	1.6	1,375	2.2 (1.3–3.0)	2.1
Northeast	1,070	2.1 (1.1–3.1)	2.2	988	1.9 (0.8–3.0)	2.0	2,426	*	*	877	1.7 (0.9–2.5)	1.8
South	1,751	2.0 (1.1–3.0)	2.1	2,068	2.2 (1.1–3.4)	2.3	2,316	2.5 (1.1–3.8)	2.5	1,584	1.6 (0.8–2.6)	1.7
West	722	1.3 (0.8–1.8)	1.2	730	1.2 (0.8–1.7)	1.2	691	1.2 (0.6–1.7)	1.1	1,839	*	2.8
MSA:												
Rural	236	0.4 (0.2–0.6)	0.4	300	0.5 (0.3–0.7)	0.5	227	0.4 (0.2–0.5)	0.4	184	0.3 (0.2–0.4)	0.3
Urban	4,676	2.5 (1.9–3.1)	2.5	4,798	2.4 (1.7–3.0)	2.4	6,233	3.0 (1.5–4.5)	3.0	5,491	2.6 (1.8–3.4)	2.6

Rate per 100,000 based on 1994, 1996, 1998 and 2000 population estimates from CPS, CPS Utilities, Unicon Research Corp. for relevant demographic categories of civilian noninstitutionalized population in the United States, age adjusted rate adjusted to the United States Census derived age distribution of the year under analysis and individuals of other races, and with missing or unavailable race and ethnicity, and missing MSA included in the total (counts may not sum to total due to rounding) (source: HCUP Nationwide Inpatient Sample, 1994, 1996, 1998 and 2000).

* Value does not meet reliability or precision standard.

rhythms have influenced this rate, or because of changes in disease coding.¹⁶

Treatment for VUR is predicated on the concept that the condition usually resolves spontaneously, although various factors modify the resolution rate, including initial grade, age at presentation and abnormal toileting habits or bladder obstruction. Thus, a favorable resolution rate can be predicted for children who are younger at presentation, who have lower grade VUR (grade III or less) and who have unilateral VUR. Most VUR resolves within 4 years but some cases resolve after 5 or more years of followup, especially in the absence of interval improvement.¹⁷

Given the natural history of VUR, initial management in the majority of cases relies on preventing UTI, which is the etiology of acquired renal scars in VUR, by daily administration of low doses of antibiotic. Extended prophylactic antibiotic therapy is generally well tolerated in children and it rarely needs to be discontinued.

Differences of opinion exist regarding the indications for surgical correction of VUR, particularly since the advent of minimally invasive options. Classic indications are grade V reflux that does not resolve after a year of surveillance, and acute pyelonephritis with fever and positive urine culture despite compliance with daily antibiotic prophylaxis. Some clinicians contend that VUR should be corrected only if there is evidence of renal inflammation on renal scan. Open surgical correction of uncomplicated VUR can typically be accomplished with a greater than 95% success rate, while comparable success (85%) can be achieved by endoscopic implantation of dextranomer/hyaluronic acid paste (Deflux).

Ureterocele, which are often associated with VUR, may be identified in as many as 1/500 children, almost exclu-

sively white children. Ureterocele occurs in association with ureteral duplication in 80% of cases with the ureter to the upper pole of the kidney affected and it is bilateral in 15% of cases. In 20% of cases the ureterocele is associated with a single ureter. Ureterocele are associated with duplex systems in 95% of cases in girls, while in boys only 44% of cases involve duplex systems.¹⁸

Although it is somewhat controversial, management for ureterocele is predicated on preserving renal function. It considers whether the ureterocele is associated with a single or double system, associated VUR or renal obstruction and the degree of renal dysfunction, if any.¹⁸

MATERIALS AND METHODS

The analytical methods used to generate these results were described previously.^{19,20}

RESULTS

Trends in Health Care Use

Inpatient. Data from HCUP revealed that for children 18 years or younger annual inpatient hospitalizations for VUR increased slightly between 1994 and 2000 from 6.4/100,000 to 7.0/100,000 (table 1), although this trend did not attain statistical significance. This increasing trend was noted in girls and boys with the ratio of girls-to-boys remaining relatively constant at 3:1. The ratio of white-to-Hispanic children hospitalized for VUR also remained constant at 3:2. Data from HCUP KID on 1997 and 2000 provided insight into inpatient visits for each age group (younger than 3, 3 to 10 and 11 to 17 years, table 2). KID is based on a sample of pediatric discharges from community hospitals in the United States. Because it samples

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