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# Vesicoureteral Reflux and Ureterocele

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**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*

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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.<sup>1</sup> 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.<sup>2-7</sup>

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

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.<sup>14,15</sup> 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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Submitted for publication October 10, 2006.

Supported by National Institutes of Health N01-DK-1-2460.

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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.<sup>16</sup>

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.<sup>17</sup>

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.<sup>18</sup>

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.<sup>18</sup>

## MATERIALS AND METHODS

The analytical methods used to generate these results were described previously.<sup>19,20</sup>

## 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

TABLE 2. Inpatient hospital stays for VUR as primary diagnosis in 2000

	1997			2000		
	Count	Rate (95% CI)	% All Hospitalizations	Count	Rate (95% CI)	% All Hospitalizations
Totals	6,290	8.8 (7.4–10)	0.10	7,210	10 (8.3–12)	0.11
Age (yrs):						
Younger than 3	2,029	17 (13–21)	0.04	2,236	19 (15–23)	0.05
3–10	3,698	11 (9.8–13)	0.56	4,250	13 (11–15)	0.75
11–17	564	2.1 (1.7–2.4)	0.06	723	2.6 (2.0–3.1)	0.08
Race/ethnicity:						
White	Not available	Not available	Not available	4,678	10 (8.2–12)	0.16
Black	Not available	Not available	Not available	132	1.2 (0.8–1.6)	0.02
Hispanic	Not available	Not available	Not available	811	6.9 (4.7–9.2)	0.08
Sex:						
M	1,747	4.8 (3.8–5.7)	0.05	1,815	4.9 (4.0–5.8)	0.06
F	4,544	13 (11–15)	0.14	5,395	15 (13–18)	0.17
Region:						
Midwest	1,065	6.3 (4.2–8.4)	0.07	1,117	6.4 (3.9–9.0)	0.08
Northeast	1,691	13 (6.0–20)	0.14	1,694	13 (5.7–20)	0.14
South	1,790	7.3 (4.6–10)	0.08	2,511	10 (7.2–13)	0.11
West	1,744	10 (7.4–13)	0.12	1,888	11 (7.5–14)	0.13
MSA:						
Rural	189	1.2 (0.7–1.6)	0.02	182	1.2 (0.6–1.8)	0.02
Urban	6,101	11 (9.2–13)	0.11	6,996	12 (10–14)	0.13

Rate per 100,000 based on 2000 population estimates from CPS, CPS Utilities, Unicon Research Corp. for relevant demographic categories of civilian noninstitutional population younger than age 18 years in the United States and individuals of other races and with missing race and ethnicity, and missing MSA included in the total (counts may not sum to total due to rounding) (source: HCUP KID, 2000).

only pediatric discharges, KID allows more in-depth analysis of pediatric resource use than is available in the HCUP data set of all ages. KID for 2000 includes 2,784 hospitals from 27 states. KID for 1997 includes 2,521 hospitals from 22 states. These data confirmed the general trend toward more inpatient visits across all age groups, although the trend did not attain statistical significance. Regionally the rates were relatively constant.

According to HCUP data inpatient hospitalization for ureterocele 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, table 3). The rate of inpatient hospitalization was similar for males and females (1.0/100,000 to 1.1/100,000 children) and it varied little between 1994 and 2000. Of inpatient admissions 77% were white children. However, there were no signif-

TABLE 3. Inpatient hospital stays for ureterocele 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	2,786	1.1 (1.0–1.2)	1.1	2,848	1.1 (1.0–1.2)	1.1	3,018	1.1 (1.0–1.2)	1.1	2,818	1.0 (0.9–1.2)	1.0
Age (yrs):												
Younger than 18	257	0.4 (0.2–0.5)		376	0.5 (0.4–0.7)		525	0.7 (0.5–0.9)		494	0.7 (0.4–1.0)	
18–24	*	*		167	0.7 (0.4–0.9)		*	*		169	0.6 (0.4–0.9)	
25–34	320	0.8 (0.6–1.0)		350	0.9 (0.7–1.1)		359	0.9 (0.7–1.2)		224	0.6 (0.4–0.8)	
35–44	504	1.2 (1.0–1.5)		467	1.1 (0.8–1.3)		437	1.0 (0.8–1.2)		373	0.8 (0.6–1.0)	
45–54	413	1.4 (1.0–1.8)		377	1.2 (0.9–1.5)		376	1.1 (0.8–1.4)		424	1.2 (0.9–1.4)	
55–64	316	1.6 (1.1–2.0)		330	1.6 (1.2–2.0)		322	1.4 (1.0–1.9)		290	1.2 (0.9–1.6)	
65–74	475	2.7 (2.1–3.3)		386	2.1 (1.6–2.6)		426	2.4 (1.8–3.0)		398	2.2 (1.8–2.7)	
75 or Older	354	2.8 (2.1–3.6)		393	2.9 (2.2–3.7)		416	2.3 (2.2–3.6)		448	3.0 (2.3–3.7)	
Race/ethnicity:												
White	1,692	0.9 (0.8–1.0)	0.9	1,738	0.9 (0.8–1.0)	0.9	1,657	0.9 (0.8–1.0)	0.8	1,578	0.8 (0.7–0.9)	0.8
Black	279	0.9 (0.6–1.1)	1.0	238	0.7 (0.5–0.9)	0.8	256	0.8 (0.6–1.0)	0.8	220	0.6 (0.4–0.9)	0.8
Hispanic	204	0.8 (0.5–1.1)	1.1	252	0.9 (0.6–1.1)	1.2	219	0.7 (0.5–0.9)	1.1	248	0.8 (0.5–1.0)	0.9
Sex:												
M	1,423	1.2 (1.0–1.3)	1.2	1,359	1.1 (0.9–1.2)	1.1	1,546	1.2 (1.0–1.4)	1.2	1,308	1.0 (0.8–1.1)	1.0
F	1,363	1.0 (0.9–1.2)	1.0	1,489	1.1 (0.9–1.3)	1.1	1,473	1.1 (0.9–1.2)	1.0	1,510	1.1 (0.9–1.2)	1.1
Region:												
Midwest	638	1.1 (0.8–1.3)	1.1	714	1.2 (0.9–1.4)	1.2	773	1.2 (1.0–1.5)	1.2	598	0.9 (0.8–1.1)	1.0
Northeast	610	1.2 (0.9–1.5)	1.1	637	1.2 (0.9–1.5)	1.2	596	1.2 (0.8–1.5)	1.1	516	1.0 (0.8–1.2)	1.0
South	1,129	1.3 (1.1–1.6)	1.3	1,066	1.2 (1.0–1.3)	1.2	1,169	1.2 (1.0–1.4)	1.2	1,095	1.1 (1.0–1.3)	1.1
West	409	0.7 (0.5–0.9)	0.8	430	0.7 (0.5–1.0)	0.8	480	0.8 (0.6–1.0)	0.8	610	1.0 (0.7–1.3)	1.0
MSA:												
Rural	540	0.8 (0.6–1.1)	0.8	439	0.7 (0.6–0.9)	0.7	571	1.0 (0.7–1.2)	0.9	451	0.8 (0.6–0.9)	0.7
Urban	2,230	1.2 (1.0–1.3)	1.2	2,402	1.2 (1.0–1.3)	1.2	2,434	1.2 (1.0–1.3)	1.2	2,367	1.1 (1.0–1.2)	1.1

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.

TABLE 4. Trends in mean inpatient length of stay in days and cost in children admitted with ureterocele as primary diagnosis from 1999 to 2003

	Count (%)	Stay (days)	Mean Cost/Child (\$)
Totals	473	3.3	7,669
Age (yrs):			
0-2	433 (92)	3.3	7,576
3-10	37 (8)	3.5	8,716
11-17	3 (1)	4.3	8,219
Race/ethnicity:			
Asian	6 (1)	2.5	5,891
Black	25 (5)	3.1	7,465
Hispanic	66 (14)	3.4	7,075
Missing	23 (5)	3.3	7,799
Other	52 (11)	2.8	7,171
White	301 (64)	3.4	7,928
Sex:			
F	336 (71)	3.3	7,593
M	137 (29)	3.2	7,858
Region:			
Northeast	75 (16)	3.6	8,834
Midwest	115 (24)	3.2	7,812
South	176 (37)	3.4	7,630
West	107 (23)	2.9	6,765

Primary diagnosis ICD-9 code 753.23 (source: NACHRI, 1999 to 2003).

icant differences in the rate of hospitalization among ethnic/racial groups, suggesting that, although ureteroceles occur more commonly in white children, the natural history is independent of race. Averaging across the years shown in table 3, annual inpatient admissions for ureteroceles were highest in the South (1,115), intermediate in the Northeast and Midwest (590 and 681, respectively) and lowest in the West (482). Age adjusted rates differed little among regions or across study years.

In NACHRI data from 1999 to 2001, 92% of admissions were children younger than 2 years and 8% were 3 to 10-year-old children. The average inpatient stay for ureteroceles was independent of age at 3.3 days, which was consistent with uncomplicated postoperative recovery fol-

TABLE 6. Physician office visits for VUR

Diagnosis	1992-2000			
	Count	Rate (95% CI)	Av Annualized Rate/Yr	Age Adjusted Rate
Primary	418,954	160 (73-247)	32	159
Any	700,489	268 (139-396)	54	266

Rate per 100,000 based on 1992, 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 and age adjusted rate adjusted to the United States Census derived age distribution of the mid point of years (source: National Ambulatory Medical Care Survey, 1992, 1994, 1996, 1998 and 2000).

lowing open surgery for upper or lower urinary tract reconstruction. Average length of stay was not statistically different when stratified by sex, race or region (tables 4 and 5).

**Outpatient care.** For physician office visits data from the National Ambulatory Medical Care Survey indicated that during the 5 years sampled between 1992 and 2000, 418,954 office visits (32/100,000 yearly) were associated with VUR as the primary diagnosis (table 6). Tables 7 and 8, and figures 1 and 2 show CHCPE data on visits by children insured commercially or through Medicaid for whom VUR was listed as the primary diagnosis. 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). During this period visit rates for children with Medicaid were higher than for those with commercial insurance. This difference is probably not explained by greater VUR severity among Medicaid participants. Rather, socioeconomic factors may have influenced compliance with treatment, leading to more frequent office visits for managing VUR complications. Of commercially insured children the ratio of out-

TABLE 5. Inpatient hospital stays for ureterocele as primary diagnosis in 1997 and 2000

	1997				2000			
	Count	Rate (95% CI)	Age Adjusted Rate	% All Hospitalizations	Count	Rate (95% CI)	% All Hospitalizations	
Totals	608	0.8 (0.7-1.0)	0.8	0.01	604	0.8 (0.7-1.0)	0.01	
Age (yrs):								
Younger than 3	321	2.7 (2.1-3.4)		0.01	350	3.0 (2.2-3.7)	0.01	
3-10	173	0.5 (0.4-0.7)		0.03	157	0.5 (0.4-0.6)	0.03	
11-17	114	0.4 (0.2-0.6)		0.01	96	0.3 (0.2-0.5)	0.01	
Race/ethnicity:								
White	Not available	Not available		—	359	0.8 (0.6-1.0)	0.01	
Black	Not available	Not available		—	36	*	0.00	
Hispanic	Not available	Not available		—	78	0.7 (0.4-0.9)	0.01	
Sex:								
M	255	0.7 (0.5-0.9)	0.7	0.01	285	0.8 (0.6-0.9)	0.01	
F	353	1.0 (0.8-1.2)	1.0	0.01	319	0.9 (0.7-1.1)	0.01	
Region:								
Northeast	144	1.1 (0.6-1.6)	1.2	0.01	99	*	0.01	
Midwest	136	0.8 (0.4-1.2)	0.8	0.01	132	1.0 (0.5-1.5)	0.01	
South	189	0.8 (0.5-1.1)	0.8	0.01	227	0.9 (0.7-1.2)	0.01	
West	139	0.8 (0.6-1.1)	0.8	0.01	146	0.8 (0.5-1.2)	0.01	
MSA:								
Rural	23	*	*	0.00	15	*	0.00	
Urban	586	1.1 (0.9-1.3)	1.0	0.01	589	1.0 (0.8-1.2)	0.01	

Rate per 100,000 based on 1997 population estimates from CPS, CPS Utilities, Unicon Research Rate Corp. for relevant demographic categories of civilian noninstitutional population younger than 18 years in the United States, age adjusted rate adjusted to 2000 United States Census and individuals of other races, and with missing race and ethnicity included in the totals (counts may not sum to total due to rounding and race/ethnicity breakdown not included because of large percent of missing values in 1997) (source: HCUP KID, 1997 and 2000).

\* Value does not meet reliability or precision standard.

TABLE 7. Visits for VUR as primary diagnosis for children with commercial health insurance

	1994		1996		1998		2000		2002	
	Count	Rate	Count	Rate	Count	Rate	Count	Rate	Count	Rate
	<i>Physician office</i>									
Totals	123	12	239	15	536	22	655	24	617	26
Age (yrs):										
Younger than 3	33	*	83	143	182	207	232	243	228	305
3-10	59	41	119	58	268	88	333	103	321	124
11-17	11	*	13	*	53	20	48	16	32	13
Sex:										
M	29	*	65	8.3	122	10	150	11	145	12
F	94	17	174	22	414	34	505	37	472	41
Region:										
Midwest	95	15	147	17	250	21	287	21	287	23
Northeast	6	*	16	*	56	28	46	28	22	*
Southeast	9	*	60	14	207	22	300	28	294	32
West	13	*	16	*	23	*	22	*	14	*
	<i>Emergency room</i>									
Totals	0	*	1	*	2	*	0	*	0	*
Age (yrs):										
Younger than 3	0	*	0	*	1	*	0	*	0	*
3-10	0	*	0	*	0	*	0	*	0	*
11-17	0	*	0	*	0	*	0	*	0	*
Sex:										
M	0	*	1	*	0	*	0	*	0	*
F	0	*	0	*	2	*	0	*	0	*
Region:										
Midwest	0	*	0	*	1	*	0	*	0	*
Northeast	0	*	0	*	1	*	0	*	0	*
Southeast	0	*	0	*	0	*	0	*	0	*
West	0	*	1	*	0	*	0	*	0	*
	<i>Inpt</i>									
Totals	32	3.0	66	4.2	74	3.0	100	3.7	66	2.8
Age (yrs):										
Younger than 3	7	*	14	*	12	*	21	*	16	*
3-10	17	*	35	17	48	16	66	20	42	16
11-17	3	*	5	*	9	*	8	*	4	*
Sex:										
M	4	*	12	*	11	*	20	*	17	*
F	28	*	54	6.8	63	5.2	80	5.9	49	4.2
Region:										
Midwest	21	*	39	4.4	33	2.8	52	3.8	35	2.8
Northeast	4	*	4	*	10	*	7	*	4	*
Southeast	1	*	19	*	28	*	36	3.3	23	*
West	6	*	4	*	3	*	5	*	4	*
	<i>Hospital outpt</i>									
Totals	15	*	28	*	52	2.1	36	1.3	49	2.1
Age (yrs):										
Younger than 3	4	*	6	*	16	*	12	*	18	*
3-10	9	*	16	*	28	*	16	*	26	*
11-17	2	*	2	*	5	*	5	*	1	*
Sex:										
M	2	*	9	*	9	*	9	*	13	*
F	13	*	19	*	43	3.5	27	*	36	3.1
Region:										
Midwest	14	*	25	*	47	3.9	26	*	27	*
Northeast	0	0	0	0	2	*	2	*	1	*
Southeast	0	0	2	*	2	*	8	*	21	*
West	1	*	1	*	1	*	0	0	0	0
	<i>Ambulatory surgery</i>									
Totals	14	*	22	*	82	3.4	117	4.3	113	4.8
Age (yrs):										
Younger than 3	1	*	2	*	17	*	36	38	33	44
3-10	9	*	14	*	42	14	56	17	68	26
11-17	1	*	0	*	11	*	7	*	7	*
Sex:										
M	4	*	3	*	21	*	28	*	21	*
F	10	*	19	*	61	5.0	89	6.5	92	7.9
Region:										
Midwest	9	*	17	*	32	2.7	46	3.4	36	2.9
Northeast	0	*	1	*	23	*	28	*	5	*
Southeast	5	*	3	*	21	*	42	3.9	57	6.2

Rate per 100,000 based on member months of enrollment in calendar years for males in the same demographic stratum (source: CHCPE, 1994, 1996, 1998, 2000 and 2002).

\* Value does not meet reliability or precision standard.

patient visits by girls to visits by boys was constant at 3:1 (fig. 3). This trend could not be analyzed for children with Medicaid because Medicaid data did not meet reliability

or precision criteria. Regional data on commercially insured children showed relatively constant rates during the years that could be evaluated (fig. 1).

TABLE 8. Visits for VUR as primary diagnosis for children with Medicaid health insurance

	1994		1996		1998		2000		2002	
	Count	Rate	Count	Rate	Count	Rate	Count	Rate	Count	Rate
Physician office:	7	*	39	43	59	103	58	85	32	60
Age (yrs):										
Younger than 3	4	*	20	*	28	*	30	306	10	*
3-10	3	*	17	*	26	*	27	*	19	*
11-17	0	*	1	*	5	*	1	*	2	*
Sex:										
F	5	*	20	*	29	*	38	92	25	*
M	2	*	19	*	30	136	20	*	7	*
Region:										
Midwest	6	*	10	*	2	*	1	*	0	*
Northeast	0	*	27	*	39	110	36	88	28	*
Southeast	0	*	0	0	0	*	0	*	0	*
West	1	*	2	*	18	*	21	*	4	*
Emergency room	0	*	0	*	0	*	2	*	0	*
Inpt	4	*	6	*	4	*	9	*	5	*
Hospital outpt	0	0	2	*	2	*	1	*	18	*
Ambulatory surgery	1	*	3	*	16	*	28	*	18	*

Rate per 100,000 based on member months of enrollment in calendar years for males in the same demographic stratum (source: CHCPE, 1994, 1996, 1998, 2000 and 2002).  
Value does not meet reliability or precision standard.

CHCPE data on ambulatory surgery visits by children with VUR as the primary diagnosis demonstrated a trend toward increasing outpatient surgical procedures. 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 (table 7). Similar estimates were not available for children covered by Medicaid (table 8). The increase in ambulatory surgery for VUR may represent more patients electing Deflux implantation instead of

open surgical correction and/or more repeat Deflux procedures. Data from the National Survey of Ambulatory Surgery on 1994, 1995 and 1996 reflected an annualized rate of implantation of 0.6/100,000 children (table 9). Approximately two-thirds of these cases were associated with procedure codes for cystoscopy, of which most predated Food and Drug Administration approval of Deflux. Few diagnostic cystoscopies are performed on children with VUR but our anecdotal review of current use suggested increased use of therapeutic cystoscopic procedures.

Emergency room use by children with a primary diagnosis of VUR 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 ureterocele treatment.

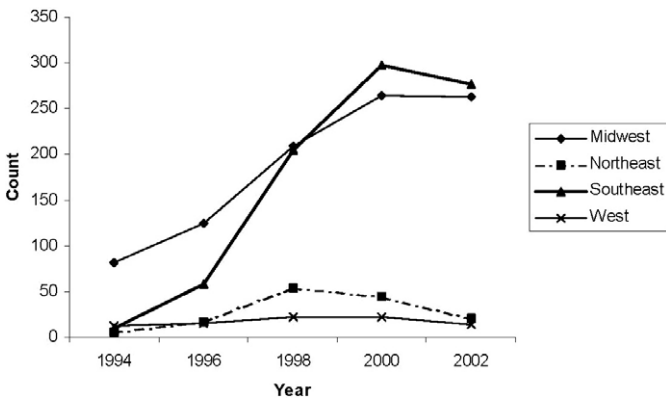


FIG. 1. Physician outpatient visits for children with VUR and commercial health insurance by region. Source: CHCPE, 1994, 1996, 1998, 2000 and 2002.

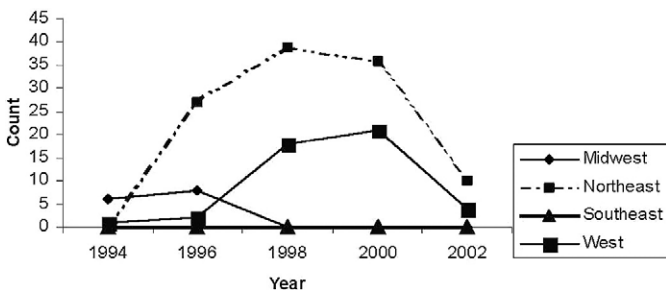


FIG. 2. Physician outpatient visits for children with VUR and Medicaid I health insurance by region. Source: CHCPE, 1994, 1996, 1998, 2000 and 2002.

**Economic Impact**

The economic burden of VUR was estimated by combining data from several sources. NACHRI provided data on the

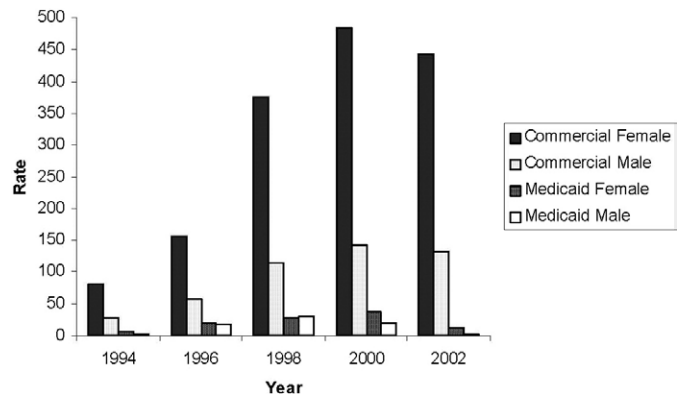


FIG. 3. Physician outpatient visits for children with VUR and commercial or Medicaid health insurance by gender. Source: CHCPE, 1994, 1996, 1998, 2000 and 2002.

TABLE 9. 1994–1996 ambulatory surgery visits for VUR as primary diagnosis

	Count	Rate (95% CI)	Av Annualized Rate/Yr	Rate/100,000 Visits (95% CI)
Totals	4,928	1.9 (1.1–2.7)	0.6	100,000 (57,082–142,918)
With associated primary diagnosis cystoscopy (ICD-9 5732)	3,387	1.3 (0.6–2.0)	0.4	66,730 (33,868–103,592)

Rate per 100,000 based on 1994 to 1996 population estimates from CPS, CPS Utilities, Unicon Research Corp. for relevant demographic categories of civilian noninstitutionalized population in the United States and rate per 100,000 based on estimated number of visits for VUR in National Survey of Ambulatory Surgery, 1994 to 1996 (source: National Survey of Ambulatory Surgery, 1994, 1995 and 1996).

mean cost of treating a child with a primary diagnosis of VUR in 1999 to 2003 and HCUP KID provided information on the number of pediatric inpatient hospitalizations for VUR in 1997 and 2000 (table 10). The average cost per hospitalization derived from NACHRI was applied to case counts reported in HCUP KID to calculate annual national estimates for inpatient pediatric VUR expenditures by sex, age and region. NACHRI data represent practices at specific children hospitals and, thus, they may differ from data on practice at community hospitals.

In 2000 total expenditures for inpatient pediatric VUR were \$47 million, an increase of more than \$10 million since 1997 (table 10). Expenditures increased between 1997 and 2000 for all ages and regions, and for the 2 sexes. The increase between 1997 and 2000 was particularly large in the South, where expenditures increased by 56%. Inpatient pediatric VUR costs were greatest in 3 to 10-year-old children, primarily because of the large number of cases in this group. Inpatient cases of VUR were most costly in 11 to 17-year-old children, totaling \$7,699 in 2000. The cost of an inpatient VUR case was slightly higher for males than for females but there were almost 3 times as many female cases, leading to higher overall costs for female patients. High spending in the South was the result of a moderate cost per case but a high number of cases, while expenditures in the Northeast reflected a high cost per case and only a moderate number of cases. Costs were low in the Midwest because of the relatively small number of cases there.

The economic impact of inpatient treatment for pediatric VUR was considerable (tables 10 and 11). 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 were not considered in this estimate. Furthermore, indirect economic costs, such as work loss to parents of pediatric VUR cases, were not considered, causing even greater underestimation of the true costs associated with the condition.

Although NACHRI and HCUP KID include data on ureteroceles, the data were limited. Thus, they could not be used to determine reliable cost trends.

Available data indicated that the mean cost per ureterocele case was almost \$8,000 with little variation observed across ages, regions or sexes (table 4). For the 604 cases of ureterocele in 2000 in HCUP KID national inpatient expenditures were an estimated \$4 million (table 5).

**CONCLUSIONS**

The economic impact of VUR is considerable and it is estimated to be \$47 million based on 2000 data. The cost increased by \$10 million in 3 years (1997 vs 2000). There appeared to be regional differences in cost of care and in the rate of yearly increases in the cost of care. There is a paucity of data on Medicaid insured children with VUR, which should stimulate further research on identifying potential inequities in care, perhaps due to issues surrounding access to care. These data do not identify cost-effective treatment strategies and further research in this field is necessary.

Available ureterocele data were limited. There appeared to be little regional variation in treatment cost per case. The incidence of ureteroceles has remained relatively constant.

TABLE 10. Cost per child admitted with VUR as primary diagnosis

	1997			2000		
	Cost/Pt (\$)	No. Cases	Estimated Total Cost (\$)	Cost/Pt (\$)	No. Cases	Estimated Total Cost (\$)
Totals	5,892	6,290	37,061,475	6,551	7,210	47,230,671
Age (yrs):						
0–2	6,008	2,029	12,188,151	6,680	2,236	14,937,974
3–10	5,700	3,698	21,081,036	6,338	4,250	26,938,748
11–17	6,925	564	3,902,218	7,699	723	5,568,983
Sex:						
F	5,617	4,544	25,523,411	6,246	5,395	33,694,918
M	6,726	1,747	11,749,518	7,479	1,815	13,574,641
Region:						
Northeast	7,607	1,691	12,864,860	8,458	1,694	14,324,996
Midwest	6,046	1,065	6,438,820	6,722	1,117	7,510,553
South	5,451	1,790	9,757,451	6,060	2,511	15,218,755
West	5,141	1,744	8,965,905	5,716	1,888	10,790,123

Primary diagnosis using ICD-9 codes 593.70, 593.71, 593.72 and 593.73 (2 cases not coded for gender) (source: HCUP KID, 2000 and NACHRI, 1999 to 2003).

TABLE 11. Trends in mean inpatient length of stay and cost per child hospitalized with VUR in 1999 to 2003

	Count (%)	Stay (days)	Mean Cost (\$)
<i>Primary diagnosis</i>			
Totals	14,629	2.7	6,852
Age (yrs):			
0-2	4,424 (30)	2.9	6,987
3-10	9,058 (62)	2.6	6,629
11-17	1,090 (7)	3.1	8,053
18 or Older	57 (0)	3.3	8,768
Race/ethnicity:			
Asian	161 (1)	2.9	7,682
Black	313 (2)	3.5	8,395
Hispanic	1,338 (9)	3.0	6,741
Missing	797 (5)	2.6	6,567
Other	1,248 (9)	2.7	7,170
White	10,744 (73)	2.6	6,792
North American native	28 (0)	2.8	6,968
Sex:*			
F	11,012 (75)	2.6	6,533
M	3,616 (25)	3.1	7,823
Region:			
Northeast	2,132 (15)	3.3	8,847
Midwest	4,403 (30)	2.8	7,031
South	5,628 (38)	2.6	6,339
West	2,466 (17)	2.4	5,979
<i>Any diagnosis</i>			
Totals	28,777	5.5	12,230
Age (yrs):			
0-2	13,931 (48)	7.7	16,476
3-10	12,641 (44)	3.2	7,654
11-17	2,061 (7)	4.7	11,579
18 or Older	144 (1)	5.0	12,479
Race/ethnicity:			
Asian	389 (1)	6.2	13,021
Black	1,411 (5)	9.0	17,896
Hispanic	3,610 (13)	5.9	12,263
Missing	1,406 (5)	5.7	12,208
Other	2,228 (8)	6.1	14,213
White	19,664 (68)	5.1	11,541
North American native	69 (0)	10.6	22,731
Sex:*			
F	19,075 (66)	4.6	10,139
M	9,700 (34)	7.3	16,341
Region:			
Northeast	3,285 (11)	4.8	11,717
Midwest	9,062 (31)	5.6	12,534
South	11,757 (41)	5.7	12,113
West	4,673 (16)	5.3	12,293

Primary diagnosis using ICD-9 codes 593.70, 593.71, 593.72, and 593.73 (source: NACHRI, 1999 to 2003).  
\* Three cases not coded.

**Abbreviations and Acronyms**

CHCPE	=	Center for Health Care Policy and Evaluation
CPS	=	Current Population Survey
HCUP	=	Health Care Cost and Utilization Project
ICD-9	=	International Classification of Diseases, 9th revision
KID	=	Kids' Inpatient Database
MSA	=	metropolitan statistical area
NACHRI	=	National Association of Children's Hospitals and Related Institutions
NAMCS	=	National Ambulatory Medical Care Survey
UTI	=	urinary tract infection
VUR	=	vesicoureteral reflux

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