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ORIGINAL ARTICLE

Physician preference is a major factor in management of vesicoureteral reflux

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Abstract
Background Known factors affecting the management of vesicoureteral reflux (VUR) include reflux grade, infection frequency, age and gender. We hypothesized that provider preference is highly associated with management.
Methods Utilizing the national billing database, Faculty Practice Solutions Center, a multivariable logistic regression model, was applied to analyze the association of pediatric urologist treatment patterns, patient age, gender, uni- or bilateral disease, insurance type, presence of nephropathy and race with the type of VUR treatment a patient would receive.
Results We identified 59 pediatric urologists who managed 7,882 new reflux patients from 2009 to 2011. Over this 3-year period there was wide variation in surgical utilization between surgeons (mean 50 %) but minimal change for each surgeon (5 %). For every 100 new reflux patients, median utilization of reimplantation surgery and injection of dextranomer/hyaluronic acid copolymer (Deflux) was 26 and 20 %, respectively. Age ranked highest in predicting surgical versus non-surgical management, while a surgeon's historic Deflux utilization rate ranked highest in predicting surgery type. Older age, female gender and white race also increased the odds of Deflux utilization over reimplantation.
Conclusions A surgeon's historic Deflux utilization was the most important predictor of VUR surgery type. Although data on reflux grade were not available, analysis of patient and surgeon characteristics suggests that surgeon preference is the first or second most critical factor in determining a patient's treatment.

Keywords Vesicoureteral reflux · Deflux · Ureteral reimplantation · Ureter · Surgery

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Introduction

Standard management of primary vesicoureteral reflux (VUR) in the pediatric population includes observation, prophylactic antibiotics, subureteric injection of Deflux (dextranomer/hyaluronic acid copolymer) or ureteral reimplantation. Commonly known factors affecting the management choice include the grade of reflux, frequency and severity of urinary tract infection, age and gender. There are no current guidelines on the use of each treatment modality and, therefore, there is a high variability in the treatment of VUR [1]. Provider characteristics have been shown to be highly predictive of treatment choices for adult patients with urologic disorders such as prostate cancer, incontinence and renal masses and in those needing urinary diversion [2–5]. Based upon the wide variation of Deflux utilization, we hypothesized that provider preference might be the most critical factor in the ultimate management of patients with reflux.

Materials and methods

Materials

The Faculty Practice Solutions Center (FPSC) was initiated by an alliance between the University Health System Consortium (UHC) and the Association of American Medical Colleges (AAMC) in 2001 in an effort to collect benchmarking data on academic clinical practices throughout the country. Its goal is

to improve clinical performance and outcomes. More than 90 institutions nationwide with over 60,000 physicians are associated with the FPSC. Coding data include hospital, de-identified provider and specialty, patient identification, as well as date of birth, gender and race, Current Procedural Terminology (CPT) codes, International Classification of Diseases book 9 (ICD-9) diagnosis billing codes, service date, site of service, payer category and much more. FPSC is unique not only for its large scale of data capture, but also for its role in tracking billing information, which offers a more reliable reflection of practice patterns with both the CPT and ICD-9 codes.

Methods

The FPSC database designates specialty and urology, but not subspecialty. Pediatric urologists were identified as those urologists who performed at least three orchiopexies (CPT 54640) or three hypospadias repairs (CPT 54324) in 2009. The orchiopexy code we used (54640) is specific for orchiopexies performed for undescended testes. In order to exclude the possibility of capturing orchiopexies performed by adult urologists, we did not include orchiopexies done for emergent torsion (CPT codes 54600, 54620). New patients seen by these physicians in 2009 were identified using the new consult or new patient CPT codes: 99201–99205 and 99241–99245. VUR patients with and without nephropathy were identified by ICD-9 codes 593.7 and 593.71–73, respectively. Information on reflux grade and history of urinary tract infection (UTI) was not available in this database.

Based on 2009 data, five variables were calculated to characterize the practice pattern of each physician. The number of patients treated with reimplantation or Deflux in 2009 divided by the number of new consults seen in 2009 is designated R/P or D/P, respectively (Fig. 1). The number of surgical patients treated with reimplantation or with Deflux is designated R/S or D/S, respectively. All four proportions are given as a percentage.

To determine whether the participating physicians' practice patterns in 2009 were predictive of treatment choices in the future, we evaluated patients with VUR who saw these physicians for an initial consultation in 2010 to determine if these patients had a Deflux or reimplantation procedure in 2010 or 2011. Deflux procedures were identified using the CPT code 52327, and reimplantation procedures were identified using CPT codes 50780 and 50782. We excluded laparoscopic ureteral reimplantation (CPT codes 50947, 50948) since this procedure is not considered standard practice and was only performed on ten occasions over 3 years. Exclusion criteria included patients aged >10 years, those bearing diagnosis codes associated with posterior urethral valves, neurogenic bladder, spina bifida, ureterocele, ureteropelvic junction

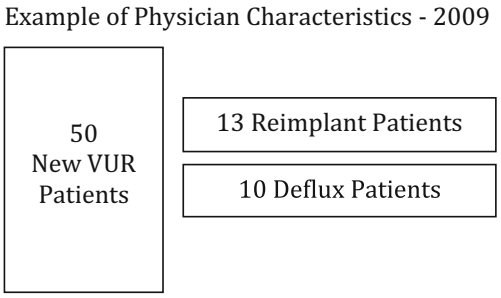

Fig. 1 Example of physician characteristics in 2009. *VUR* Vesicoureteral reflux, *Deflux* dextranomer/hyaluronic acid copolymer, *R/P*, *D/P* number of patients treated with reimplantation or Deflux in 2009 divided by the number of new consults seen in 2009 ($n = 50$), respectively, expressed as a percentage, *R/S*, *D/S* Number of surgical patients ($n = 23$) treated with reimplantation or with Deflux, expressed as a percentage

obstruction, hypospadias, spinal cord injury, sacral agenesis, VATER syndrome, urethral fistula, bladder fistula, bladder exstrophy, traumatic ureteral, bladder or urethral injury, prune belly syndrome, renal agenesis or solitary kidney. In addition, those patients with concomitant procedure codes associated with bladder augmentation, valve ablation, ureterocele excision or incision, and other ureteral surgery were excluded.

Statistical analyses

In order to examine the magnitude of variability between surgeons, mixed effects models were fitted to practice pattern metrics [D/P, R/P, D/S, R/S and D/P+R/P (percentage of new patients treated with any surgery)] from 2009 through 2011. Each model included a fixed effect for year (in order to adjust for any overall time trends) and a random effect for surgeon. The joint effects of the 2009 D/P, R/P, D/S, R/S and D/P+R/P of the treating physician, patient age, gender, uni- or bilateral disease, insurance type, region, presence of nephropathy and race upon the treatment received between 2010 and 2011 were analyzed using multivariable logistic regression models incorporating random effects for physician and hospital.

The probability of a patient having reimplantation or Deflux was analyzed using two separate mixed effects logistic regression models. First, a model was fitted to all patients whether or not the patient received either surgical treatment as a binary outcome. Then, a model was fitted to data from

patients who received treatment using reimplantation versus Deflux as the binary outcome.

The D/P, R/P, D/S, R/S and D/P+R/P are highly correlated with one another. Therefore, rather than including all five of these numbers in each analysis, the Akaike Information Criterion (AIC) was used to select among models, including one or more of the D/P, R/P, D/S, R/S and D/P+R/P. The AIC is based on the likelihood ratio statistic, which measures how closely a statistical model fits the observed data. Results reported are for the "best" model for each analysis; i.e. the model with the smallest AIC [6].

Variable importance rank was calculated such that for a given ordering of the variables in a model, variables were added sequentially and the reduction in deviance for the addition of each variable was calculated [7, 8]. The reduction in deviance was then averaged over 1,000 randomly sampled permutations of the order in which variables could enter the model, and variables were ranked in order of average reduction in deviance. It should be noted that variable importance is a distinct concept from statistical significance and would not necessarily be expected to yield the same ranking of variables as one might get from a *p* value ordering [9].

Data extraction was conducted using SAS for Windows, version 9.3 (SAS Institute, Cary, NC). Statistical analyses were conducted using R, version 2.15.2, with mixed effects logistic regression modeling conducted using the R package lme4, version 0.999999-0 ® Foundation for Statistical Computing, Vienna, Austria).

Results

We identified 59 pediatric urologists who saw 7,882 new VUR patients from January 1, 2009 through to December 31, 2011. We found that each physician who met our criteria as a pediatric urologist performed a minimum of 20 elective orchiopexies per year and saw a minimum of 22 unique reflux patients per year. Table 1 illustrates representative demographics for 1 year—2010.

Surgeon practice patterns

There was a wide variation in surgical utilization between surgeons but minimal change for each individual surgeon over the 3-year period. Figures 2 and 3 show the percentage of new patients treated with Deflux (D/P) and percentage of surgical patients treated with Deflux (D/S) for each urologist from 2009 through to 2011.

For all of the metrics analyzed, variability between surgeons was a significant source of variation in the data. The between-surgeon standard deviations were significantly different from 0 (likelihood ratio test $P<0.001$, Table 2), and larger than the residual (within-surgeon) standard deviations in all cases.

Utilization of any surgery

The highest ranking predictor from 2010 to 2011 of surgical versus non-surgical treatment for new patients seen in 2010 was age. Mixed effects logistic regression analysis found that each additional year of age was associated with a 26 % increase in the odds of treatment versus observation ($P<0.001$) (Table 3). Second and fourth in importance ranking was physician practice patterns: for every 10 % increase in a physician's percentage of surgical patients treated with reimplantation (R/S), there was a 22 % increase in the odds of surgical treatment versus observation ($P=0.003$). In addition, for every 10 % increase in a physician's percentage of new patients treated with Deflux (D/P), there was a 34 % increase in odds of surgical treatment ($P=0.006$). Regional differences, which ranked third in importance ranking, did not affect the odds of a patient receiving surgery or observation. Nephropathy was identified in 19 % of reflux patients. A diagnosis of nephropathy was associated with a significantly higher (80 % increase) odds of surgical treatment ($P=0.038$) compared to the diagnosis of reflux without nephropathy.

Surgery type

For every 100 new reflux patients in 2009, surgeon median utilization of reimplantation (R/P) and Deflux (D/P) was 26 and 20 %, respectively (Table 4). The median reimplantation percentage of surgery patients (R/S) and Deflux percentage of surgery patients (D/S) was 63 and 38 %, respectively (Table 4). Among those who underwent surgery, the variable importance ranking found a surgeon's rate of new patients treated with Deflux (D/P) to be the highest predictor of surgery type.

Multivariable analysis performed in those patients treated surgically revealed that for every 10 % increase in a surgeon's percentage of new patients treated with Deflux (D/P), there was a 2.2-fold increased odds of a patient receiving Deflux injection over reimplantation ($P<0.001$). Similarly, for every 10 % increase in a surgeon's percentage of new patients treated with reimplantation (R/P), there was a 64 % increased odds of receiving a reimplant over Deflux ($P=0.001$). Furthermore, for each additional year of patient age, there was an associated 42 % increased odds of receiving Deflux over reimplantation ($p<0.001$) (Table 5). Male gender was associated with an 8-fold lower odds of receiving Deflux over reimplantation ($P=0.001$). In terms of importance of the variable in affecting treatment

Table 1 Patient and surgery characteristics by treatment (2010)

Treatment	Reimplantation	Deflux	No surgery
Median age at initial consult, years (range)	3.6 (0.1–9.9)	4.0 (0.0–9.9)	1.6 (0.0–9.9)
Race			
White	67 (29 %)	55 (45 %)	645 (32 %)
Asian	2 (1 %)	0	9 (<1 %)
Black	3 (1 %)	0	28 (1 %)
Hispanic	15 (7 %)	5 (4 %)	110 (5 %)
Native American	1 (<1 %)	0	1 (<1 %)
Other	13 (6 %)	5 (4 %)	75 (4 %)
Unknown	128 (56 %)	58 (47 %)	1,140 (57 %)
Gender			
Female	162 (71 %)	105 (85 %)	1,491 (74 %)
Male	67 (29 %)	15 (12 %)	490 (24 %)
Unknown	0	3 (2 %)	27 (1 %)
Insurance Type			
Commercial	137 (60 %)	74 (60 %)	1,222 (61 %)
Medicaid	76 (33 %)	39 (32 %)	617 (31 %)
Self Pay	4 (2 %)	3 (2 %)	66 (3 %)
Other	12 (5 %)	7 (6 %)	103 5 %)
Bilateral Procedure			
No	139 (61 %)	70 (57 %)	–
Yes	90 (39 %)	53 (43 %)	–

choice, a surgeon's percentage of new patients treated with Deflux (D/P) was ranked first, followed by gender (second) and age (third) . Lastly, non-white race was associated with a 3-fold lower odds of Deflux rather than reimplantation when compared to white patients (P=0.032).

Discussion

To our knowledge, this study is the first analysis which has attempted to identify management patterns of urologists treating children with VUR. Ferrer et al. evaluated 155 survey questionnaires returned by pediatric urologists and found general agreement in the diagnostic workup of VUR patients and

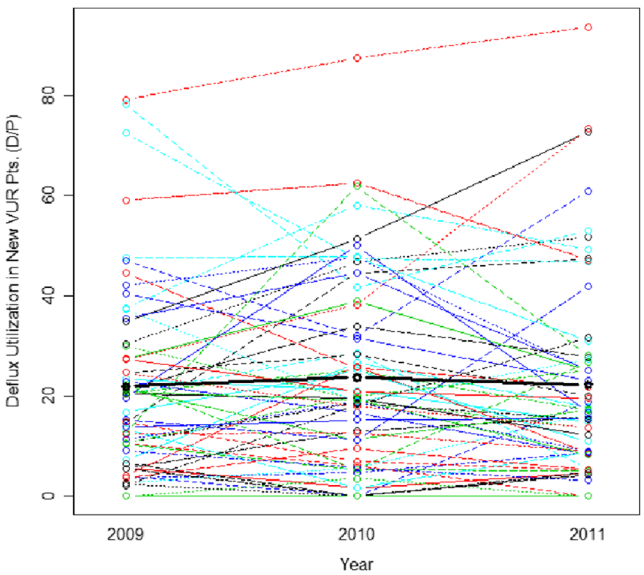

Fig. 2 Deflux utilization in new vesicoureteral reflux (*VUR*) patients over time for each urologist. Each *line* corresponds to a single urologist. *Bold line* Mean for each year

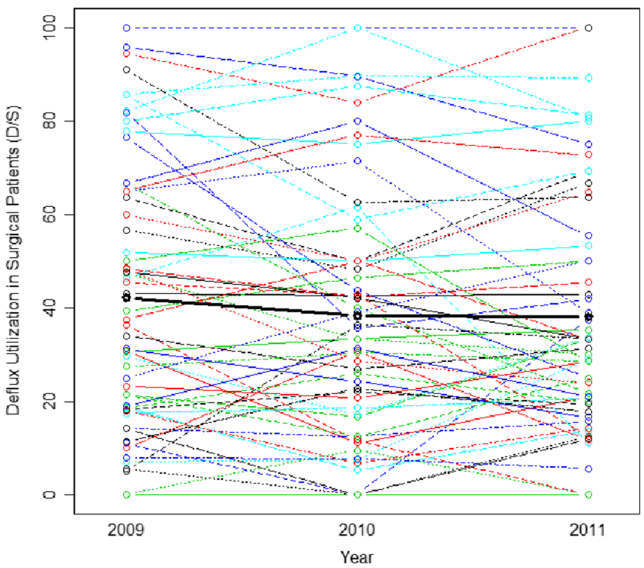

Fig. 3 Deflux utilization in surgical patients over time for each urologist. Each *line* corresponds to a single urologist. *Bold line* Mean for each year

Table 2 Between- and within-surgeon standard deviations of practice pattern metrics

Metrics[a]	Between-surgeon SD[b]	Within-surgeon SD[b]	Likelihood ratio test *P* value for surgeon effect
D/P	0.17	0.10	<0.001
R/P	0.24	0.20	<0.001
D/P+R/P	0.26	0.26	<0.001
D/S	0.26	0.11	<0.001
R/S	0.26	0.11	<0.001

[a] D/P, Percentage of new patients treated with Deflux (dextranomer/hyaluronic acid copolymer); R/P, percentage of new patients treated with reimplantation; D/S, percentage of surgical patients treated with Deflux; R/S, percentage of surgical patients treated with Deflux; D/P-R/P, percentage of new patients treated with any surgery

[b] The between-surgeon standard deviations (SD) were significantly different from 0 (likelihood ratio test $P<0.001$), and larger than the residual (within-surgeon) SDin all cases

those with febrile UTIs; however, the indications for treatment were not as clear [10]. While common reasons to choose surgical intervention include severity and frequency of UTI, renal scarring and persistence of reflux, no standard algorithm has been universally accepted. Furthermore, the choice of endoscopic or open surgical intervention lacks a specific algorithm and leaves the recommended procedure to the discretion of each surgeon. Our findings demonstrate that surgeons indeed differ greatly in their utilization of surgery for reflux. Our analysis presents true practice patterns in contrast to survey-based studies that rely upon opinion and memory.

Our results should be interpreted in light of a number of limitations. Most important is the absence of data on radiographic reflux grade, which is a major determining factor in VUR management. However, in our experience, the distribution of reflux grades between surgeons does not show significant variability. Moreover, our analysis of individual surgeons excludes institutional bias. Second, data on UTI frequency and severity were unavailable. Similar to VUR grade, it is assumed that for these large academic pediatric practices, there is a common distribution of UTI frequency. Third, patients who were seen by healthcare providers who do not choose surgery type, such as nurse practitioners or pediatric nephrologists, were not captured. Fourth, it is important to note that patients included in this study were referred with the diagnosis of reflux and,

Table 3 Logistic regression analysis of probability of any surgical treatment (Deflux or reimplantation) versus no surgical treatment

Variable	OR	*P* value	95 % CI for OR	Variable importance ranking[a]
Age (years)	1.26	<0.001	1.18; 1.34	1
R/S	1.02	0.003	1.01; 1.04	2
Region				
Midwest (referent)	1.00	–	–	3
Northeast	0.48	0.128	0.19; 1.23	
South	0.74	0.368	0.39; 1.42	
West	0.67	0.398	0.26; 1.70	
D/P	1.03	0.006	1.01; 1.05	4
Nephropathy				
No (referent)	1.00	–	–	5
Yes	1.80	0.038	1.03; 3.14	
Insurance type				
Commercial (referent)	1.00	–	–	6
Medicaid or self pay	1.15	0.506	0.77; 1.70	
All other	0.85	0.680	0.38; 1.89	
Gender				
Female (referent)	1.00	–	–	7
Male	1.17	0.475	0.76; 1.81	
Race				
White (referent)	1.00	–	–	8
Non-white	0.95	0.824	0.61; 1.49	

OR, Odds ratio; CI, confidence interval

[a] Based on average reduction in deviance when covariates were added to model sequentially, averaged over 1,000 randomly sampled permutations of variable ordering

Table 4 Physician characteristics (urologists included in multivariable analysis[a]

Physician characteristics	Median[b] (Range)
New VUR patients in 2009 (*n*)	54 (22–112)
VUR patients with reimplantation (*n*)	13 (0–63)
VUR patients with Deflux (*n*)	9 (0–37)
R/P (%)	26 % (0–111 %)
D/P (%)	20 % (0–79 %)
D/P+R/P (%)	45 % (7–135 %)
R/S (%)	63 % (0–100 %)
D/S (%)	38 % (0–100 %)

VUR, Vesicoureteral reflux

[a] Based on 2009 data

[b] Median practice patterns of pediatric urologists caring for patients with VUR

therefore, the analysis excludes patients who may have acquired the diagnosis while under the care of the urologist. Finally, coding differences, omissions or inaccuracies may confound the data from this billing database. Databases that draw from billing (CPT) sources, such as FPSC, tend to be more accurate than administrative, non-billing, databases that use ICD-9 diagnosis and procedural codes.

Variations in treatment patterns depend on patient and surgeon factors. Figures 2 and 3 and Table 2 illustrate the marked variability between surgeons yet relative consistency of each individual surgeon from year to year. There was wide variation in surgical utilization between surgeons (mean 50 %), but minimal change for each surgeon (5 %), over the 3-year period. This suggests that surgeons are practicing based on their past tendencies more than on a shared consensus practice pattern.

A study by Routh et al. [11] involving 11,415 pediatric patients found that those who received Deflux surgery instead of ureteral reimplantation were older, female, white and publicly insured. Information on reflux grade was not available (Pediatric Health Information System database). These authors found hospital type, academic and metropolitan, was the most important predictor of procedure choice, but they lacked data on individual providers. Similar to Routh et al.'s study, we found that white patients, older patients and females were more likely to receive Deflux. Unique to our study is that a surgeon's historical practice pattern was the most important and

Table 5 Logistic regression analysis of probability of Deflux versus reimplantation in patients who received treatment

Variable	OR	*P* value	95 % CI for OR	Variable importance ranking[a]
D/P	1.08	<0.001	1.05; 1.11	1
Gender				
Female (referent)	1.00	–	–	2
Male	0.12	0.001	0.03; 0.44	
Age (years)	1.42	<0.001	1.17; 1.73	3
R/P	0.95	0.001	0.92; 0.98	4
Race				
White (referent)	1.00	–	–	5
Non-white	0.32	0.032	0.11; 0.91	
Region				
Midwest (referent)	1.00	–	–	6
Northeast	0.31	0.283	0.04; 2.63	
South	0.93	0.911	0.26; 3.31	
West	2.50	0.321	0.41; 15.3	
Insurance type:				
Commercial (referent)	1.00	–	–	7
Medicaid or self pay	1.32	0.562	0.52; 3.34	
All Other	2.87	0.266	0.45; 18.3	
Nephropathy				
No (referent)	1.00	–	–	8
Yes	0.99	0.984	0.23; 4.15	
Bilateral procedure:				
No (referent)	1.00	–	–	9
Yes	1.04	0.928	0.42; 2.61	

[a] Based on average reduction in deviance when covariates were added to model sequentially, averaged over 1,000 randomly sampled permutations of variable ordering

significant predictor of whether a patient would receive Deflux. Our results, along with those by Routh et al. lead to the same conclusion that VUR management and type of surgical management in particular are highly variable between providers [11]. Provider preference plays a major role in treatment type and may have more impact on decision-making than patient factors.

Outcome studies in adult urology have found similar phenomena. Pollack et al. [2] utilized the SEER-Medicare database to characterize practice patterns among three U.S. cities. They found widely varied rates of prostatectomy utilization, as well as large differences in the racial, ethnic and socioeconomic composition of patients. Poon et al. [3] found that surgeons who practice in large population areas were more likely to place male slings for incontinence and those at academic institutions were more likely to place artificial urinary sphincters. Lane et al. [4] found surgeon volume, fellowship training and proportionate use of robotic surgery were associated with higher partial nephrectomy implementation in adults. These studies, along with the present one, demonstrate the large role that surgeon preference plays in patient management.

In our analysis of surgical versus non-surgical management of reflux, it is not surprising that increasing age was a significant predictor of surgery and ranked first in variable importance. This is consistent with the general management of VUR patients who do not have spontaneous resolution. Szymanski et al. [12] found higher age at presentation to be an independent predictor of ureteral reimplantation. They also found that in patients who were followed for antenatal hydronephrosis, bilateral reflux and high-grade reflux were independent predictors of ureteral reimplantation. In our analysis we found that, in addition to patient characteristics, surgeon characteristics predicted surgical treatment. A VUR patient had increased odds of having surgical treatment for each incremental increase in a surgeon's historical rate of reimplantation (R/S) and Deflux injection utilization (D/P).

In the analysis of type of antireflux surgery, higher odds of Deflux were associated with a surgeon's historic Deflux utilization (D/P) and, similarly, higher odds of reimplantation were associated with a surgeon's reimplant utilization (R/P) (Table 5). This strongly suggests that a surgeon's past practice predicts his/her future choices. In our analysis, a surgeon's historic percentage of new patients treated with Deflux (D/P) bears greater importance in choice of treatment than other independently significant predictors that we analyzed, including gender and age. The findings that female gender and white race independently predicted greater odds of Deflux over reimplantation were unexpected.

Conclusion

As expected, age was independently associated with surgical treatment of reflux. Surprisingly, female gender and white race were independently associated with endoscopic treatment, and a surgeon's historic Deflux utilization was the most important predictor of surgery type. Although data on reflux grade were not available, these results combined with the finding that the majority of surgeons had minimal change in their Deflux utilization suggest that surgeon preference is the first or second most critical factor in determining a patient's treatment.

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Conflicts of interest None.

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