

Salvage Surgery Rates for Pediatric Testicular Torsion: Comparison of the Pre- and Post-Quality Metric Eras

Brian Chun, Marc Colaco, Janelle A. Fox et al.

Correspondence: Brian Chun (email: chunb@upmc.edu).

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Study Need and Importance: Standardized hospital quality metrics are powerful tools that can inform quality-based care. However, defining what constitutes high-quality care in pediatric urology remains controversial. In 2015, the U.S. News & World Report “Best Children’s Hospitals” included management of testicular torsion as a scored quality metric based on time-to-operating room. To date, no study has reexamined or compared testicular salvage surgery rates after implementation of this quality metric.

What We Found: Using the Pediatric Health Information System® database, testicular salvage surgery rates for pediatric testicular torsion increased a mean of 12.5% (from 58.4% to 70.9%) after implementation of the U.S. News & World Report quality metric (see Figure). The most significant improvement was between 2015 and 2016, 1 year after the metric was instituted, and remained durable to the study end point. Our data suggest a strong hospital response to these

metrics as the proportion of top 50 ranked hospitals achieving a full score improved from 62% in 2015 to 98% in 2019. Additionally, hospitals that initially received partial scores showed a more robust improvement in salvage surgery rates compared to initially full-scoring hospitals.

Limitations: Our study was a retrospective analysis of the Pediatric Health Information System database, in which cases of testicular torsion were identified by ICD (International Classification of Diseases) diagnosis and procedure codes at the time of presentation. Followup data after orchiopexy were inconsistent between hospitals, and thus our data could not be generalized to describe overall testicular salvage rate. The effects of other quality metrics or institution-specific protocols could not be independently measured.

Interpretation for Patient Care: Management of testicular torsion is a promising marker of quality in pediatric urology, and its adoption has improved testicular salvage surgery rates.

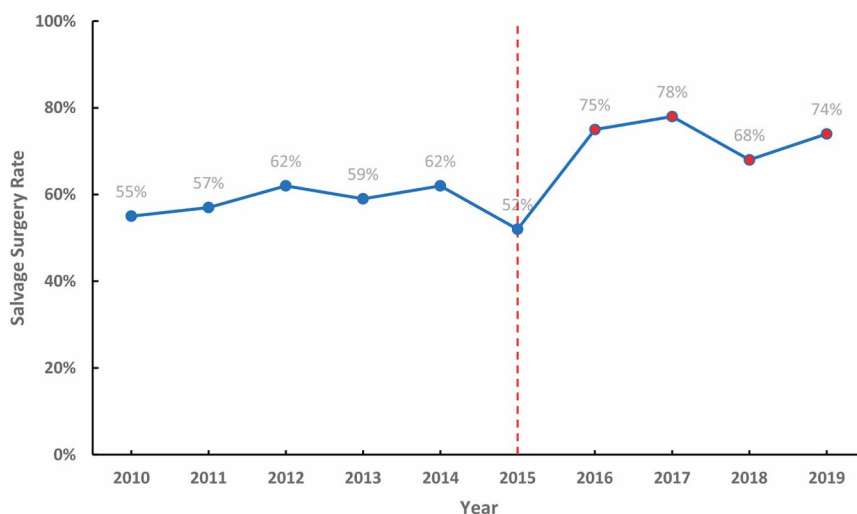


Figure. Testicular salvage surgery rates by year. Dotted red line reflects year of quality metric implementation. Red data points reflect post-quality metric salvage surgery rates.

Salvage Surgery Rates for Pediatric Testicular Torsion: Comparison of the Pre- and Post-Quality Metric Eras

Brian Chun,^{1*} Marc Colaco,¹ Janelle A. Fox,¹ Glenn M. Cannon,¹ Francis X. Schneck,¹ Rajeev Chaudhry¹ and Jeffrey Villanueva²

¹UPMC Children's Hospital of Pittsburgh, Pittsburgh, Pennsylvania

²State University of New York Upstate Medical University, Syracuse, New York

Abbreviations and Acronyms

CM = Clinical Modification
ED = emergency department
ICD = International Classification of Diseases
OR = operating room
PHIS = Pediatric Health Information System®
USNWR = U.S. News & World Report

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Conflict of Interest: none.

Ethics Statement: This study was deemed exempt from IRB approval by the International Review Board of the Children's Hospital of Pittsburgh, as all patient information was de-identified prior to analysis.

* Correspondence: UPMC Children's Hospital of Pittsburgh, 3471 Fifth Ave., Suite 700, Pittsburgh, Pennsylvania 15213 (telephone: 313-815-6980; FAX: 412-692-4101; email: chunb@upmc.edu).

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Purpose: Pediatric testicular torsion is a urological emergency that requires timely intervention. In 2015, quality metrics for testicular torsion were implemented in the U.S. News & World Report "Best Children's Hospitals" rankings. Our study examines and compares testicular salvage surgery rates before and after the institution of national quality metrics from a multi-institutional database.

Materials and Methods: The Pediatric Health Information System® was surveyed for all testicular torsion encounters using ICD (International Classification of Diseases), Ninth and Tenth Revisions coding from 52 hospitals between January 2010 and December 2019. Patients <1 year and ≥18 years of age were excluded. Only hospitals that reported outcomes before and after quality scoring were included. Testicular salvage surgery was defined as patients having undergone orchiopexy without concomitant orchiectomy. Age, race, distance from hospital, household income and insurance status were compared.

Results: A total of 890 patients (551 pre-metric and 339 post-metric) from 38 hospitals were included. The testicular salvage surgery rate was 12.5% higher in the post-metric cohort (70.9% versus 58.4%). Hospital compliance to testicular torsion quality metrics increased from 62% in 2015 to 98% in 2019. Mean age, race, distance to hospital, household income, insurance status and use of ultrasound were not statistically different between pre- and post-metric cohorts.

Conclusions: Since the implementation of quality metrics, salvage surgery rates for testicular torsion increased to 70.9%, an improvement of 12.5% when compared to pre-metric outcomes. Patient factors were similar between the 2 groups. Multi-institutional prospective data are needed to validate this database study and evaluate overall testicular salvage rate.

Key Words: spermatic cord torsion, quality improvement, economics

TESTICULAR torsion afflicts an estimated 3.8 per 100,000 males <18 years of age and is a pediatric emergency associated with significant morbidity. Management is predicated on prompt diagnosis and surgical detorsion with the goal of testicular salvage.¹ Testicular viability is maximized when definitive surgery can be performed within 6 hours of symptom onset.² In 2011, Cost et al described a 68.1% testicular salvage

rate in over 2,800 torsion cases over a 7-year query of the Pediatric Health Information System® (PHIS).³ In the past decade, mandated reporting and scoring of hospital metrics have become increasingly emphasized with the goal of improving health care quality. These can be powerful motivators to promote high-quality patient care. For example, quality metrics have shown to decrease incidence of health care-associated

infections at a national level.⁴ At the practitioner level, government-mandated consent can significantly reduce prescription habits for opiates in pediatric patients undergoing inpatient and outpatient surgery.^{5–7}

Time of symptom onset is among the most robust predictors of testicular salvage and is highest when detorsion is performed within 6 hours.² In response to this, the U.S. News & World Report (USNWR) “Best Children’s Hospitals” included management of pediatric testicular torsion as a scored quality metric for hospital rankings in June 2015; a maximum of 2 points are awarded if >90% of torsion patients have a time from emergency department (ED)/clinic registration to operating room (OR) <4 hours.⁸ Consequently, several institutions have independently adopted quality improvement initiatives ranging from streamlined diagnostic checklists⁹ to interdisciplinary clinical care pathways¹⁰ and straight-to-OR protocols for tertiary care transfers.¹¹ Such efforts appear to have reduced time to detorsion surgery; however, whether these initiatives independently improve testicular salvage is unclear. To our knowledge, no multi-institutional study reexamining testicular salvage surgery rates in the post-quality metric era currently exists. In our study, we describe the testicular salvage surgery rate before and after the institution of quality metric scoring from a national, multi-institutional database. We hypothesized that implementation of testicular torsion quality metrics would lead to an increase in testicular salvage surgeries.

MATERIALS AND METHODS

Data Source

Data were obtained from the PHIS, which is an administrative database that contains de-identified data from inpatient, ambulatory surgery, ED and observation encounters. PHIS currently collects data from 52 member hospitals. We included data from 38 hospitals that provided continual reporting for the study period of January 2010 through December 2019. Performance scoring from USNWR “Best Children’s Hospitals” was obtained from published annual reports, which included score breakdowns of top 50 ranked hospitals. Our study was assessed and exempted by the International Review Board at Children’s Hospital of Pittsburgh as all patient information was de-identified prior to analysis. This database has been used for a variety of studies across multiple pediatric subspecialties, including pediatric urology.

Subjects

Eligible patients were defined as pediatric patients (1 to 18 years of age) with primary diagnosis of testicular torsion. International Classification of Diseases (ICD), Ninth and Tenth Revisions, Clinical Modification (CM) diagnosis codes were used to identify patient diagnoses (see supplementary Appendix, <https://www.jurology.com>). Patients below the age of 1 were excluded to avoid analysis of the clinically separate

entity of neonatal testicular torsion. Patients were separated into cohorts based on the date of their initial presentation. Patients who presented prior to June 15, 2015 (the date USNWR first released its testicular torsion metric) were assigned to the pre-metric cohort, and those who presented after were assigned to the post-metric cohort.

Outcomes

Testicular salvage surgery was defined as patients who underwent orchiopexy without undergoing concomitant orchiectomy. Procedure type was identified using ICD-9-CM or ICD-10-CM procedure codes (see supplementary Appendix, <https://www.jurology.com>). In addition to date of presentation, patients were also assessed for age, race, distance of home from hospital, mean household income and primary payer (public versus private) as other possible variables associated with testicular salvage rates.

Statistical Analysis

Statistical analysis was performed using SPSS® version 26. Categorical variables were assessed using chi-square, whereas interval variables were compared using independent sample t-tests.

RESULTS

A total of 890 patients (551 pre-metric and 339 post-metric) from 38 hospitals were included in this study. Table demonstrates demographic data. There was no significant difference in mean age (12.00 years pre-metric versus 11.97 years post-metric, $p=0.92$), distance to treating hospital ($p=0.92$), household income ($p=0.69$), ethnic distribution ($p=0.81$) or commercial versus public payer insurance status ($p=0.31$) between cohorts.

Figure 1 demonstrates testicular salvage surgery rates in each cohort. Testicular salvage surgery rate increased 12.5% in the post-quality metric period when compared to the pre-metric cohort (58.4% versus 70.9%, $p < 0.001$). Figure 2 demonstrates the change in salvage surgery rates over time, with the greatest rate change occurring between 2015 and 2016 when testicular torsion quality scoring was implemented. The use of testicular ultrasound increased between cohorts (57.6% pre-metric versus 63.7% post-metric), but this value only approached significance ($p=0.08$).

Figure 3 describes trends in testicular torsion scoring among the top 50 ranked pediatric hospitals from 2015 to 2019. The number of hospitals that received a full score of 2 points (>90% with time to

Table. Patient characteristics

	Pre-Metric	Post-Metric	p Value
No. pts	551	339	
Mean age (yrs)	12.00	11.97	0.92
Mean distance from hospital (miles)	26.22	26.54	0.92
Mean household income (\$)	45,325.96	45,854.98	0.69
% Non-White pts	55.5	54.7	0.81
% Pts with private payer	43.6	39.9	0.31
Rate of ultrasound use (%)	57.6	63.7	0.08

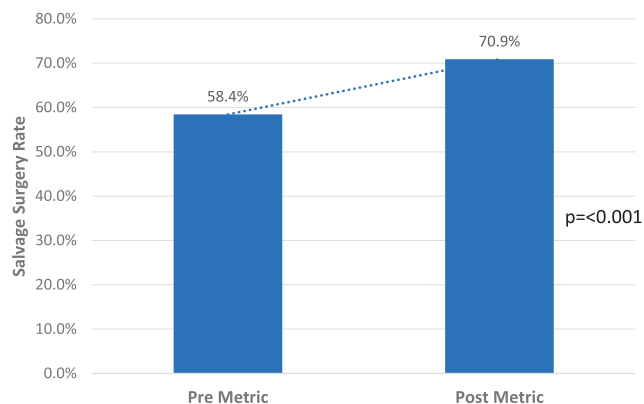


Figure 1. Testicular salvage rates; pre-metric versus post-metric.

OR <4 hours) increased from 31 (62%) in 2015–2016 to 49 (98%) in 2019–2020. None of the top 50 ranked hospitals scored lower than 1 point (>50% and <90% with time to OR <4 hours). Figure 4 shows testicular salvage surgery rates stratified by partial- or full-scoring hospitals in 2015. Among reporting hospitals, 11 initially received partial scores and salvage surgery rate increased 13.8% (50.9% to 64.7%, $p=0.01$). Ten of these 11 partial-scoring hospitals improved to a full score by 2019. Of the 16 reporting hospitals that initially received full scores, salvage surgery rates increased 7.7% but did not reach significance (59.2% to 67.0%, $p=0.19$).

DISCUSSION

We hypothesized that quality metric scoring would lead to an increase in testicular salvage surgery rates. Indeed, salvage surgery rates increased 12.5%, from 58.4% to 70.9%, in the post-metric cohort, with

the most significant improvement seen between 2015 and 2016, 1 year after the implementation of the USWR scoring metric for testicular torsion (Fig. 2). This effect was durable to our study end point. Our pre-metric salvage rate correlates with rates seen in other contemporary analyses and suggests a strong response from participating hospitals.² The proportion of top 50 ranked hospitals achieving a full score (2 points) improved significantly, from 62% in 2015 to 98% in 2019 (Fig. 3). Additionally, when stratified by initial scoring, hospitals that received a partial score showed a 13.8% increase in salvage surgery rate ($p=0.01$) compared to 7.7% among hospitals that already achieved a full score ($p=0.07$, Fig. 4).

We believe that improvements in the salvage surgery rate are the result of enhancements in systems-based care flow in response to quality metrics. Specifically, the objective measurement of time-to-OR for torsion has likely increased hospital administration and nonurological services' awareness on a patient's wait time to the OR and allows the urologist to advocate for this. The USNR metrics were implemented in 2015, and since then, multiple publications have described novel institutional protocols designed to expedite diagnosis, transfer and transport for torsion cases, which can lead to shorter time to treatment.^{9–11} However, their independent effect on overall testicular salvage is less clear and heterogeneous. For example, Arevalo et al showed that utilizing straight-to-OR protocols for testicular torsion transfers reduced incision time by 40 minutes with no effect on testicular salvage.¹¹ Comparatively, Afsarlar et al described an ED scoring checklist which both decreased time-to-OR and improved testicular salvage by 17.2%, although this did not reach significance.⁹

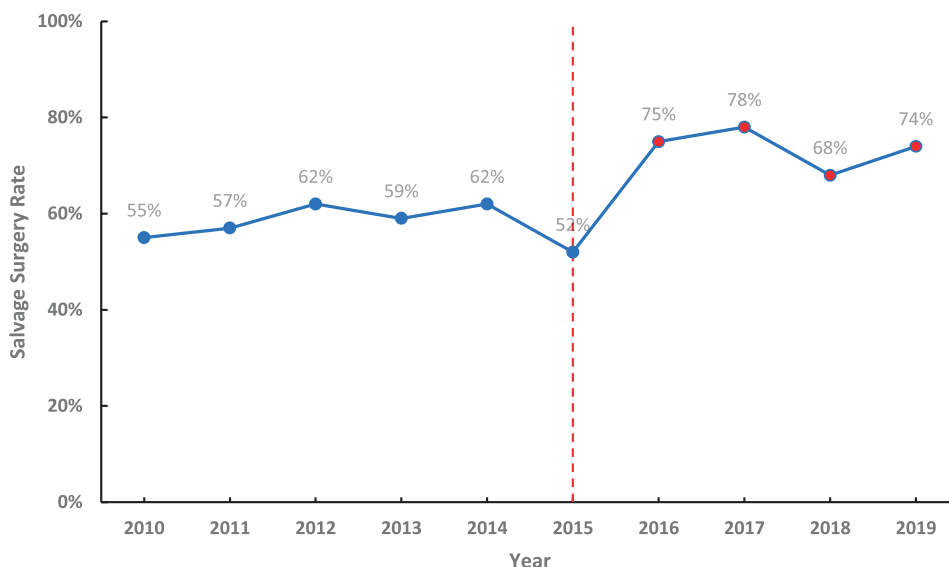


Figure 2. Testicular salvage surgery rates by year. Dotted red line reflects year of quality metric implementation. Red data points reflect post-quality metric salvage rates.

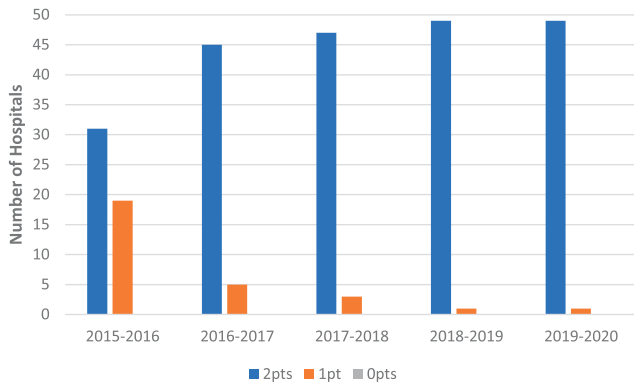


Figure 3. Scoring for testicular torsion among top 50 ranked pediatric hospitals.

These studies are principally limited by small sampling of an infrequent emergent condition, which is addressed in our study with the utilization of a multi-institutional database before and after the institution of a clearly defined quality metric. We considered other explanations for the increase in salvage surgeries, such as improved community education leading to improved presentation times; however, pre-hospital factors could not be measured within the scope of our study. While it is possible that surgeons could lower their threshold to perform an orchiopexy, we believe that the USNWR metric would have minimal influence on this clinical decision as scoring was based on time-to-OR and not the type of surgery performed.

We did not demonstrate any significant differences in patient age, distance from treating hospital, socioeconomic status, ethnicity or insurance status between both cohorts. Interestingly, the use of diagnostic ultrasound appeared to increase in the post-metric cohort but did not reach significance ($p=0.08$). This may reflect an increased availability of ED ultrasound in response to USNWR scoring as one of 13 available subspecialty points for pediatric urology is indeed allocated for “having an in-house

ultrasound technologist to support prompt imaging and diagnosis of suspected testicular torsion.”⁸

Our study has several notable limitations. Importantly, it is a retrospective analysis of the PHIS database in which cases of testicular torsion were identified by ICD code only. Still, testicular torsion is a rare emergent clinical entity for which large administrative data sets have been commonly used to illustrate practice patterns and outcomes.^{3,12} Additionally, other quality metrics that exist outside of USNWR, such as the American College of Surgeons National Surgical Quality Improvement Program or institution-specific protocols, cannot be explicitly described in our study. The adoption of such metrics is variable among hospitals. The primary benefit of using the USNWR metric is that these were instituted equally among participating hospitals at a focal time point. This is a valuable parameter in evaluating hospital response. Indeed, among 19 hospitals that received partial scoring in the inaugural year, 73.7% (14 of 19) were able to meet full compliance set forth by USNWR the following year and 94.7% (18 of 19) met full compliance by the study end period (Fig. 3). Hospitals that initially received partial scores also showed a more robust improvement in salvage surgery rates compared to hospitals which already received a full score (Fig. 4). Taken together, these findings suggest a potent effect in hospital behavior following the enactment of USNWR metrics.

Our definition of testicular salvage surgery assumed that an orchiopexy was performed without an orchiectomy at the time of surgery.³ Historically, this has been used to define overall testicular salvage in other PHIS-based studies; however, this does not account for potential testicular atrophy following orchiopexy. Followup after testicular torsion surgery is historically poor, and PHIS reporting of these outpatient encounters is variable from hospital to hospital.^{8,13} For these reasons, our study is limited to the clinical diagnosis at the time of intervention and cannot be generalized to describe overall testicular salvage rate. Further prospective studies which include followup physical examination findings are needed to determine true long-term testicular salvage rate.

A portion of symptom time occurs in the pre-hospital setting, with delays in presentation commonplace due to lack of community awareness.^{14,15} Indeed, patient surveys from outpatient pediatric urology offices showed that only a third of families had heard of testicular torsion, with the most common source of knowledge coming from informal word-of-mouth sources.¹⁶ To maximize quality outcomes for testicular torsion, institutions should consider both pre-hospital and in-hospital systems. For example, improvements in community and parental education for scrotal pain and testicular torsion may help salvage rates when complemented with hospital objectives such as those scored in USNWR.

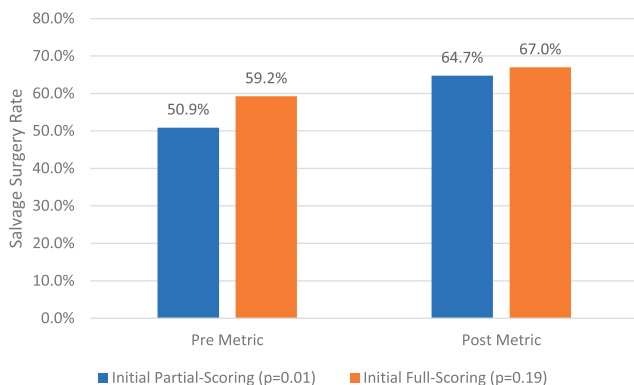


Figure 4. Salvage surgery rates among partial- and full-scoring hospitals; pre-metric versus post-metric.

The USNWR is an influential third-party institution that ranks hospitals based on clinical outcomes and reputation as well as comprehensive clinical and operational surveys.¹⁷ Although such publications can be powerful tools to inform quality-based care, USNWR has been scrutinized for its reliance on secondary analysis of claims data which may not adjust for clinically important variables.¹⁸ In addition to torsion, quality scoring for pediatric urology considers complication rates for distal hypospadias repair, pyeloplasty and ureteral reimplantation. Baker et al recently demonstrated these metrics to be poorly powered to stratify hospital performance, leading to misclassification rates exceeding 50%.^{8,19} Furthermore, Pohl et al reported a discordance in hypospadias repair complication rates between the USNWR benchmarks, PHIS data and published data from several major academic centers, suggesting that some USNWR metrics are less appropriate than others.²⁰ In contrast, quality scoring of testicular

torsion is reliably and objectively assessed with a durable outcome effect measured years after implementation. As a result, management of testicular torsion appears to be a promising marker for quality. Similar conditions such as postoperative opioid utilization and management of vesicoureteral reflux may also serve as markers of pediatric urological health care quality by third-party institutions.⁵⁻⁷

CONCLUSIONS

Testicular salvage surgery rates have increased 12.5%, from a mean 58.4% to 70.9%, since the implementation of USNWR quality metric scoring for pediatric testicular torsion. Patient factors such as age, distance to treating hospital, socioeconomic status, ethnicity, insurance payer status and use of ultrasound were similar between both groups. Multi-institutional prospective data are needed to validate this database study and evaluate overall testicular salvage rate.

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EDITORIAL COMMENTS

Testicular salvage rates are directly related to the time from symptom onset to surgical intervention. There are 2 distinct time frames within that period.

One is the time from symptom onset to presentation, and the other is the time from presentation to surgical intervention. Time from symptom onset to

emergency room presentation is unlikely to be changed by any specific measure outside of population education. In addition, as mentioned by the authors, the effect of any of these measures would likely result in a heterogeneous effect. In contrast, the time from emergency room presentation to surgery is something that not only can be measured but certainly improved, as it depends on the hospital team taking care of the patient.

The finding that improvement in testicular salvage rates coincides with the establishment of the U.S. News & World Report new metric of time to operating room in torsion cases is striking. Furthermore, the fact that hospitals initially noncompliant with the metric achieved the greatest improvement in salvage rates after becoming compliant reinforces these results. While research done with health care databases has limitations, the authors were not able to identify any other explanations for their findings.

While there has been plenty of criticism aimed at U.S. News & World Report, the manuscript findings may have shown a positive side regarding this particular metric. It has led to the creation of quality improvement programs that appear to have had a positive impact on patient outcomes. Tracking patient outcomes and identifying areas of improvement are the cornerstones of quality improvement programs and should be a goal that all people involved in health care have. This not only can help surgeons improve their outcomes, but, most importantly, will improve the quality of health care and benefit the most important stakeholders, the patients.

Daniel DaJusta¹

¹Department of Urology
Ohio State University
Nationwide Children's Hospital
Columbus, Ohio

“Time is tissue” remains the guiding principle in the successful management of testicular torsion. As such, beginning in 2015, the time from patient presentation to the operating room for testicular torsion was incorporated as a metric of quality in the U.S. News and World Report (USNWR) “Best Children's Hospitals” rankings for pediatric urology.¹

In this study, Chun et al investigated whether implementation of this quality metric improved clinical care, using testicular salvage as an indicator of success. Using data from the Pediatric Health Information System® (PHIS) and the USNWR rankings, the authors compared testicular salvage rates before and after the incorporation of testicular torsion metrics in the rankings. The authors found that testicular salvage improved significantly in the post-metric period. And, most importantly, the greatest improvement was found in institutions that initially received partial scores but improved to achieving full scores in meeting the time metrics for testicular torsion by the end of the study.

Although the timely care of testicular torsion is well recognized by urologists, the expeditiousness of

getting these patients from initial presentation in the emergency department to the operating room is dependent on the actions and processes of multiple players and departments within the health care system. Changes to improve care often require the prioritization, motivation and cooperation of hospital leadership and various stakeholders across multiple departments. Despite criticism of their overreliance on methodologically flawed complication rates and subjective measures such as reputational scores, the USNWR rankings remain a powerful motivator for institutional change.² This study demonstrates how the proper selection of objective and impactful metrics can lead to improvement in quality of care. Thus, instead of advocating for nonparticipation, perhaps the emphasis should be on advocating for an overhaul of the current USNWR ranking system to increase incorporation of more meaningful quality metrics.

Dennis B. Liu¹

¹Division of Urology
Ann and Robert H. Lurie Children's Hospital of Chicago
Chicago, Illinois

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