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Original Article

Improving testicular examinations on paediatric patients in the emergency department: A quality improvement study to improve early diagnosis of testicular torsion

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Abstract *Objective:* Male paediatric patients presenting with abdominal and/or testicular pain are common in the emergency department. As a time-sensitive diagnosis, the importance of early recognition, referral, and definitive management is critical. Missed or delayed diagnoses and management of testicular torsion can result in significant long-term sequelae including impaired fertility and psychological burden. In this quality improvement study, we utilised educational posters aiming to improve awareness of testicular torsion as a differential for abdominal pain and therefore, improve the quality of testicular examinations performed in the emergency department.

Methods: Observational pre- and post-intervention study was conducted at a tertiary hospital emergency department. A pre-interventional retrospective review of the electronic medical records was conducted. All male patients under 16-years-old presenting with “abdominal pain” or “testicular problem” were included. We assessed the rate of testicular examination and the quality of the examination based on four domains: Cremasteric reflex, lie, swelling, and hardness. Educational posters targeting both patients and clinicians were placed around the emergency department. Subsequent review of the electronic medical records post-intervention was performed assessing the same domains.

Results: A total of 235 presentations were analysed with 124 in the pre-intervention group and 111 in the post-intervention group. Overall rate of documented testicular examinations increased by 14% ($p=0.032$). The quality of testicular examinations also improved from an

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average of 0.85 domains documented to 2.29 post-intervention ($p < 0.001$). Subgroup analysis found doctors in training had a greater improvement in both rate and quality of documented testicular examination.

Conclusion: Our study demonstrated the value of continuing education in promoting awareness of testicular torsion in the emergency department. We found a clear improvement in the quality of clinical documentation of a time-sensitive condition which may infer a decreased risk of missed and delayed diagnosis of testicular torsion.

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1. Introduction

Abdominal and testicular pain are common presentations in the emergency department among paediatric patients. Testicular torsion is a surgical emergency, with an estimated incidence of 5 in 100 000 among males aged 16 years and below [1]. It is well established that delays in diagnosis can critically prolong ischaemia, increase the risk of testicular atrophy, and reduce the chance of salvage. Patients who have endured prolonged ischaemia or undergone orchiectomy are particularly at risk of long-term adverse consequences on fertility [2].

As a time-sensitive condition, accurate and timely diagnosis is critical in facilitating early surgical review and intervention. The initial diagnosis of testicular torsion is predominantly based on findings on physical examination [3,4]. Typically, testicular torsion presents with sudden onset of testicular pain, associated with nausea and vomiting [3]. However, up to 12% of cases have been reported to present atypically with abdominal pain alone [4,5]. Additionally, abdominal pain is an important early symptom of testicular torsion. Patients characteristically describe an initial lower abdominal pain shifting towards the scrotal area few hours after onset [6]. Valuable time is lost if testicular torsion is not considered prior to the typical migration of pain. Each year, a proportion of such presentations result in missed or delayed diagnosis resulting in permanent, but preventable testicular loss [7]. In patients presenting within 6 h from the onset of symptoms, almost all cases of testicular torsion are salvageable, and for those presenting within 12 h, up to 90% [8]. Recent literature, however, estimates orchiectomy rates between 28% and 42% [5,7]. The factors underlying missed and delayed diagnoses have been attributed to, among other things, suboptimal testicular examinations [9].

The Testicular Workup for Ischaemia and Suspected Torsion (TWIST) score was specifically developed for the risk stratification of paediatric patients presenting with acute scrotum, where testicular torsion is suspected [10]. The scoring system includes five components of history and findings on physical examination (Table 1), providing an overall score ranging from 0 to 7. These include testicular swelling (2 points), hard testicle (2 points), absent cremasteric reflex (1 point), nausea or vomiting (1 point), and high riding testicle (1 point). A score of 5 or above indicates

Table 1 The TWIST score* [9].

| Criteria | Score |
|---------------------------|-------|
| Testicular swelling | 2 |
| Hard testicle | 2 |
| Absent cremasteric reflex | 1 |
| Nausea or vomiting | 1 |
| High riding testicle | 1 |

TWIST, Testicular Workup for Ischaemia and Suspected Torsion.
* Risk stratification based on the total TWIST: Low risk (score 0–2), intermediate risk (score 3–4), high risk (score 5–7).

high risk of testicular torsion and immediate surgical exploration is recommended [10]. The TWIST score has been validated in several studies demonstrating high positive predictor values for high risk patients of 90%–100% [11,12].

Our study was conducted to determine the impact of educational interventions on the clinical practice of emergency clinicians when treating testicular torsion in paediatric patients. Specifically, we sought to investigate whether educational interventions increased the rate as well as the quality of documented testicular examinations for appropriately triaged presentations, utilising the TWIST score as a gold-standard measure. Finally, we aimed to investigate whether the value of education depended on the clinical experience of treating doctors.

2. Methods

A retrospective review was performed at an emergency department of a tertiary referral hospital in New South Wales, Australia. The emergency department has a dedicated paediatric emergency area with approximately 20 000 paediatric presentations per year.

2.1. Stage 1—pre-intervention

The first stage involved a retrospective review of all paediatric male patients under the age of 16 triaged with “abdominal pain” or “testicular problem” between the dates of July 1, 2018 to September 30, 2018. Patients were

excluded from this study if they were not seen by a clinician or were mistakenly triaged due to clerical error.

2.2. Poster intervention

An educational initiative focusing on detecting testicular torsion was commenced. An educational poster was developed and placed around clinical and non-clinical areas of the emergency department. The posters displayed information on testicular torsion and listed four of the examination components of the TWIST score (Supplemental Fig. 1). Awareness and promotion of the posters occurred “on shift” and were made clearly visible to all clinicians working in the paediatric area of the emergency department.

A separate poster was placed in patient waiting areas and paediatric emergency care areas, targeting parents and older children. This poster utilized lay language explaining the need for testicular examination in male patients presenting with abdominal pain (Supplemental Fig. 2).

2.3. Stage 2—post-intervention

The second stage reviewed patients between the dates of November 1, 2019 and January 31, 2020 with the same inclusion criteria, all paediatric male patients under the age of 16 triaged with “abdominal pain” or “testicular problem”. Once again, patients who were not seen by a clinician or mistakenly triaged were excluded.

2.4. Data collection

Medical records were reviewed by two authors (Cheng EM and Crowe M). The primary outcome measured was the number of documented testicular examinations. The secondary outcome assessed the quality of the examination performed. Documentation of a testicular examination was recorded as either “Yes” or “No”. If the clinician had documented a testicular examination, the quality of the examination was reviewed based on the four physical examination components of the TWIST score (Table 1).

The groups were compared in respect to the number of documented testicular examinations. Subgroup analyses were performed for clinical seniority as a measure for clinical experience of the treating clinician. Clinical seniority was divided into consultants and doctors in training. Consultants were the most senior emergency clinicians in the department. Doctors in training consisted of a combination of doctors undergoing emergency training and junior doctors rotating through the emergency department.

2.5. Statistical analysis

The statistical analysis of data was performed using SPSS version 15.0 (SPSS Inc., Chicago, IL, USA). Differences between groups were calculated using the Chi-square and Mann-Whitney *U*-tests. A value of $p < 0.05$ was considered statistically significant.

3. Results

A total of 254 paediatric presentations meeting the inclusion criteria were retrieved from the medical records. This included 136 in the pre-intervention phase and 118 in the post-intervention phase. Nineteen presentations were excluded as either the patient did not wait to be seen by a clinician ($n = 14$) or was incorrectly triaged ($n = 5$). A total of 235 presentations were analysed with 124 in the pre-intervention group and 111 in the post-intervention group. A summary of study characteristics is included in Table 2.

3.1. Rate of testicular examinations

The educational intervention resulted in a 14% increase in the rate of testicular examinations ($p = 0.032$). In the pre-intervention group, 49% documented a testicular examination compared to 63% in the post-intervention group. Subgroup analysis demonstrated no significant difference between the consultant groups, however, in both groups the consultants were more likely to perform a testicular examination (Table 3). Meanwhile, there was a 16%

Table 2 Summary of study characteristics.

| Characteristic | Control group ($n = 124$) | Intervention group ($n = 111$) |
|------------------------------|-----------------------------|----------------------------------|
| Triage category, n (%) | | |
| Abdominal pain | 114 (92) | 101 (91) |
| Testicular problem | 10 (8) | 10 (9) |
| Clinician seniority, n (%) | | |
| Doctors in training | 104 (84) | 99 (89) |
| Consultant | 20 (16) | 12 (11) |

Table 3 Rate of testicular examinations performed in control group and intervention group by clinical seniority.

| Clinical seniority | Control group | Intervention group | χ^2 | p -Value ($\alpha = 0.05$) |
|---------------------|---------------|--------------------|----------|--------------------------------|
| Doctors in training | 47% (49/104) | 63% (62/99) | 4.910 | 0.027 |
| Consultants | 60% (12/20) | 67% (8/12) | 0.142 | 0.710 |
| Total | 49% (61/124) | 63% (70/111) | 4.060 | 0.032 |

increase in the rate of testicular examinations in doctors in training ($p=0.027$).

3.2. Quality of testicular examinations

Quality of testicular examinations were evaluated based on the examination components of the TWIST criteria. A Mann-Whitney U -test indicated that there was a statistically significant difference in the average quality of examinations performed by clinicians with and without educational intervention ($p<0.001$). This was significant for doctors in training but not consultants. Greater frequency of documentation was found in each four components of the TWIST criteria individually post educational intervention (Table 4).

4. Discussion

The present study has demonstrated that simple poster education improves the documented rate and quality of testicular examinations performed. Additionally, our study demonstrated that clinicians of all levels of training may benefit from such measures, with the greatest improvement observed among doctors in training.

Previous studies have identified the failure to perform adequate testicular examinations as a major contributing factor to missed or delayed diagnosis for testicular torsion [3,5,9]. We subsequently demonstrated the efficacy of educational posters as an interventional strategy. As a clinical diagnosis, patient outcomes critically depend on clinicians' diligence in performing thorough testicular examinations and obtaining early diagnosis to facilitate timely access to definitive management. Testicular torsion has a potential for organ loss and can result in lifelong emotional, psychological, and fertility sequelae for young patients [9]. Even where salvage is successful, patients will face long-term consequences on fertility with reduced semen and sperm quality [2].

We found doctors in training were more receptive to the educational intervention and likely to alter their clinical practice. This suggested that visual prompts on the clinical

floor in the form of educational posters can be tailored towards clinicians at this level of training. Education on testicular torsion in this group is particularly important as the initial assessment of these patients is often performed by doctors in training, with later examinations performed by supervising consultants or surgical colleagues.

Reducing the rates of missed or delayed diagnosis of testicular torsion is an important clinical governance issue for emergency departments in their overall assessment and management of paediatric male patients presenting with abdominal pain, and in particular in the assessment of younger age children who may be unwilling or unable to localise "abdominal pain" to the groin or scrotum [4]. Delayed or misdiagnosis of testicular torsion commonly occurs in paediatric malpractice lawsuits [13]. Emergency clinicians represent the largest group of health practitioners affected by such litigation claims, with numerous reported cases involving the failure to conduct a testicular exam [13,14].

Our educational intervention was a simple and cost-effective tool to raise awareness among emergency clinicians. To our knowledge, our study is among the few reporting on poster education for quality improvement in emergency care. Corkill [15] previously reported on the value of educational posters, in the context of reducing the rates of haemolysed blood samples collected within the emergency department.

Several assumptions were made in this study. As medical records were retrospectively reviewed, the documentation was assumed to reflect the quality of the clinical assessment. While our study highlights the importance of accurate record keeping, it is well recognised that medical documentation in an emergency setting may be compromised by the often hectic and unpredictable working environment of the emergency department [16]. Additionally, while clinical seniority was used as a surrogate marker of clinical experience, this did not take into consideration specific sub-speciality training in paediatrics and paediatric emergency medicine undertaken by several of our senior clinicians. Similarly, doctors in training often have a wide variation in previous experience, with many having

Table 4 Quality of testicular examinations in the pre- and post-intervention groups.

| Sub-analysis group | Control ($n=62$) | Intervention ($n=70$) | Statistics | p -Value |
|------------------------|---------------------------------|-------------------------|------------------------------|------------|
| Type of examination | Number of components (out of 4) | | U -Value ^a | |
| Documented examination | 0.85 | 2.29 | 814 | <0.001 |
| Doctors in training | 0.75 | 2.32 | 512.5 | <0.001 |
| Consultant | 0.92 | 2.00 | 22 | 0.246 |
| TWIST score criteria | Number of examined cases (%) | | χ^2 -Value ^b | |
| Cremasteric reflex | 15 (24) | 38 (54) | 12.390 | <0.001 |
| Lie | 17 (27) | 48 (69) | 9.764 | 0.002 |
| Swelling | 15 (24) | 55 (79) | 39.032 | <0.001 |
| Hard/soft | 1 (2) | 19 (27) | 16.670 | <0.001 |

TWIST, Testicular Workup for Ischaemia and Suspected Torsion.

^a U -Value (Mann-Whitney U -test) for statistics.

^b χ^2 -Value (Chi-square test) for statistics.

completed previous dedicated paediatric or surgical rotations. These represent potential factors influencing practice, as well as the efficacy of education.

We acknowledge that the findings of this study represent the experience of a single institution. Nonetheless, our study has succeeded in highlighting several important lessons that may inform future studies and most relevantly, the impact of educational interventions on subsequent patient outcomes. Finally, the value of targeted patient education would be another area that warrants further inquiry. One parent of a 9-year-old boy with abdominal pain presenting to our emergency department commented to our clinicians, "I saw your poster and have told my son that you might need to examine his testicles and he is fine with that." It is this kind of patient engagement that, while unmeasured in this study, is an important part of embedding cultural change.

5. Conclusion

The present study examined the rate and quality of assessments for testicular torsion among emergency clinicians, with the aim of preventing missed or delayed diagnoses and advocates for accurate medical documentation. The findings of this study form a strong basis for ongoing education especially in time-sensitive diagnosis such as testicular torsion.

Author contributions

Study design: Andrew Cooke.

Data acquisition: Ernest M. Cheng, Murray Crowe.

Data analysis: Ernest M. Cheng, Juanita N. Chui, Murray Crowe.

Drafting of manuscript: Ernest M. Cheng, Juanita N. Chui.

Critical revision of the manuscript: Ernest M. Cheng, Juanita N. Chui, Andrew Cooke, Murray Crowe.

Conflicts of interest

All authors declare no conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ajur.2021.07.002>.

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