Imaging strategy for South African children with their first proven UTI in a tertiary hospital setting

Abstract
Urinary tract infection (UTI) is the most common invasive childhood bacterial infection. While it has a benign course in most children, there is a risk that some will develop renal scarring, hypertension and chronic renal failure. There are no simple clinical means to identify those at risk and who would benefit from treatment and so all children with first proven UTI are subjected to imaging. Imaging is directed at detecting vesico-ureteric reflux (VUR), obstruction from pelviureteric junction (PUJ) obstruction or posterior urethral valves (PUV) and kidneys that are scarred or at a risk for scarring. Unfortunately, no single imaging method is able to detect all of the above. Also, the advantages and limitations of many of the imaging methods are not clearly appreciated. This article presents the uses, advantages and disadvantages of current imaging methods and outlines a strategy that attempts to limit the radiation dose and invasiveness of the procedure.

Keywords
Vesico-ureteric reflux, ultrasound, MCUG, DMSA, MAG3

Introduction
Many children develop a urinary tract infection (UTI), but only a few of them develop permanent renal damage. Currently all children with a proven UTI are imaged to detect treatable predisposing conditions. Unfortunately, no single imaging method is able to detect all of these conditions. Also, the advantages and limitations of many of the imaging methods are not clearly appreciated. This article presents the uses, advantages and disadvantages of current imaging methods and outlines a strategy that attempts to limit the radiation dose and invasiveness of the procedure.

Ultrasoundography is a basic screening test to demonstrate the presence and size (with reference to standard size for age) of two kidneys, exclude obstruction and demonstrate the post-micturition voiding residue.11
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Discussion

Urinary tract infection (UTI) is the most common invasive childhood bacterial infection. While it has a benign course in most children, there is a risk that some will develop renal scarring, hypertension and chronic renal failure. Controversy exists as to the role of the predisposing factors, imaging and management in determining the final outcome in these children. The commonly accepted treatable causes are vesico-ureteric reflux (VUR) and obstruction from pelviureteric junction (PUJ) obstruction or posterior urethral valves (PUV).

A DMSA scan is useful to assess for renal scarring. Reversible defects in isotope uptake may be seen following a UTI. Scarring should be diagnosed only if it persists for more than three months on follow-up DMSA scans. A DMSA scan provides no information about the lower urinary tracts.

VUR is associated with UTI and renal scarring and this combination results in a poor prognosis. There are no simple clinical means to identify those at risk and those who would benefit from treatment and so all boys and girls with a first proven UTI are subjected to imaging on this first episode.

No single imaging method is able to detect all of these conditions and children therefore undergo a series of imaging procedures. Imaging with a 99mTc dimercaptosuccinic acid (DMSA) isotope study is directed at identifying renal involvement and those kidneys that are at a risk of damage. Studies to demonstrate renal obstruction and VUR are also performed. The uses, advantages and disadvantages of the various imaging methods are compared in the accompanying table. Examples of normal and abnormal findings identified at these investigations are shown in Figures 1 to 10.

While the highest rates of renal scarring occur before one year of age, the risk does not decrease significantly until after the age of five. Scarring occurs in a growing kidney susceptible to delays in treatment of UTI, recurrent UTI and severe VUR. Numerous studies on
first proven UTIs have shown varying results, but overall have demonstrated obstruction in 0-4%,\(^6\) VUR in 8-40%,\(^2\) acute kidney damage in 40%, persistent scarring in 15%, hypertension in 1% and CRF possibly at an incidence of 1 in 20 000.\(^1\) Local experience has found a very low incidence of VUR in the black population.\(^12\)

Realistically, in South Africa, it is
not practically manageable to fully investigate every child under five years of age. Figure 11 outlines an imaging strategy that attempts to limit the radiation dose and invasiveness of the procedures while providing information about both the upper and lower urinary tracts. Unfortunately, a DMSA scan is not available in many regions of this country and, where it is offered, may be prohibitively expensive as a screening tool. Figure 12 outlines an alternative approach that takes into account these problems.

An MCUG provides good detail of the bladder and urethra. It does not provide information about the upper renal tracts and the absence of VUR does not exclude the possibility of significant renal scarring.

Are we missing pathology? Most children with a surgically treatable condition will present before two years of age or have an abnormal ultrasound and hence will be further investigated with an MCUG and will be detected. Are we missing renal scarring? Remember that the development of hypertension and chronic renal failure is rare. This concern is addressed by investigating those children with severe (systemic symptoms and signs) or recurrent infections. Also, milder grades of VUR may resolve spontaneously.

**Conclusion**

The highest risk for scarring is in children less than two years of age and they therefore need appropriate investigation and aggressive therapy. The objective of imaging is to show renal scarring, obstruction and VUR. While catheterisation is traumatic and should be avoided where possible in children, all boys must have a micturating cystourethrogram (MCUG) to exclude posterior urethral valves. Isotope studies have a far lower radiation dose than fluoroscopic studies. In an older child that can void on demand (something many adults are unable to do), an indirect cystogram using intravenous $^{99m}$Tc mercaptoacetyltriglycine (MAG3) can demonstrate reflux without catheterisation and at a lower radiation dose. It is useful for follow-up of VUR where milder grades may resolve spontaneously. Practically, in South Africa, an ultrasound and MCUG are still the mainstays of investigation and should detect all the surgically treatable conditions. Most importantly, ensuring that the UTIs are
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microbiologically confirmed will reduce the number of unnecessary investigations.

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