Introduction
Surgical removal of the kidney in children is a major undertaking. The procedure may be for non-malignant conditions of the kidney and upper urinary tract caused by poorly functioning nephron units. These non-malignant conditions may include chronic destructive infections, chronic obstructive uropathy, or nephroplasty and severe trauma. Nephrectomy in children may also be for malignant conditions of the kidney and adrenal glands. The major indications for nephrectomy vary in different parts of the world and in different age groups and sexes with some recording more benign conditions and others more of malignancies.

Traditionally, nephrectomy is undertaken by open surgery and this is still the practice in our unit as well as other centers in Low and Middle Income Countries (LMICs). More recently, however, minimally invasive laparoscopic surgical techniques have been increasingly applied for nephrectomy in High Income Countries (HICs). There has also been a growing interest in the use of nephron-sparing surgery for selected patients. However, late presentation in our environment, especially for malignant diseases of the kidney, is still a daunting challenge, making such renal conserving surgeries uncommon.

Materials and Methods
This is a retrospective review of all children aged ≤16 years who had nephrectomy from January 2007 to December 2016. We requested the medical records department to permit us to have access to patients data from the theatre records and data. The medical records were reviewed and data retrieved with emphasis on age, sex, side of nephrectomy, duration of symptoms before presentation, indication for nephrectomy, in-hospital complications, length of hospital stay, in-hospital mortality SS version 15 was used for data entry and analysis.

Results
There were 52 nephrectomies in 32 males and 20 females. They were for 35 malignant and 17 non-malignant conditions. Most of the malignancies were Wilms tumour (34/35) while non-malignant conditions were later presenting pelvi-ureteric junction obstruction (6), renal trauma with pedicle avulsion (1), posterior urethral valve with atrophic kidney (1), duplex system with nonfunctioning upper pole moiety (2). Mean age at nephrectomy was 51.0±36.6 years (range 7 weeks to 16; years). Of the nephrectomies, on the left and 41% on the right. Mean duration of hospital stay was 31.78±16.3 days (range 7-66 days).

Male to Female ratio for malignancy was 0.75:1. Malignancy was an indication for all nephrectomies in females (20/35), 60% (21/35) of all malignancies and 54% (28/52) of all nephrectomies were in children aged 1-5 years.

Mean follow-up duration was 25.82 ± 34.12 weeks (range 0.156 weeks). There was only one nephron-sparing surgery in a patient with duplex renal system and nonfunctioning upper pole moiety (19%). All others had total nephrectomy. Complications of treatment included stitch reaction (2), small bowel volvulus and small bowel gangrene (1), hypertrophic scar (1). None of the (3) mortalities in 2 males and 1 female were noted while on initial hospital admission (mortality rate of 5.8%).

Discussion
In this series, 67.6% of the nephrectomies were for malignant renal conditions and 33% for benign conditions. This was similar to finding by Bouhafs et al in Morocco where 62.5% of the nephrectomies were for nephroblastomas. This finding, however, is contrary to many other studies on pediatric nephrectomy from different parts of the world, where there were more benign than malignant indications recorded. From Sammon et al in USA, 73.8% of nephrectomies were for benign indications. Davdaidea in Jordan 59%, Hamad et al in New Zealand 76%, Adamson et al in England 70.5%, Chaboukh et al in Tunisia 78.7%, Fetherston et al in London 67.5%, Nggada et al in Nigeria 60.3%. However, in some studies on indications for nephrectomy in the adult population in both developed and Low and Medium Income Countries (LMICs) more malignancies were noted as indication for nephrectomy in adults. This may be due to the higher incidence of malignancy in older patients and the higher proportion of children who present with congenital malformations. One may not readily explain why malignancy was the major indication for nephrectomy in our pediatric population just like adults in some environment. However, this may be related to this study, in this study, of key non-malignant indications like complications of vesicoureteric reflux (VUR) and reflux.
Malawi Medical Journal (2); 94-98 June 2018

Paediatric nephrectomy: Patterns, indications and outcome

Cape Town no nephrectomy was done for PUJ obstruction despite the substantial number of prenatals diagnosed of PUJ obstruction(5). We compared the indications for nephrectomy more in females and malignancy more in males(3,4,6,10). In this current study, we had only one emergency nephrectomy following renal trauma with pedicle avulsion in a 15 year old male who had low-velocity penetrating abdominal trauma. This corroborates with findings in other studies where trauma to the kidney has been the primary indication for nephrectomy(3,3,12,24). Though our unit is in a teaching hospital, mean age at nephrectomy of 5.1±3.7 years is higher than 3 years Sammon et al. recorded for Teaching Hospitals in the USA for nephrectomy attributable to late presentation generally seen in LMICs. However, this mean age is comparable to 6 years for Non-Teaching Hospitals in The USA(1,2),(5,6). The second most common non-malignant indication in this study is enlarging multicystic dysplastic kidneys (MCDK) disease, Posterior Urethral Valve (PUV) with unilateral non-functioning kidney, duplex renal system with non-functioning upper moiety, renal trauma with pedicle avulsion. It is important to note that complicated VUR, which is generally more common in females, was not an indication for nephrectomy in this study. This may be related to the low incidence of VUR complications in black when compared to Caucasians(25).

Since VUR is the most common benign condition in some series and also more common in females, this finding may explain why this is less likely in males in this study. In the current study, however, non-malignant indications were seen only in males and these were mainly complicated PUJ obstruction. It must be noted that PUJ obstruction is more common in males than females(3).

Overall male: female ratio for all nephrectomies is 1.61 comparable to 1.5:1 recorded by Hammad et al (26) and 1.61 by Nggada et al(14). However, our study showed more male: female ratio of 1.6:1 for non-malignant indications. Differences in the male: female ratio could be explained by the fact that most late-presenting cases of PUV may have developed chronic kidney disease and end stage renal disease where various renal substitution strategies, and not nephrectomy, are employed in their treatment. In some other studies, stone disease was the major non-malignant indication for nephrectomy(12,14). It is noteworthy that no nephrectomies were done for stone disease nor renal tuberculosis was observed in this study.

Early investigation of children suspected to have urological malformations, who present with upper tract infection, will encourage early diagnosis and reduce incidence of complications. In this study, the majority of cases of PUJ obstruction will present earlier for monitoring and possible pyelostomy instead of later for very late nephrectomy. In a report by Ochse et al in 2011, the patient survival rate was 100% for nephrectomy in children(27). The most common non-malignant indication for nephrectomy in this study is 8 while in Sammon et al it was 12. Mean number per year was 5. The mean follow-up duration of 26.37 weeks (range, 0—156 weeks) is short. It is encouraged that children with a failed initial intervention be followed up until they reach adulthood because they could experience subtle renal deterioration at that time or later in adult life(25). Long term follow up is important in early detection of malignant renal tumors. In 2010, Sammon et al(12) noted that 5.8% of their pediatric nephrectomies had minimally invasive nephrectomy, though open transabdominal approach was still the common route for nephrectomy in their series. In the current study, however, there were no facilities and manpower in our hospital for minimally invasive nephrectomy, during the study period and only 7% were done via the transabdominal route. In Hammad et al(26), all partial nephrectomies were done for duplex renal systems and there was increase in number of partial nephrectomies done over their study period. In the current study, however, only one partial upper pole nephrectomy was done in a patient with duplex system and non-functional upper pole moiety. The lower pole was preserved in this patient. There was no recorded partial nephrectomy in all other studies. This may be due to the fact that many patients present late as already documented in a previous study from the same environment(26). Furthermore, there were no cases of benign renal tumors in all of the reviewed study. This corroborates with findings in other studies from the same environment(3,12).

Some other authors had cases of bilateral Wilms tumor in their series and the patients subsequently had nephron-sparing nephrectomy(1,25,26). No Wilms tumours were common as we recorded stitch reaction in (2) patients, hypertrophic scar in (1) patient. Only one patient who had emergency nephrectomy following low velocity penetrating abdominal injury. Ghadima et al., recorded 2 (0.33%) complications in patients who underwent minimally invasive nephrectomy and were the only indications in our study. Major post-operative complications were not common as at the abdominal approach was still the most common route for nephrectomy in children with malignancies(28). This corroborates with findings in other studies(5,12,26). It is noteworthy that no nephrectomies were done for stone disease nor renal tuberculosis was observed in this study. In this study, the malignant cases were mainly Wilms tumour (96.5%). When compared to other studies, renal tuberculosis was the major non-malignant indication and occurred only in males. Most nephrectomies were done within the age range of 1-5 years. Nephron-sparing nephrectomy, major morbidity and re-operation are uncommon. In-hospital mortality from nephrectomy is still high at 5.8%.

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