Canadian Urological Association/Pediatric Urologists of Canada guideline on the investigation and management of antenatally detected hydronephrosis

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Introduction

Prior to the advent of maternal ultrasonography in the 1980s, children with significant congenital hydronephrosis requiring surgery presented symptomatically with abdominal pain, urinary infection, hypertension, hematuria, or failure to thrive. Antenatal hydronephrosis (AHN) became one of the most commonly detected ultrasound (US) findings, affecting 1–5% of pregnancies.[1] The majority of AHN in the third trimester is discovered due to US for maternal indications. The benefits of this early detection of urinary tract dilation include a reduction in the renal damage due to obstruction and infection.[2,3] On the other hand, many of these antenatally detected cases spontaneously resolve with observation and consequently can be submitted to unnecessary investigations and continued medical followup.[4] The challenge to this day remains to predict which of these prenatally detected infants will require corrective surgery, prior to the development of symptoms or potentially irreversible renal damage, thus permitting a more tailored screening.

Methodology

This article presents an update to the 2009 guidelines,[5] based on review of the current literature. The available evidence is summarized and recommendations provided based on the modified Oxford Centre for Evidence-Based Medicine grading system for guideline recommendations, as employed by the International Consultation on Urologic Disease.[6]

Characterizing the patient population

The literature on AHN suffers from a lack of good-quality prospective studies, which precludes any recommendations with a high level of evidence. Published prospective studies are hindered by the limitation that to this date no single gold standard diagnostic test for urinary obstruction exists. In order to appreciate this dilemma, it is imperative to understand the difference between hydronephrosis and urinary tract obstruction. Hydronephrosis simply refers to dilation of the renal collecting system. Congenital renal obstruction has been defined as, "impaired urinary drainage, which, if uncorrected, will limit the ultimate functional potential of the developing kidney."[7] To date, no single imaging study exists that can prove the presence of renal obstruction, contributing to the controversy surrounding management.

The differential diagnosis of AHN, in order of likelihood, includes transient primary hydronephrosis, uretero-pelvic junction obstruction (UPJO), vesicoureteric reflux (VUR), uretero-vesical junction obstruction (UVJO) or primary non-obstructive megaureter, ureterocele, ectopic ureter, and causes of megacystis. Megacystis, or dilated urinary bladder, includes causes of bladder outlet obstruction due to posterior urethral valves (PUV) and, less commonly, Prune Belly syndrome, megacystis-megaureter syndrome, megacystis-microcolon intestinal hypoperistalsis syndrome (MMIHS), anterior urethral valves, megalourethra, urethral atresia, and cloacal anomalies. Some of these entities have gender-specific and hereditary predispositions, which have potential diagnostic implications not discussed herein.

Various grading systems for the severity of AHN exist, which are paramount in decision-making. The simplest grading is the antero-posterior renal pelvic diameter (APD), which is an objective measure of the degree of pyelectasis or dilation of the renal pelvis in the transverse plane. Descriptors such as mild, moderate, or severe should not be used in isolation, as they are subjective and undefined. Since 1993, the standard among pediatric urologists in North

America has been the classification from the Society for Fetal Urology (SFU) (Table 1).[8] The SFU grading classification has been validated with good intra-rater reliability and modest inter-rater reliability, with Grade 3 being the least reliable.[9] The SFU has recently proposed the UTD classification, which combines elements of both APD and SFU. Initial validation has been possibly more reliable than the SFU system,[10,11] with others showing the same issues with inter-rater reliability.[12] The UTD classification for HN was released to address potential shortcomings of the current SFU grading system; more specifically, to deal with inconsistencies between prenatally detected HN and postnatal management strategies within and across specialties. The UTD classification uses a three-point system based on six different US observations (renal pelvis APD, calyceal dilation, parenchymal thickness/appearance, ureteral dilation, and bladder abnormalities) to stratify patients into three risk categories based on the most concerning of six US variables (UTD P1, P2, and P3): UTD P1 (low-risk) with 10–15 mm renal pelvis APD and central calyceal dilation to UTD P3 with renal pelvis APD >15 mm, peripheral calyceal dilation, parenchymal thinning, ureter dilation, and or bladder abnormality (high-risk).[13] Nevertheless, the added complexity of the UTD classification imposes a need for greater validation prior to supplanting the simplicity of the SFU classification.

Definition of the dilated urinary tract

The diagnosis and management of the fetus or child with a dilated urinary tract requires an understanding of what are acceptable degrees of dilation (Table 2).[1,14] The definitions of pyelectasis, hydroureter, and megacystis will determine the intensity of investigations and frequency of followup, both antenatally and postnatally. It is generally accepted that pyelectasis in the third trimester is defined as APD >4–5 mm.[1] Nevertheless, the ideal cutoff for routine postnatal screening remains controversial, since high grades of AHN can resolve postnatally and conversely low grades can deteriorate; notwithstanding, most centres use a cutoff of 7 mm in the third trimester for indicating a postnatal evaluation. Postnatal data on magnetic resonance imaging (MRI), not US, suggest that the normal APD in children is 3 mm at one year of age, 6 mm at 18 years, with the 99th percentile for children <5 years of age being <10 mm.[1]

Aside from APD, the severity of hydroureteronephrosis (HUN) has also been classified by the SFU based on the transverse measure of the distal ureter; Grade 1 is <7 mm, Grade 2 is 7–10 mm, and Grade 3 is >10 mm.[8] This classification is mostly descriptive and has not been submitted to much scrutiny. The dilated fetal bladder or megacystis has been defined based on the formula for fetal bladder sagittal length (FBSL) in mm = gestational age in weeks + 2.[15]

It is important to remember that a dilated urinary tract does not automatically infer obstruction of the urinary tract. Whereas hydronephrosis equates a dilated renal collecting system, obstruction cannot be proven on the basis of any single imaging study, hence the need for a period of observation to demonstrate deterioration over time.

Antenatal vs. postnatal followup

The frequency of antepartum followup of a pregnant mother is left to the discretion of the obstetrician. While AHN is more common in fetuses with serious chromosomal anomalies, most sources do not recommend routine karyotyping for all cases of isolated AHN. However, this may be considered in the presence of multiple system anomalies.[1] Second trimester AHN is often followed up so that progression of severity can be detected and appropriate postnatal followup planned. Cases with severe bilateral AHN and/or oligohydramnios raise concern over potential renal failure and are often referred to the pediatric urologist for antenatal counselling. Other concerning sonographic findings include renal cortical hyper-echogenicity, renal cortical cysts, and a dilated bladder. The evaluation and selection of cases for in utero intervention is beyond the scope of this guideline, but treating physicians should be aware that many tertiary care centres offer interventions, such as vesico-amniotic shunting, in selected cases of bladder outlet obstruction in the setting of multidisciplinary teams. The impact of prenatal diagnosis of HN is also a subject of lengthy discussion; one is referred to the excellent reviews by Thomas.[3,4]

Postnatal resolution has been noted in 25–50% of AHN cases.[1,16] Of those persisting postnatally, the majority will be low-grade (Table 3).[17] In view of this, most centres will refer cases for postnatal evaluation if the third trimester APD is >7 mm, despite the fact that >4 mm is considered abnormal

Table 1. SFU grading of hydronephrosis

SFU grade	Ultrasound findings
0	Normal kidney (resolved antenatal hydronephrosis)
1	Pyelectasis
2	Pyelectasis with dilation of 1 or more major calyces (caliectasis)
3	Pyelectasis with dilation of all 3 major calyces
4	Pyelectasis with parenchymal thinning compared to contralateral kidney

SFU: Society for Fetal Urology.

Table 2. Severity of antenatal hydronephrosis (AHN) by APD[14]

Degree of ANH	Second trimester	Third trimester
Mild	4 to <7 mm	7 to <9 mm
Moderate	7 to ≤10 mm	9 to ≤15 mm
Severe	>10 mm	>15 mm

APD: antero-posterior renal pelvic diameter.

Table 3. Distribution of antenatal hydronephrosis (AHN) severity and likelihood of postnatal urinary tract pathology[17]

Degree of AHN	% of ANH	% postnatal pathology
Mild	57–88	12
Moderate	10–30	45
Severe	1.5–13	88

by definition. In a meta-analysis, Lee et al demonstrated that antenatal APD >15 mm in the third trimester predicted an 88% chance of postnatal pathology.[14] An association between higher rates of postnatal pathology and severity of HN holds true for most HN diagnoses, with the exception of VUR. VUR rates among patients with mild, moderate, and severe prenatal HN are not significantly different.[14] Similarly, Dias et al have shown that if prenatal APD is >18 mm in the third trimester and >16 mm postnatally, the sensitivity and specificity of these cutoff values to identify infants who would eventually require pyeloplasty for UPJO were 100% and 86%, respectively.[18]

What are the postnatal investigations?

Clinical examination

Thorough physical examination should specifically include verifying the presence of a palpable kidney or bladder, abdominal wall abnormality, signs of spina bifida occulta, a normal introitus in females, and in males the presence of gonads and a normal urethra. A baseline urinalysis can be useful in the infant followup period and when the child is non-verbal and unable to express symptoms of a urinary tract infection (UTI), although the need for bag specimens introduces a high risk of contamination. Serum creatinine is indicated in cases of severe bilateral HN or abnormal renal echogenicity, similarly in a solitary kidney. Serum creatinine should be obtained after two days to avoid confusion with maternal creatinine.

Renal–bladder US (RBUS)

All children with AHN should have a complete abdomino-pelvic US, with particular attention to both the kidneys and bladder. One of the most common oversights is to focus merely on the kidneys, likely due to the fact that many radiology requisition forms separate the abdomen and pelvic US. The RBUS should include assessment of cranio-caudal length of the kidneys, degree of echogenicity and cortico-medullary differentiation, SFU grade of hydronephrosis, maximal APD on transverse axial view of the renal pelvis, diameter of both proximal and distal ureter if dilated, the degree of bladder filling, the detrusor thickness or presence of bladder trabeculation, diverticula, ureterocele, and posterior urethral dilation in males.

A full bladder should prompt a period of observation with re-imaging post-void to assess for the capability to empty the bladder and to assess whether the HN improves post-void. The state of bladder filling should especially be noted on serial ultrasounds and compared to the previous study when worsening HN is detected.[19] Similarly, comparisons of renal length or APD between serial studies should be consistent with the patient positioning, as the prone views can differ from the supine or decubitus views.[20] Fasting for a RBUS is both unnecessary and unpleasant.

Timing of the first postnatal US has been studied in a limited fashion, yet the practice standard has become to avoid doing an US in the first two days of life due to a concern of understaging secondary to neonatal oliguria.[1,21] Others have studied this issue and have not confirmed the findings.[22] Certainly, in cases such as PUV where immediate postnatal management is required, there is no reason to delay the US. The acceptable delay in the timing of the first postnatal US is controversial, with the SFU suggesting anywhere from 1–4 weeks. The timing of this study depends, to a certain degree, on the treating physician's attitudes to detecting asymptomatic VUR. In the absence of a desire to detect such VUR, it is intuitive that antenatal HGHN (HGHN, SFU Grades 3–4) should be imaged soon so as to establish a baseline for serial comparison, whereas low-grade HN (LGHN, SFU Grades 1–2) can be imaged at a greater time interval. On the other hand, families are greatly reassured by a timelier investigation. In addition, the postnatal US may reveal subtle findings, such as poor cortico-medullary differentiation, a ureterocele, or detrusor hypertrophy, which can easily be missed when imaging a moving fetus.

Voiding cysto-urethrography (VCUG)

Technical considerations are important and often overlooked in centres not accustomed to the evaluation of children.[23] The study should include a scout view for assessment of spine anomalies and the presence of significant constipation or urinary stones. A balloon catheter should not be used, as the balloon can obscure the filling defect characteristic of a ureterocele. The amount of urine removed should be recorded and the urine sent for analysis and culture as indicated. The bladder should be gravity filled until the first void occurs, with recording of the obtained bladder capacity. Voiding views of the urethra with post-void views of the bladder are needed. Delayed imaging after the post-void image may be required if there is VUR into a dilated renal pelvis or ureter so as to assess for concomitant UPJO and UVJO. A cyclical study with at least two fill and void cycles will increase the detection of VUR.[24] Nuclear cystography is more sensitive for VUR with less radiation exposure and is

generally recommended for surveillance studies or, where indicated, sibling screening.

The purpose of a VCUG is to assess for the precise cause of AHN and is especially helpful in excluding entities such as VUR and ureteroceles, as well as urethral anomalies, such as PUV. Historical practice patterns at the onset of the era of maternal ultrasonography in the 1980s were to evaluate all infants with AHN with both VCUG and nuclear renography, due to concerns over obstructive nephropathy and UTI. With experience, the yield of such studies and the natural history were better understood.[14] On average, 16% of infants with AHN are found to have VUR, with 25% of such cases occurring in the non-dilated, contralateral renal unit.[25] In this meta-analysis, the prevalence of VUR in a non-dilated kidney was 4%, suggesting this may be the normal prevalence of VUR in the human infant. Szymanski et al compared a group of children with AHN screened with VCUG to a group managed with observation and demonstrated that the incidence of UTI was 1% in LGHN (SFU Grades 1and 2) and occurred exclusively in the group who underwent VCUG.[26] In this cohort, the incidence of UTI was three-fold higher in the HGHN group (SFU Grades 3 and 4) than in the LGHN group, suggesting that the grade of HN was a more important risk factor for UTI than VUR. Of note, children with bladder anomalies or renal anomalies apart from isolated HN were excluded from the study.

Certainly, any infant with suspected bladder outlet obstruction (e.g., PUV) should have an urgent VCUG. Bladder outlet obstruction would be suspected with findings of megacystis, thick or trabeculated detrusor, bilateral HGHN, or dilated posterior urethra. This suspicion is amplified with findings of increased renal cortical echogenicity, renal cortical cysts, or a history of oligohydramnios.

It is important to note that the clinical utility of a VCUG in HGHN is not due to concern over UTI, rather it helps to distinguish an obstructive cause of AHN from one due to VUR, thus helping to tailor the frequency and type of serial imaging studies. The American Urological Association (AUA) guidelines panel on VUR similarly recommends that VCUG be performed in infants with HGHN, hydroureter, or bladder anomalies.[25]

Diuretic renography

The current imaging test of choice for the assessment of the function of a hydronephrotic kidney is the MAG3 diuretic renogram, as it permits assessment of both the differential renal function (DRF) and the drainage time. Technical considerations can alter the test results; hence, a standardized protocol is important in permitting comparisons of serial studies. The "well-tempered renogram" was first described in 1992 by the SFU and the Society for Nuclear Medicine (SNM).[27] The protocol includes hydration to stress the urinary collecting system and bladder catheterization to avoid artifacts due to a full bladder. The SNM revised their guidelines in 2008[28] and to this day, significant differences exist compared to the protocol from the European Association of Nuclear Medicine.[29] These different protocols have been compared experimentally and can lead to different interpretations of the results.[30] This highlights the importance of comparing serial studies only if they were performed with the same institutional protocol.

The diuretic renogram should include a report of the DRF, which can vary from 45–55%; the cortical transit time, which is normal up to five minutes; the half-time; and the shape of the curve.[31] Test results can be influenced by poor renal function (single kidney glomerular filtration rate [GFR] <15 ml/min), poor hydration, massively dilated collecting system, full bladder, and a dilated distal ureter.[32]

Familiarity with the history of diuretic renography helps in understanding current controversies over the timing of this test. Diuretic renogram definitions of obstruction were first introduced in patients with symptomatic UPJO or a positive Whitaker test.[33] When maternal ultrasonography was introduced and AHN was discovered, the same criteria were initially applied; with time, the realization occurred that too many infants were having unnecessary pyeloplasties. In the early 1990s, two landmark series of the conservative management of AHN arose that contributed to two schools of thought. In the Ransley group, renograms were done at four weeks of life due to concerns over false positive studies with immature neonatal GFR. Pyeloplasty was indicated on the basis of a single study with initial poor split function (<40% DRF).[34] In the Koff study, renograms were performed at the time of diagnosis, regardless of age, and all patients were given a chance at observation.[35] The purpose of the first renogram was to serve as a baseline for serial comparison, the thinking being that drainage times would improve with renal maturation. The followup interval was tailored to the severity of the initial DRF in cases with low initial split function. It is interesting to note that the Koff group suffered no irreversible loss of function with observation, whereas the Ransley group had a 9% renal deterioration rate. In conclusion, renograms can be performed at any age, as long as they are used as a baseline study for serial comparison. One should also consider a dimercaptosuccinic acid (DMSA) study to establish early split function in cases of neonates or premature infants, since the DRF in this study is not influenced by an immature GFR.[36]

Ancillary tests

Additional studies are sometimes necessary to further elucidate the precise cause of AHN, which, because of their invasive nature, are reserved for only select cases. Percutaneous antegrade pyelography or endoscopic retrograde pyelog-

raphy can be useful when multiple levels of obstruction are suspected, such as combined UPJO and UVJO. Cystoscopy can help for evaluation of ectopic ureters and ureteroceles as can magnetic resonance urography (MRU). MRU can be especially helpful with the abnormal anatomy found in duplication anomalies, renal ectopy and renal fusion anomalies. This type of abnormal anatomy is often found in children with the VACTERL association or cloacal anomalies. Non-invasive studies, such urinary biomarkers (e.g., transforming growth factor beta) are still under investigation, but hold promise in predicting those cases that could deteriorate and require closer followup.[37] Similarly, the field of functional renography holds promise both with nuclear medicine[38] and positron emission tomography.[39] GFR renal scan may be helpful in cases of severe bilateral HN.

Continuous antibiotic prophylaxis (CAP)

CAP has empirically been recommended for newborns with prenatal HN in an attempt to reduce the rate of UTI during the first two years of life. However, the AUA, SFU and Canadian Urological Association (CUA) all acknowledge that use of CAP for prevention of UTI in infants with prenatal HN has been based on low levels of evidence. Not surprisingly, this lack of high-quality evidence has resulted in practice variability for CAP use. According to the 2010 SFU consensus statement on HN, CAP should be recommended only for infants with HGHN and those with VUR.[1]

Given the uncertainty over CAP use in prenatal HN patients, a systematic review was conducted in 2013 to summarize the latest evidence regarding CAP use in children with prenatal HN. Data of nearly 4000 patients from 21 full-text articles demonstrated that pooled UTI rates were four times higher for HGHN patients when compared to those with LGHN. In children with LGHN, UTI rates were equivalent, regardless of their CAP status (2.2% on CAP vs. 2.8% not on CAP). On the contrary, HGHN patients on CAP experienced fewer UTIs than those not on CAP (14.6% vs. 28.9%; $p<0.01$), suggesting that CAP may be beneficial in this population. The estimated number needed to treat was seven, meaning that a clinician would offer CAP to seven patients with HGHN in order to prevent one UTI.[40] A more recent systematic review confirmed that there seems to be value in providing CAP to infants with HGHN.[41]

The suggestion has also been made that the presence of hydroureter or ureterocele carries a higher risk of UTI (Table 4).[42]

The subgroup of patients with primary non-refluxing megaureters (hydroureteronephrosis) has been studied in greater detail. These infants had a much higher febrile UTI rate than those with isolated HN (19/59 [32%] vs. 12/218 [6%]) according to a prospective study.[43] Moreover, another study demonstrated that febrile UTIs developed in 34% of megaureter patients within the first six months of life and that circumcision and CAP significantly decreased their infection rates.[44] Other studies with retrospective design have reported similar findings.[45] In addition, females and uncircumcised males with prenatal HN have also exhibited a much higher risk of UTI.[46]

Table 4. Incidence of UTIs in patients with hydronephrosis[42]

	No. UTI (%)	p	OR	95% CI
Sex				
Male	67 (19)	0.8	0.93	0.51–1.71
Female	16 (20)			
Obstruction				
Yes	50 (39)	0.001	5.23	3.148–8.67
No	33 (11)			
Hydroureter				
Yes	37 (47)	0.001	6.00	3.49–10.32
No	46 (13)			
Uretetocele				
Yes	10 (59)	0.001	6.65	2.45–18.06
No	73 (18)			
HN grade				
I	6 (4)			
II	13 (14)	0.001	4.15	1.52–11.32
III	26 (33)	0.001	12.67	4.95–32.47
IV	38 (40)	0.001	16.93	6.80–42.15

CI: confidence interval; HN: hydronephrosis; OR: odds ratio; UTI: urinary tract infection.

The role of prophylactic antibiotics in children with prenatal HN who are awaiting completion of postnatal investigations is controversial. While it is believed that CAP may prevent UTI in children with prenatal HN, it has yet to be proven. A randomized, controlled trial comparing trimethoprim to placebo in infants with SFU Grades 3–4 HN is currently underway in order to answer this question.[47] Therefore, some authors suggest institution of CAP at birth, while others recommend a low threshold for investigation and treatment of a suspected UTI. Commonly used prophylaxes in the neonate include amoxicillin, cephalexin, and trimethoprim. Trimethoprim-sulfamatholxazole and nitrofurantoin should NOT be used in the neonate because of the respective risk of kernicterus and hemolytic anemia.

Followup protocols

SFU Grades 3 and 4, APD >15 mm, HGHN

The initial postnatal RBUS should be done as soon as feasible after Day 2 of life, as this represents the cohort most likely to require surgery and to experience UTI. The likelihood of Grade 4 HN undergoing a pyeloplasty is up to 75%.[35] Most centres recommend the US within two weeks of life. Bilateral HGHN requires more urgent consultation,

including a VCUG to exclude PUV. If the postnatal US reveals persistent HGHN, these cases should be referred to a pediatric urologist for immediate consultation. These cases are most likely to benefit from CAP and should have both a VCUG and MAG3 renal scan. It is worth repeating that the clinical utility of a VCUG in HGHN is not due to concern over UTI, rather it helps to distinguish an obstructive cause of AHN from one due to VUR, helping to tailor the frequency and type of serial imaging studies. In the absence of any pathology requiring immediate intervention, repeat US and MAG3 should be performed within three months, although a repeat MAG3 is optional if the first exam is normal (Fig. 1). If improvement is not seen, close followup should continue to at least 18 months of age, by which time most childhood UPJO becomes apparent. One should keep in mind that historical cohorts of symptomatic UPJO prior to the advent of maternal ultrasonography would undergo pyeloplasty at an average age of six years,[2] hence a persistent Grade 3 HN requires active surveillance.

SFU Grade 1 and 2, APD <10 mm, LGHN

The timing of the first postnatal US is open to debate and left to the discretion of the treating physician. For cases with antenatal APD between 10–15 mm, the SFU grading is suggested to clarify which followup protocol should be used. Most physicians will obtain an US within the first months of life and a followup can be obtained six months later. In the absence of deterioration, followup US can then be performed on an annual basis. VCUG and MAG3 are not required. Szymanski

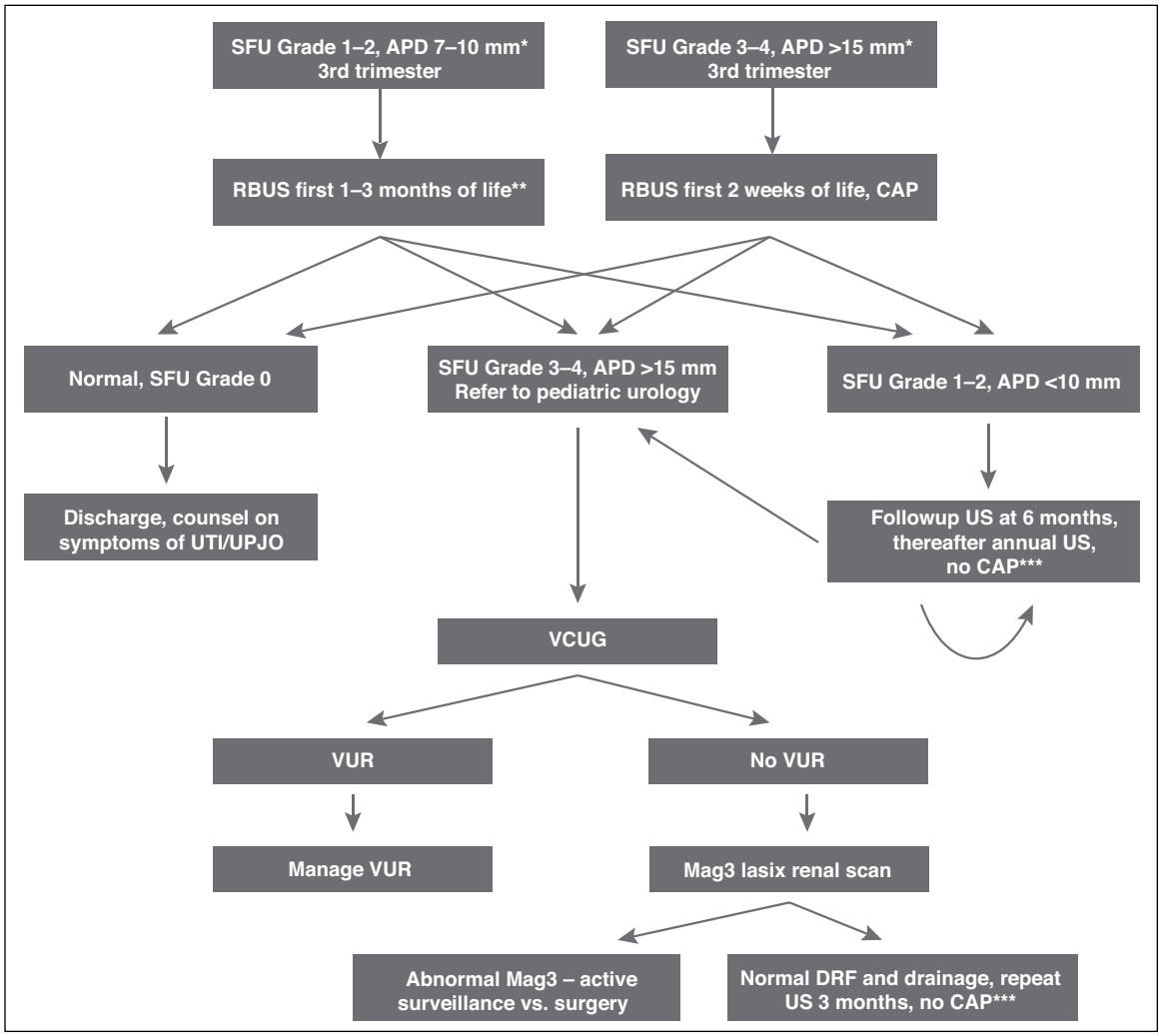

Fig. 1. Algorithm for management of antenatal hydronephrosis. *APD between 10 and 15 mm should be managed by the SFU grade. **Dilated ureters, abnormal bladders, or abnormal renal parenchyma should be imaged sooner. ***Some authors advocate CAP for LGHN with dilated ureters or abnormal bladders. The risk of UTI is also increased in females and uncircumcised males. APD: antero-posterior renal pelvic diameter; CAP: continuous antibiotic prophylaxis; LGHN: low-grade hydronephrosis; RBUS: Renal–bladder ultrasound; SFU: Society for Fetal Urology; UPJO: uretero-pelvic junction obstruction; US: ultrasound; UTI: urinary tract infection; VCUG: voiding cysto-urethrography; VUR: vesicoureteric reflux.

et al demonstrated the risk of UTI in isolated LGHN with no renal size discrepancy and no ureteral or bladder abnormalities to be <1 %;[26] hence, CAP is unnecessary. The majority of such cases improve by two years of age.[48] Since the majority of congenital UPJO progresses to pyeloplasty by 18 months of age, it seems prudent to continue the followup to at least such an age. Multiple authors have shown that with long-term followup to 10 years, the risk of deterioration requiring surgical intervention is 2%.[49,50] The question then arises as to the need for followup beyond two years of age in patients who have persistent LGHN. Some authors recommend discharge and counsel families on the symptoms of UPJO. Future prospective studies will be needed to determine the most cost-effective and clinically appropriate followup protocol for children with prenatal HN. Akhavan et al have looked at the resource utilization associated with the diagnostic evaluation of non-refluxing HN infants and found that decreasing the number of ultrasounds performed during followup for patients with SFU Grades 1–2 HN could reduce 24% of the healthcare costs.[51]

SFU Grade 0

Up to 50% of AHN can resolve at birth and is referred to as SFU Grade 0 HN. Such transient HN is also the subject of controversy, with the SFU guidelines recommending a repeat US within the first month of life.[1] Many centres will discharge the patient after a normal postnatal US, since the majority of late or recurrent HN are symptomatic and can be counselled as such. Certainly, it appears contradictory to follow up a documented LGHN within six months, whereas a normal US is followed up within one month.

Indications for surgery in obstructive HN and HUN

The current difficulty in proving the presence of obstruction in HN and HUN imply that a period of observation is needed to document deterioration. This period of observation carries a risk of potentially irreversible loss of renal function.[52] For this reason, appropriate counselling of families should include a discussion of the risks of observation vs. immediate surgery. Strong indications for reconstructive surgery include loss of DRF of >5% on serial renography or worsening HN with worsening drainage times on renography. In older children, flank pain or vomiting are also suggestive of obstruction, especially if exacerbated by fluid intake. Hypertension and renal calculi can rarely be signs of obstruction. Relative indications for surgery include UTI, low DRF on initial renogram, palpable giant HN, concern over non-compliance with followup imaging protocols, and family preference in cases of persistent HGHN requiring repeated renographic evaluation. In one study, an alarming 42% of children with HGHN were lost to followup.[53] The threshold for surgical intervention is lowered in cases of solitary kidney or bilateral HGHN.

Summary of recommendations

1. All significant AHN should be investigated with a postnatal RBUS. Most centres define significant AHN in the third trimester as APD ≥7 mm *(Level 3 evidence; Grade C recommendation)*.
2. The role of CAP initiated at birth is controversial, but may be of greater benefit in Grades 3 and 4 HN and in cases with dilated ureter or bladder abnormality. Females and uncircumcised males with AHN may also benefit more compared to circumcised boys *(Level 3 evidence; Grade C recommendation)*.
3. VCUG is not necessary in the evaluation of isolated LGHN (SFU 1–2) with normal renal parenchyma and symmetric renal size *(Level 3 evidence; Grade C recommendation)*.
4. HGHN (SFU 3–4) should be investigated with a VCUG, followed by diuretic renography if the HN cannot be explained by VUR *(Level 4 evidence; Grade D recommendation)*.
5. Diuretic renography is not necessary in the evaluation of isolated LGHN (SFU 1–2) with normal renal parenchyma and symmetric renal size *(Level 4 evidence; Grade D recommendation)*.

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