Postnatal management of fetal hydronephrosis

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Literature review current through: May 2017. | **This topic last updated:** May 26, 2017.

INTRODUCTION — Fetal hydronephrosis (dilation of the renal pelvis) is a common, readily diagnosed finding on antenatal ultrasound examination, which may be a transient benign condition or be associated with significant congenital anomalies of the kidney and urinary tract (CAKUT). The goals of postnatal management of infants with fetal hydronephrosis is to identify those with clinically significant CAKUT while avoiding unnecessary testing in patients with physiologic or clinically insignificant hydronephrosis. In addition, early identification of infants with significant disease allows initiation of interventional therapy that may minimize adverse effects of CAKUT.

Postnatal management of infants diagnosed with fetal hydronephrosis is reviewed here. The definition, etiology, and prenatal issues of fetal hydronephrosis and specific urologic conditions that may present as fetal hydronephrosis are discussed separately. (See "Overview of fetal hydronephrosis" and "Congenital ureteropelvic junction obstruction" and "Primary megaureter in infants and children" and "Ectopic ureter".)

BACKGROUND AND MANAGEMENT GOALS — In most cases, renal pelvic dilation diagnosed in utero is a transient, physiologic state, however, congenital anomalies of the kidney and urinary tract (CAKUT) can present with fetal hydronephrosis due to urinary tract obstruction and vesicoureteral reflux (VUR). These conditions may be associated with impaired normal renal development and/or cause renal injury. Nevertheless, the majority of cases of fetal hydronephrosis are not clinically significant, and therefore excessive concern may lead to unnecessary testing of the newborn infant and anxiety for parents and health care providers.

The goals of postnatal management of infants with fetal hydronephrosis are to identify patients with significant CAKUT while avoiding unnecessary testing in patients with physiologic or clinically insignificant hydronephrosis. Evaluation includes physical examination and the use of imaging studies to detect abnormalities that will require postnatal intervention.

There is not a single test or finding that accurately differentiates infants with significant disease from those who are normal or have insignificant findings. In our practice, we use an approach based upon the presence of predicative factors (bilateral involvement and severity of persistent fetal hydronephrosis) for postnatal management that limits unnecessary testing and minimizes parental distress [1,2]. (See 'Approach' below and "Overview of fetal hydronephrosis", section on 'Congenital anomalies of the kidney and urinary tract (CAKUT)'.)

It is important to remember that it is rarely necessary to operate on an obstructed kidney in a neonate in the first few days or weeks of life because the fetal kidneys start to make urine between the fifth and ninth week of gestation; therefore, an additional few days and/or weeks of observation after birth awaiting an accurate diagnosis rarely affects long-term outcome. In addition, the added anesthetic risk in the neonatal period needs to be taken into account. An important exception are patients with posterior urethral valves (PUV), who require intervention to relieve post-bladder obstruction as soon as possible after birth. (See "Management of posterior urethral valves", section on 'Postnatal management'.)

PHYSICAL EXAMINATION — The neonatal physical examination can identify abnormalities that are indicative of congenital anomalies of the kidney and urinary tract (CAKUT), which are associated with fetal hydronephrosis. These include the following:

- The presence of an abdominal mass that could represent an enlarged kidney due to obstructive uropathy or multicystic dysplastic kidney (MCDK). (See "Congenital ureteropelvic junction obstruction" and "Renal cystic diseases in children", section on 'Multicystic dysplastic kidney'.)
- A palpable bladder in a male infant, especially after voiding, may suggest posterior urethral valves (PUV). (See "Clinical presentation and diagnosis of posterior urethral valves".)
- A male infant with prune-belly syndrome will have deficient abdominal wall musculature and undescended testes. (See "Prune-belly syndrome".)
- The presence of outer ear abnormalities is associated with an increased risk of CAKUT. (See "Congenital anomalies of the ear", section on 'Association with renal anomalies'.)

- A single umbilical artery is associated with an increased risk of CAKUT, particularly vesicoureteral reflux (VUR). (See "Assessment of the newborn infant", section on 'Umbilical cord'.)

- Spinal and/or lower extremity abnormalities suggesting a neurogenic bladder, which may result in hydronephrosis and dilated ureters. (See "Urinary tract complications of myelomeningocele (spina bifida)".)

IMAGING STUDIES — Postnatal evaluation of a newborn with fetal hydronephrosis begins with an ultrasound examination. The timing of ultrasonography and the need for other studies depend upon the severity of fetal hydronephrosis and whether there is bilateral involvement or an affected single kidney.

Ultrasonography — The preferred initial postnatal imaging study for infants with clinically significant fetal hydronephrosis is an ultrasound examination of the kidneys and bladder. Ultrasonography can detect most congenital anomalies of the kidney and urinary tract (CAKUT) associated with fetal hydronephrosis without radiation exposure [3,4]. The need and timing of the study depends upon the severity of the fetal hydronephrosis. In general, postnatal evaluation is performed for cases that reach a minimum **prenatal** renal pelvic diameter (RPD) of 10mm based on an antenatal ultrasound performed in the third trimester, as RPDs below this level are unlikely to be associated with CAKUT. (See "Overview of fetal hydronephrosis", section on 'Congenital anomalies of the kidney and urinary tract (CAKUT)'.)

In general, examination should be avoided in the first two or three days after birth, because hydronephrosis may not be detected due to extracellular fluid shifts that will underestimate the degree of hydronephrosis. However, infants with bilateral hydronephrosis and those with a hydronephrotic single kidney require more urgent evaluation within 48 hours of birth because of the increased likelihood of significant disease and a possible need for early intervention.

Voiding cystourethrogram — A voiding cystourethrogram (VCUG) is performed in neonates with persistent **postnatal** hydronephrosis (RPD ≥10 mm) to identify patients with bladder outlet obstruction, most commonly posterior urethral valves (PUV), and to detect vesicoureteral reflux (VUR) (algorithm 1 and algorithm 2). (See 'Approach' below and 'Persistent postnatal ultrasound findings' below and "Clinical presentation and diagnosis of posterior urethral valves", section on 'Diagnosis'.)

For this procedure, a urinary catheter is inserted into the bladder and contrast material is instilled. Fluoroscopic monitoring is performed while the bladder is filling and during voiding. Infants usually tolerate this procedure well. Although the duration of fluoroscopy is minimized, the gonads, especially the ovaries, are exposed to radiation [5].

Diuretic renography — Diuretic renography (renal scan and the administration of a diuretic, typically furosemide) is used to diagnose urinary tract obstruction in infants with persistent hydronephrosis, usually ordered after a VCUG has demonstrated no VUR [6]. It measures the drainage time from the renal pelvis, and assesses the relative contribution of each kidney to overall renal function.

The test requires insertion of a bladder catheter to relieve any pressure that can be transmitted to the ureters and kidneys. Intravenous access is needed for hydration and the administration of the radioisotope and diuretic. The preferred radioisotope is technetium-99m-mercaptoacetyltriglycine (Tc99mMAG3), which is taken up by the renal cortex, filtered across the glomerular basement membrane (GBM) to the renal tubules, and excreted into the renal pelvis and urinary tract [7].

The study includes two phases:

- Initial phase – Radioisotope is injected intravenously and renal parenchymal (cortical) uptake is measured during the first two to three minutes. The relative contribution of each kidney to overall renal function referred to as **split renal function** is assessed quantitatively. Split renal function is the most useful measure to detect differences in renal function between the two kidneys. As a rule of thumb, spilt renal function of less than 5 percent difference is unlikely to be clinically significant.

  In patients with unilateral hydronephrosis (which is the most common clinical scenario), if the normal nonhydronephrotic kidney and hydronephrotic kidney both have similar function (ie, difference in split renal function <5 percent), conservative management without surgery is a safe option. Subsequent studies can be compared to the initial baseline scan to determine whether kidney function remains stable or whether increasing differences in split renal function develop that indicate a decrease in the function of the hydronephrotic kidney, most likely due to significant obstruction, which may require intervention [8].

- Second phase – In the second phase, at peak renal uptake, intravenous furosemide is administered and the excretion of isotope from the kidney is measured (referred to as the "washout curve"). This phase indicates the extent of obstruction, if present. In the normal kidney, the administration of furosemide results in a prompt washout. In a dilated system, if washout occurs rapidly after diuretic administration (<15 minutes), the system is not obstructed. If washout is delayed beyond 20 minutes, the pattern is consistent with obstructive uropathy. However, a delayed washout must be interpreted with caution [9,10]. As an example, in a series of 39 infants with antenatal unilateral hydronephrosis followed without surgery, diuretic renography indicated obstruction in 24 patients whose renal function never decreased and thus could not have been obstructed [10]. These results may partly be due to the normally low neonatal glomerular filtration rate (GFR) that can be refractory to diuretic therapy. If washout is between 15 and 20 minutes, the study is considered indeterminate.

A number of factors can affect the accuracy of the diuretic renogram. This includes the state of hydration of the infant, the functionality of the bladder catheter, the timing of diuretic administration, the accuracy of physically outlining the renal tissue in the presence of severe hydronephrosis, and the background effect from the liver and spleen.

Magnetic resonance urography — Magnetic resonance urography (MRU) in children is becoming more commonly used in the diagnosis and management of congenital uropathies, such as ureteropelvic junction obstruction (UPJO) [11,12]. MRU is especially useful in the management of obstructed kidneys that have rotation or ascent anomalies, or are single. MRU can more clearly define the anatomy and delineate the proper surgical approach (ie, retroperitoneal versus transperitoneal). The disadvantage of MRU is that the study often requires general anesthesia or heavy conscious sedation in children. Furthermore, the contrast agent gadolinium can only be used if the renal function is normal (requiring a preprocedure serum creatinine test) because of reports of irreversible renal fibrosis in patients with renal insufficiency. Newer MRU technology may even define obstruction, eliminating the need for diuretic renal scans. (See "Nephrogenic systemic fibrosis/nephrogenic fibrosing dermopathy in advanced renal failure", section on 'Gadolinium'.)

APPROACH — The goal of evaluation is to identify all infants with significant renal or urinary tract abnormalities, but limit unnecessary radiographic studies and minimize parental distress in infants with clinically insignificant findings or normal infants. Our management approach of infants with fetal hydronephrosis is based upon confirmation of persistent postnatal hydronephrosis and the following predicative factors (algorithm 1 and algorithm 2) [1,2,13]:

- Bilateral involvement or an affected single kidney
- Severity of hydronephrosis – The severity of **postnatal** hydronephrosis is determined by an ultrasonogram performed after 48 hours of life in a full term infant and is based on anterior-posterior pelvic diameter as follows and whether or not there is calyceal dilation and renal parenchymal thinning:
  - <10 mm – Normal or mild hydronephrosis.
  - 10 to 15 mm – Moderate hydronephrosis.
  - >15 mm – Severe hydronephrosis; these infants are at the greatest risk for significant renal disease, which may require surgical correction [3].

Bilateral fetal hydronephrosis — Infants with bilateral fetal hydronephrosis are at increased likelihood to have significant disease. Infants with fetal bilateral hydronephrosis or those with a hydronephrotic single kidney with a renal pelvic diameter (RPD) >10 mm in the third trimester should be initially evaluated by ultrasonography on the first to second postnatal day (algorithm 1). Bilateral hydronephrosis suggests an obstructive process at the level of or distal to the bladder, such as ureterocele, or posterior urethral valves (PUV) in a male infant, which can be associated with impaired renal function and ongoing renal injury.

If the postnatal ultrasound demonstrates persistent hydronephrosis, a voiding cystourethrogram (VCUG) should be performed to identify cases of PUV or bilateral vesicoureteral reflux (VUR). (See 'Persistent postnatal ultrasound findings' below and "Clinical presentation and diagnosis of posterior urethral valves", section on 'Diagnosis' and "Clinical presentation, diagnosis, and course of primary vesicoureteral reflux", section on 'Diagnosis'.)

Unilateral fetal hydronephrosis — In newborns with clinically significant unilateral fetal hydronephrosis (prenatal RPD >10 mm on an antenatal ultrasound performed in the third trimester), ultrasonography should be performed after the infant returns to birth weight (after 48 hours of age and within the first two weeks of life) (algorithm 2).

Antibiotic prophylaxis — Higher rates of urinary tract infections (UTIs) have been reported in children with prenatally diagnosed hydronephrosis compared with the general pediatric population [14,15]. The risk of infection rises if there is an underlying urologic abnormality, such as VUR or obstructive uropathy, and is greater in girls compared with boys [16]. The risk also rises with the severity of fetal hydronephrosis [17].

Based on the available evidence, we suggest that antibiotic prophylaxis (amoxicillin, 12 to 25 mg/kg given orally per day) is started after delivery in infants with high-grade fetal hydronephrosis (ie, Society of Fetal Urology [SFU] grade IV (image 1) or an RPD >10 mm in the third trimester) until the diagnosis of VUR or obstructive uropathy is excluded. In our center, antibiotic prophylaxis is not generally administered to infants with low-grade and moderate-grade fetal hydronephrosis (ie, SFU grades I, II, and III, or an RPD ≤12 mm) [18,19]. Other centers provide prophylactic antibiotics for moderate hydronephrosis (ie, RPD between 10 to 15 mm); however, we feel this is unwarranted in patients with this degree of hydronephrosis.

The evidence for this recommendation is based on a systematic review that included 21 studies in its final analysis [18]. The quality of the studies was judged to be high in five studies, moderate in eight studies, low in five studies, and very low in three studies. The following findings were noted:

- In patients with low-grade hydronephrosis (n = 2181 patients with SFU grades I and II), there was no difference in the rate of UTI between patients treated with continuous antibiotic prophylaxis and those who were not treated (2.2 versus 2.8 percent).

- In contrast, patients with high-grade hydronephrosis (n = 507 patients with SFU grades III and IV) who received continuous antibiotic prophylaxis had a lower rate of UTI compared with those who were not treated with antibiotics (14.6 versus 28.9 percent).

In our practice, patients with SFU grade III hydronephrosis are typically not given antibiotic prophylaxis unless family history is positive for UTI, VUR, or other uropathy [20].

Further evaluation

Persistent postnatal ultrasound findings — Infants with persistent postnatal moderate to severe hydronephrosis (RPD >10 mm) should have a VCUG to detect VUR (algorithm 1 and algorithm 2). VUR accounts for approximately 9 percent of cases of fetal hydronephrosis, but it is more common and severe in infants with persistent postnatal hydronephrosis (13 to 30 percent) [5,21]. (See "Clinical presentation, diagnosis, and course of primary vesicoureteral reflux".)

This was illustrated in a prospective study of 106 fetuses with RPD ≥5 mm [21]. Two postnatal ultrasounds were performed at five to seven days of age and during the third week of life, and a VCUG at six to eight weeks of life. The following findings were noted:

- Of the 103 infants with complete data, 53 had normal postnatal ultrasounds, defined as RPD ≤7 mm without evidence of calyceal or ureteric dilation, renal dysplasia, or other renal anomalies. VUR was detected in only three infants with normal postnatal ultrasounds, which was grade I in all three cases.
- Fifty infants had an abnormal postnatal ultrasound. Thirteen had evidence of calyceal/ureteric dilation but a normal RPD (≤7 mm), of which one infant had grade IV VUR. Thirty-seven patients had persistent hydronephrosis (RPD >7 mm), of which five infants had VUR (grade IV and V in three cases, and grade II in two cases).

Infants who have VUR demonstrated on VCUG should remain on antibiotic prophylaxis until the therapeutic options can be discussed with the family and care providers. Options include observation, medical management including antibiotic prophylaxis, or surgical correction. (See "Management of vesicoureteral reflux", section on 'Therapeutic options'.)

If the VCUG does not show reflux, antibiotics are discontinued.

Further evaluation if there is **no VUR** is dependent on the degree of hydronephrosis (algorithm 1 and algorithm 2).

- Infants with persistent postnatal **severe** hydronephrosis (RPD ≥15 mm) should have diuretic renography (renal scan with technetium-99m-mercaptoacetyltriglycine [Tc99mMAG3]) to detect possible obstruction. At this stage of evaluation, referral to a center with expertise in pediatric urologic care is warranted, because the renal scan is an invasive procedure requiring placement of an intravenous line and bladder catheter, and surgical interventions may be required if the kidney is obstructed. In general, diuretic renography can be performed after six weeks of life because surgical intervention is rarely required prior to this time (eg, severe hydronephrosis without VUR).

  The use of antibiotic prophylaxis in patients with severe hydronephrosis without VUR remains controversial. In our practice, antibiotic prophylaxis is continued for cases with severe SFU grade IV hydronephrosis (image 1) or RPD ≥15 mm until surgical correction is performed or there is a decrease in the severity of hydronephrosis detected by ultrasonography (RPD <15 mm) [22,23]. It is prudent to remember that prior to the era of prenatal sonography, ureteropelvic junction obstruction (UPJO) typically presented with urosepsis. (See "Congenital ureteropelvic junction obstruction".)

- In our center, infants with **moderate** postnatal hydronephrosis (RPD 10 to <15 mm) have a repeat ultrasound when they reach four to six months of age. The majority of cases with mild or moderate postnatal hydronephrosis resolve by 18 months of age [24-26]. If the degree of hydronephrosis increases in subsequent ultrasounds, diuretic renography may be performed to determine if there is an obstructive process.

  However, in a small number of patients, hydronephrosis may worsen after initial improvement. In a retrospective review, 4 of 394 kidneys (1 percent) with hydronephrosis followed nonoperatively worsened after initial spontaneous improvement on renal ultrasonography [27]. All four patients presented with clinical symptoms including abdominal pain, gross hematuria, and vomiting at a mean age of 40 months (range 22 to 60 months), consistent with a diagnosis of intermittent UPJO requiring pyeloplasty.

  As a result, if there is persistent dilation at three months of age, we continue to monitor the degree of hydronephrosis with an ultrasound performed at one year of age, and if needed, between three and five years of age. In symptomatic cases, or if there is a marked increase in dilation, diuretic renography may be performed to determine if there is an obstructive process.

Normal ultrasound or mild hydronephrosis — Infants with a normal postnatal examination or mild hydronephrosis (defined as an RPD ≤10 mm without any evidence of calyceal or ureteric dilation, or signs of renal dysplasia or anomalies) require no further evaluation. This was supported in one study of patients with fetal hydronephrosis and normal postnatal ultrasounds that demonstrated normal dimercaptosuccinic acid (DMSA) scans in 49 of the 103 children available for evaluation

at two years of age [19]. Renal ultrasound was normal in three additional children whose families refused a follow-up DMSA scan.

INFORMATION FOR PATIENTS — UpToDate offers two types of patient education materials, "The Basics" and "Beyond the Basics." The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword (s) of interest.)

- Basics topics (see "Patient education: Prenatal hydronephrosis (The Basics)")

SUMMARY AND RECOMMENDATIONS

- Fetal hydronephrosis (fetal renal pelvic dilation) is a common, readily diagnosed finding on antenatal ultrasonography and can be seen as early as the 12th week of gestation.
- Although fetal hydronephrosis is most often transient or clinically insignificant, urinary tract obstruction or vesicoureteral reflux (VUR) are important causes that should be diagnosed soon after birth, because they may result in renal impairment or cause further renal damage. (See "Overview of fetal hydronephrosis", section on 'Etiology'.)
- Postnatal management is dependent upon the presence of predicative factors (bilateral involvement and severity of hydronephrosis), and is focused upon identifying all infants with significant disease, but limiting unnecessary studies and minimizing parental distress in those without significant disease (algorithm 1 and algorithm 2). (See 'Approach' above.)
- Ultrasonography is the preferred initial postnatal imaging study. The timing of the study depends on whether or not there is unilateral or bilateral involvement.
    - For infants with bilateral fetal hydronephrosis or single hydronephrotic kidney, ultrasonography should be performed on the first or second postnatal day (algorithm 1). (See 'Bilateral fetal hydronephrosis' above.)
    - For infants with unilateral fetal hydronephrosis, ultrasonography should be performed after the infant returns to birth weight (after 48 hours of age and within the first two weeks of life) (algorithm 2). (See 'Unilateral fetal hydronephrosis' above.)
- Further testing including voiding cystourethrogram (VCUG) and diuretic renography is dependent upon whether there is persistent postnatal hydronephrosis (RPD >10 mm on postnatal ultrasound). (See 'Further evaluation' above.)
- In our center, we provide antibiotic prophylaxis (amoxicillin 12 to 25 mg/kg as a single oral daily dose) for the following subset of patients (see 'Antibiotic prophylaxis' above):
    - We suggest administering antibiotic prophylaxis after birth to infants with severe fetal hydronephrosis detected in the third trimester (ie, Society of Fetal Urology [SFU] grade IV (image 1) or RPD ≥15 mm) (**Grade 2C**). Antibiotics are discontinued if the postnatal ultrasound demonstrates resolution of the hydronephrosis.
    - We suggest continued administration of antibiotic prophylaxis to infants with persistent postnatal hydronephrosis (renal pelvic diameter [RPD] >10 mm) pending the results of a VCUG as follows (**Grade 2C**).
        - Infants who have VUR demonstrated on VCUG should remain on antibiotic prophylaxis until the therapeutic options can be discussed with family and care providers. Options include observation, medical management including antibiotic prophylaxis, or surgical correction. (See "Management of vesicoureteral reflux", section on 'Therapeutic options'.)
        - For infants without VUR and who have severe postnatal hydronephrosis (RPD ≥15 mm), we continue to administer antibiotic therapy until there is a decrease in the severity of hydronephrosis, or resolution of hydronephrosis with surgical correction.
        - We discontinue antibiotic therapy for infants without VUR and who do not have severe postnatal hydronephrosis (RPD <15 mm).

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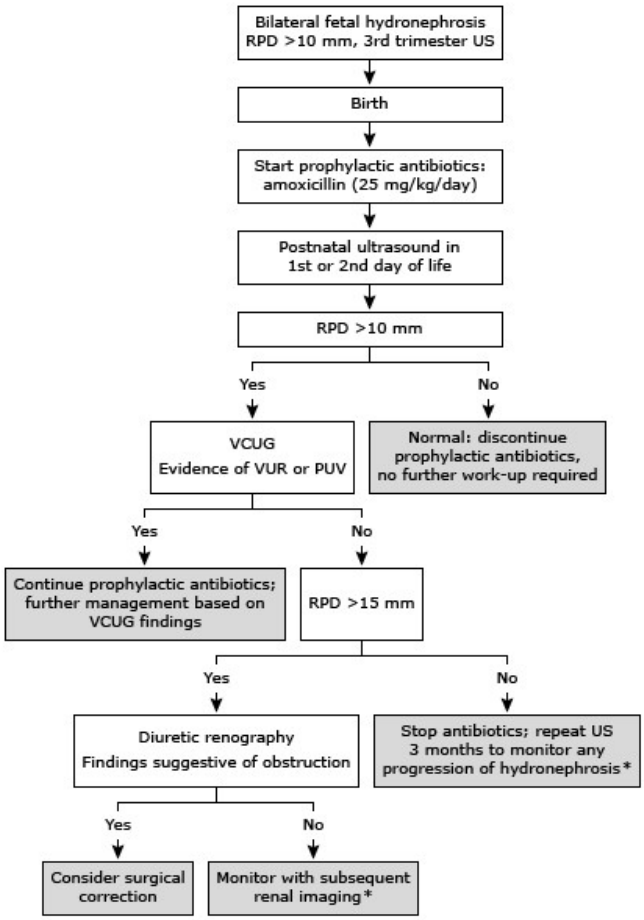
Topic 6105 Version 27.0

GRAPHICS

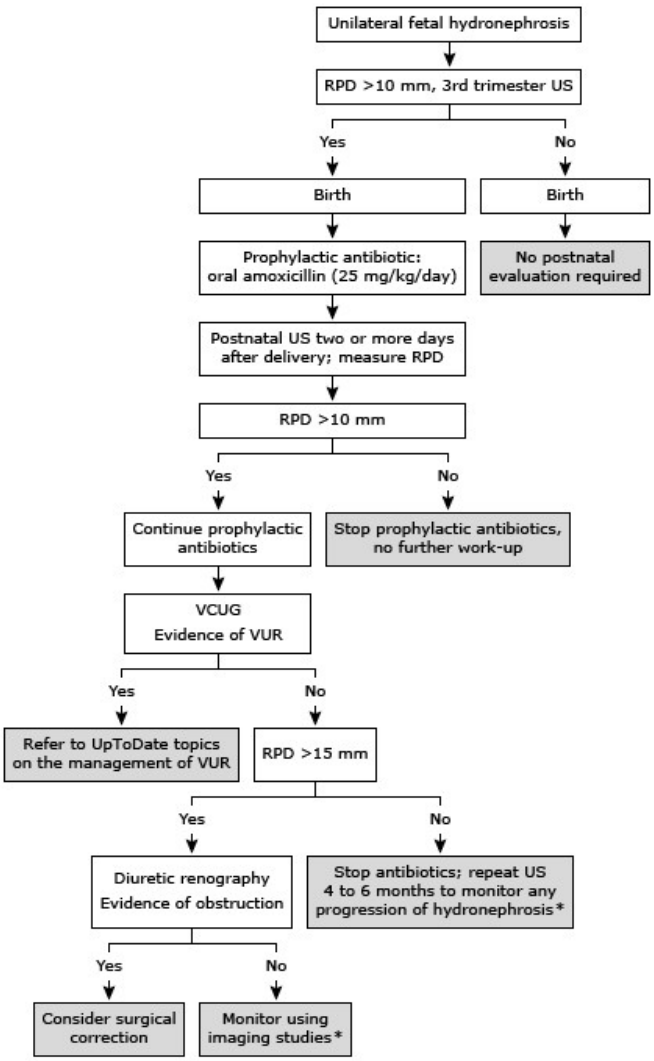
Postnatal evaluation of bilateral fetal hydronephrosis*



RPD: renal pelvic dilameter; VCUG: voiding cystourethrogram; VUR: vesicoureteral reflux; US: ultrasound; PUV: posterior uretheral valves.
* This algorithm is intended for use in conjunction with additional UpToDate content on postnatal evaluation of fetal hydronephrosis. Please refer to the topic on postnatal management of fetal hydronephrosis for more information.

Graphic 69172 Version 12.0

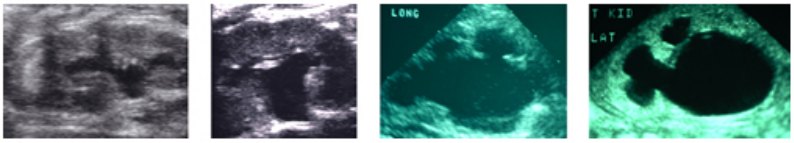
Postnatal evaluation of unilateral fetal hydronephrosis*



RPD: renal pelvic diameter; US: ultrasound; VUR: vesicoureteral reflux; VCUG: voiding cystourethrogram.
* This algorithm is intended for use in conjunction with additional UpToDate content on postnatal evaluation of fetal hydronephrosis. Please refer to the topic on postnatal management of fetal hydronephrosis for more information.

Graphic 74670 Version 6.0

Society of Fetal Urology grading system for hydronephrosis



Grade 1 Grade 2 Grade 3 Grade 4

Grade 0: no dilation (not shown). Grade 1: renal pelvis is only visualized. Grade 2: renal pelvis as well as a few, but not all, calyces are visualized. Grade 3: virtually all calyces are visualized. Grade 4: similar to Grade 3, but when compared with the normal centralateral kidney, there is parenchymal thinning.

Graphic 50549 Version 3.0

Contributor Disclosures

Laurence S Baskin, MD, FAAP Nothing to disclose **Duncan Wilcox, MD** Nothing to disclose **Melanie S Kim, MD** Nothing to disclose

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