The Role of Amniotic Fluid Assessment in Evaluating Fetal Well-Being

Thomas R. Moore, MD

Maintaining fetal well-being is the major goal of antenatal testing regimens. Although the various protocols for assessing fetal well-being have evolved significantly over the past two decades, the goal has continued to be focused on reduction of the frequency of fetal death and/or the incidence of fetal distress in labor. The first studies of antenatal fetal surveillance utilized fetal heart rate assessment alone or with the added stressor of induced uterine contractions. Contraction stress testing (CST) and subsequently nonstress testing (NST) have resulted in fetal mortality rates ranging from 1 to 2 per 1000 to 7 per 1000.1

Subsequently, with the advent of clinical sonography in obstetric care, it was recognized that abnormally high or low amniotic fluid volume (AFV) was associated with a significant increase in risk of fetal death, even after a normal CST or NST.2,3 Consequently, AFV assessment is now recognized as an indispensable adjunct to antenatal and intrapartum fetal assessment. AFV estimation has been described as the most sensitive measure within the biophysical profile (fetal movement, breathing, tone, and AFV in addition to fetal heart rate tracing evaluation) for predicting fetal death.4 A simplified protocol consisting of NST and AFV assessment (modified biophysical profile) has been shown to result in equivalently excellent fetal outcomes as the CST alone but with lower perinatal mortality than the NST alone.5

AFV assessment during ultrasound examinations for fetal anatomy and growth provides additional important information regarding fetoplacental function and fetal anatomic integrity. Severe and persistent oligohydramnios prior to 22 weeks may impede fetal lung development, resulting in lethal pulmonary hypoplasia; near-term pregnancies lacking adequate amniotic fluid have increased incidence of thick

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meconium, severe fetal heart rate decelerations, intrauterine growth restriction, intra-
partum asphyxia, and perinatal death. Similarly, abnormally increased amniotic fluid
(polyhydramnios) can be evidence of uncontrolled maternal diabetes or anatomic
defects, such as fetal esophageal atresia, or large thoracic masses, such as diaphrag-
matic hernia. Polyhydramnios has been linked to increased fetal and neonatal
demise.\(^6\)

Despite these advances, the optimal method for sonographic assessment of AFV
remains to be determined. A variety of approaches (biophysical profile, modified
biophysical profile, amniotic fluid index [AFI], single pocket, 3-D, and subjective esti-
mation) have been proposed and shown moderately effective although rigorous
comparative and clinical efficacy studies continue to be lacking. Thus, clinicians
must choose the AFV assessment technique for a given clinical situation taking into
account an understanding of the biology of amniotic fluid formation and regulation
throughout gestation.

**AMNIOTIC FLUID VOLUME ACROSS GESTATION**

Studies of AFV using dye dilution techniques in normal pregnancies\(^7\) demonstrate
progressive increase from the first trimester to approximately 31 to 33 weeks and
then a significant decline toward and beyond the estimated due date (Fig. 1). At
term, AFV averages an estimated 700 to 800 mL but after 40 weeks in normal preg-
nancy, AFV declines at a rate of 8% per week, and by 42 weeks, the mean AFV is
only 400 mL. The changes in AFV observed during gestation closely parallel fetal
growth rate, which also peaks at approximately 32 weeks and declines toward term.\(^8\)

![Fig. 1. Normal AFV in pregnancy. (From Brace RA, Wolf EJ. Normal amniotic fluid volume changes throughout pregnancy. Am J Obstet Gynecol 1989;161(2):382–8; with permission.)](image-url)
As shown in Fig. 1, the range of normal fluid volumes above the mean can vary by as much as 1000 mL or more, ranging from 750 mL (50th percentile) to approximately 1900 mL (95th percentile) at 33 weeks whereas the variability in volumes below the mean is as little as 300 mL (varying from 750 mL at the 50th percentile to 400 mL at the 5th percentile). At 40 weeks, the volume range from the 50th to the 5th percentile is only 450 mL compared to the range from 50th to 95th percentile (1400 mL).

This compression of AFV values near the oligohydramnios range is of great importance because small differences in volume estimated by ultrasound may connote large differences in percentile. Care must be taken when assigning ultrasound-assessed AFV to the normal or oligohydramnios category, because small differences in sonographic measurements may have substantial impact on predictive value (discussed later).

FACTORS INFLUENCING AMNIOTIC FLUID VOLUME

Fetal Urination and Swallowing

The dynamic balance between fetal urine production and amniotic fluid swallowing seems to control net amniotic fluid volume. Estimates of human fetal urine output derived from sonographic measurements of bladder volumes near term calculate urine production rates of 1000 to 1500 mL/day but a wide range has been observed. Reduced fetal urinary flow rates are correlated with placental insufficiency and fetal hypoxia whereas increased urinary flow rates have been demonstrated after maternal hydration and in the setting of fetal hydrops (eg, twin transfusion syndrome or fetal anemia).

Fetal swallowing is the major mechanism by which fluid is removed from the amniotic cavity, with 500 to 700 mL/day estimated from radiolabeled erythrocytes injected into the amniotic cavity. Factors known to increase fetal swallowing include decreased amniotic osmolality, increased amniotic volume, and increased fetal plasma osmolality.

Fetal Lung Fluid Secretion

The fetal lung secretes considerable fluid that is largely isotonic with fetal plasma, approximating 350 mL per day at term. At least half of the secreted lung fluid is immediately swallowed, however, so that the net of lung fluid secretion (150–170 mL/day) and its effect on AFV is small relative to the fetal urinary contribution.

Maternal-Fetal-Amniotic Fluid Osmolality

The increase in AFV observed with progressing pregnancy duration depends on a net flow of water from the maternal circulation into the fetal compartment. Correspondingly, after 33 weeks, a progressive decrease in water flow into the fetus is expected. In humans, most of the increase in AFV is driven by small but important differences in maternal and fetal systemic osmolality and the more significant differences between fetal vascular and amniotic spaces. Maternal and fetal vascular osmolalities are maintained close to each other (within 2 mOsm/mL), which limits the magnitude of water transfer directly to and from the fetus under normal conditions.

Amniotic fluid osmolality is maintained considerably lower than fetal plasma (a difference of 10 mOsm/mL), which favors transfer of water from the amniotic cavity across the fetal blood vessels on the surface of the placenta into the fetus. Consequently, the osmotically driven flow of water from amniotic cavity continuously into the fetal circulation drives fetal urinary flow. The amniotic-fetal vascular osmotic
difference allows the amniotic cavity to serve as an available depot of free water that the fetus can access in times of stress.

During maternal dehydration or stress, maternal osmolality rises, favoring water transfer out of the fetus to the mother, which reduces fetal urinary flow. The resulting fetal dehydration promotes a compensatory increase in transplacental water flow from the amniotic cavity into the fetus, restoring fetal vascular volume while decreasing net amniotic fluid volume. Maternal rehydration is a convenient intervention to resolve decreased AFV near term (discussed later).

**CLINICAL METHODS OF ASSESSING AMNIOTIC FLUID VOLUME**

**Sonographic Technique**

Although there are various sonographic methods for determining amniotic fluid volume, the AFI and single deepest pocket (SDP) techniques that involve measuring the depth of amniotic fluid pools are the most clinically utilized.

Regarding the generally accepted technique for measuring the deepest amniotic fluid pockets, the following guidelines are typically observed:

- Orient the ultrasound transducer beam perpendicular to the patient’s coronal plane and maintain aligned in the patient’s sagittal plane.
- Search for the deepest unobstructed amniotic fluid pocket in the planes above, measuring the depth of the deepest pocket.
- Avoid measurements in gray areas on the screen; amniotic fluid is ordinarily near the black end of the gray scale.
- Avoid measuring into very narrow spaces between fetal structures and the uterus; the pocket should be at least several millimeters wide at all points.
- Do not measure through fetal anatomic structures (eg, arm or leg) or through a loop of umbilical cord.

**Interobserver and Intraobserver Reliability**

Moore and Cayle\textsuperscript{12} assessed the variability in measurements of AFI between and within practitioners. They found intraobserver and interobserver errors to average between 0.5 cm and 1.0 cm, respectively. This amounts to 3% to 7% of the typical AFI measurement (12–14 cm) overall but the error can be as high as ±30% for AFI measurements below 7 cm. They recommended that AFI measurements should be performed in triplicate and averaged to minimize this error, especially in patients with decreased amniotic fluid.

Subsequently Williams and colleagues\textsuperscript{13} evaluated the intraobserver agreement of AFV assessment with AFI and SDP. Amniotic fluid volumes were categorized into normal, oligohydramnios, and polyhydramnios, and the prebiometry and postbiometry categories of AFI and maximum vertical pocket techniques were compared by \( \kappa \) statistics. The maximum vertical pocket technique showed poor intraobserver agreement (\( \kappa = 0.33 \)), whereas the \( \kappa \) for AFI (0.72) was significantly better, suggesting that the SDP technique has relatively poor reproducibility, especially with oligohydramnios.

Thus, at present, measurements of AFV in the setting of oligohydramnios should be approached with caution. Practitioners should pay meticulous attention to the guidelines (discussed previously) for obtaining reproducible, clear images and consider performing replicates of measurements to increase reliability.

**Use of Color Doppler with AFV Assessment**

Avoiding measuring through a fetal structure in an amniotic fluid pocket should be based on evaluation of the grayscale image. Although it may seem that use of color
Doppler could improve accuracy, research comparing actual amniotic fluid volumes to fluid pocket depths obtained with and without color Doppler found that use of color images increased the false diagnosis of oligohydramnios.\textsuperscript{14,15}

**Multifetal Gestation**

Assessment of amniotic fluid in multifetal pregnancy requires a modified approach. Several investigators have provided standards for the total AFI in twin gestation,\textsuperscript{16} yet this information is of little utility in diagnosis and management because it does not take into account variations between twins. The amount of amniotic fluid in each sac of a normal dichorionic twin pair is approximately equal to that of a singleton and thus use of SDP with similar cutoffs for abnormal as for singletons is appropriate.\textsuperscript{17}

**Normal Values for SDP and AFI**

**SDP**

The earliest attempts to correlate AFV and fetal well-being by Chamberlain and colleagues\textsuperscript{3} in 1984 utilized a qualitative scale for the SDP, categorizing amniotic fluid as normal if the SDP was greater than or equal to 2 and less than or equal to 8 cm (94% of cases), marginal if the visible pocket measured less than 2 cm but greater than or equal to 1 cm (2% of cases), and decreased if the pocket was less than 1 cm (1% of cases) (Table 1).

**Amniotic fluid index**

The AFI, proposed by Phelan and colleagues\textsuperscript{18} in 1987, is the most widely used sonographic method for estimating amniotic fluid volume. The AFI is calculated as the mathematical sum of the SDPs from each of four quadrants of the uterus. Limits for the AFI proposed by Rutherford and colleagues,\textsuperscript{19} based on clinical observation of increased risk of suboptimal perinatal outcome at term, were less than 5 cm for oligohydramnios, with polyhydramnios defined as an AFI of 25 cm.

Moore and Cayle\textsuperscript{12} established the mean and outer boundaries (5th and 95th percentiles, respectively) for the AFI from 16 to 42 weeks’ gestation in a cross-sectional study of 791 normal pregnancies in 1990. The mean AFI was approximately 12 to 14 cm throughout most of the pregnancy, declining after 33 weeks. The average AFI near term was 12 cm, with the 95th percentile (polyhydramnios) approximately 20 cm and the 5th percentile (oligohydramnios) approximately 7 cm.

A decade later, Magann and colleagues\textsuperscript{20} repeated the Moore and Cayle study using more advanced ultrasound equipment from 14 to 41 weeks’ gestation. As shown in Fig. 2, the shape of Magann and colleagues’ AFI curve closely resembles that of

<table>
<thead>
<tr>
<th>Amniotic Fluid Volume</th>
<th>SDP Value</th>
<th>% of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyhydramnios</td>
<td>≥8.0 cm</td>
<td>3</td>
</tr>
<tr>
<td>Normal</td>
<td>&gt;2–&lt;8 cm</td>
<td>94</td>
</tr>
<tr>
<td>Moderate oligohydramnios</td>
<td>≥1–≤2</td>
<td>2</td>
</tr>
<tr>
<td>Severe oligohydramnios</td>
<td>&lt;1 cm</td>
<td>1</td>
</tr>
</tbody>
</table>

Fig. 2. AFI during normal pregnancy. (Adapted from Magann EF, Sanderson M, Martin JN, et al. The amniotic fluid index, single deepest pocket, and two-diameter pocket in normal human pregnancy. Am J Obstet Gynecol 2000;182(6):1581–8; with permission.)
Brace and Wolf\textsuperscript{7} as determined from direct amniotic fluid measurements. The AFI values from Magann and colleagues’ investigations are approximately 1 to 2 cm less than Moore’s and Cayle’s, with the 5th percentile approximately 5 cm at term (vs 7 cm for Moore and Cayle) and the 50th percentile 9.5 cm (vs 12 cm).

Using the data from the same study, which reported the 95\% CI limits for both the SDP and AFI in normal pregnancy, Table 2 tabulates these limits from 34 weeks onward with additionally calculated values for the 2.5th percentile. This provides a finer level of discrimination in the oligohydramnios range when AFV assessment is typically utilized in antepartum testing regimens.

It can be seen in Table 2 that the 2-cm cutoff for SDP is approximately at the 3rd percentile in normal pregnancy, whereas the corresponding 3rd percentile for AFI is approximately 3 cm. Thus, use of a 5-cm cutoff for AFI, which is the 7th percentile near term, categorizes approximately twice as many pregnancies as having oligohydramnios compared to the 2-cm limit for SDP, which is at the 3rd percentile.

**Clinical Effectiveness of SDP and AFI**

**Single deepest pocket**

In their series of 7582 largely near-term cases, Chamberlain and colleagues\textsuperscript{3} reported perinatal mortality in structurally normal fetuses of 1.97/1000 with normal AFV, which rose to 109.4/1000 and 187.5/1000 if AFV was marginal (SDP <2 cm) or decreased (SDP <1 cm). This observation, associating abnormal AFV with poor fetal outcome, has formed the basis for all of the protocols for antepartum testing currently in use.

Table 2

<table>
<thead>
<tr>
<th>AFI Percentile (cm)</th>
<th>Week</th>
<th>2.5th</th>
<th>5th</th>
<th>10th</th>
<th>50th</th>
<th>90th</th>
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<td></td>
<td>5.2</td>
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<td>7.4</td>
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<td>19.4</td>
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<td></td>
<td>4.8</td>
<td>6</td>
<td>7</td>
<td>12.4</td>
<td>16.9</td>
<td>18.7</td>
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<tr>
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<td>4.5</td>
<td>5.6</td>
<td>6.5</td>
<td>11.8</td>
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<td>6</td>
<td>11.1</td>
<td>15.3</td>
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<td>13.9</td>
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and enshrined the 2-cm pocket (3rd percentile) as a criterion for defining oligohydramnios in antepartum testing near term.

Amniotic fluid index
Rutherford and colleagues reported an inverse relationship between the AFI and nonreactive NSTs, fetal heart rate decelerations, meconium staining, cesarean section for fetal distress, and low Apgar scores, even if the NST was reactive.

More recently, Magann and colleagues conducted a secondary analysis of a prospective longitudinal study of the intrapartum outcomes of pregnancies with normal and abnormal AFI obtained during antenatal testing. Abnormal was defined as AFI greater than 97.5th percentile (polyhydramnios) and less than 2.5th percentile (AFI < 2 cm).

Both polyhydramnios and oligohydramnios on the AFI identified adverse pregnancy outcomes. Comparing polyhydramnios to normal AFI, abnormal heart rate tracing influencing delivery was 29% versus 17% (P < .009), cesarean delivery for fetal labor intolerance was 21% versus 7% (P < .001), and neonatal ICU (NICU) admission was 10% versus 5% (P < .023). Pregnancies with oligohydramnios had a greater risk of labor induction (18% vs 9%; P < .001), intrauterine growth restriction (25% vs 9%; P < .001), and preterm birth (29% vs 17%; P < .01). The investigators concluded that using a cutoff of AFI at the upper and lower 2.5th percentile identified a substantial proportion of pregnancies with suboptimal intrapartum outcomes.

SDP and AFI compared
Today, most antepartum testing centers use the AFI and others the single deepest pocket. Data directly comparing the predictive value of the SDP and AFI in screening high-risk pregnancy have been conflicting, however. A large, prospective, blinded observational trial compared the predictive values of the maximal vertical pocket (MVP) and AFI techniques in pregnancies at or beyond 40 weeks of gestation undergoing antenatal testing. Using an AFI cutoff of 5 cm and an SDP cutoff of 2 cm, oligohydramnios was found in 7.9% using AFI but in only 1.4% with SDP (P < .001). The AFI technique identified cesarean delivery for fetal distress, NICU admission, asphyxia, and meconium aspiration more efficiently than SDP (28% vs 0%, P < .001). The relatively weak sensitivity of the AFI (11%–28%), however, was achieved at a cost of an increased false-positive rate (8%) compared with the SDP technique (1%).

A recent systematic review of five randomized trials comparing AFI and SDP was reported by Nabhan and Abdelmoula. In most of these trials, oligohydramnios (all using cutoffs of SDP < 2 cm and AFI < 5 cm) was considered an indication for immediate delivery in pregnancies beyond 33 weeks and for delivery 48 hours after initiation of steroid treatment in those at less than 34 weeks. The meta-analysis demonstrated that using an AFI less than 5 cm compared to SDP less than 2 cm during fetal surveillance approximately doubled the rate of diagnosis of oligohydramnios and doubled the consequent rate of labor induction but with no improvement in peripartum outcomes (Table 3). Given what is known about the comparable cutoff values for SDP and AFI, the finding of increased diagnosis of oligohydramnios with AFI compared to SDP is not surprising.

The findings of the Cochrane review by Nabhan and Abdelmoula has led to urging the abandonment of use of the AFI in antepartum testing because of the associated increased labor inductions without evident benefit. Further trials comparing SDP to AFI at similar percentiles, however, would help clarify this area.
Haws and colleagues recently performed an extensive meta-analysis of various methods of monitoring fetal well-being prior to and during labor. They affirmed that polyhydramnios as diagnosed with AFI or SDP is a clear risk factor for perinatal mortality, whether or not associated with congenital malformations, placental insufficiency, or of idiopathic origin. They also note that low AFI values (eg, 3rd percentile) are frequently associated with poor pregnancy outcomes, and in these cases a reassuring NST loses its usual predictive value.

They further assert that although the association between abnormal AFV and suboptimal perinatal outcome is now clear, evidence demonstrating that interventions in response to the identification of oligohydramnios or polyhydramnios can improve outcomes. Further research is needed to document subsequent intervention and perinatal mortality outcomes to determine the cost benefit ratio of utilizing amniotic fluid assessment procedures.

### MANAGEMENT OF OLIGOHyDRAMNIOs

At term, an AFI less than 5 cm has been used in the past as a cutoff value to define oligohydramnios. To minimize potential overestimation of oligohydramnios of clinical importance, an AFI cutoff of 3 cm may be more appropriate and accompanied by fewer interventions. Alternatively, the absence of an SDP 2 cm in depth and 1 cm wide is typically diagnostic of significant oligohydramnios. Because oligohydramnios portends significant potential fetal jeopardy, a systematic approach to evaluation and choice of management intervention, if any, is recommended.

#### Evaluate Urinary Tract Anomalies

Once a diagnosis of oligohydramnios has been made, detailed sonographic evaluation of the fetal urinary tract may reveal renal and bladder anomalies, because these are the most common causes of severe second-trimester oligohydramnios. Bilateral renal agenesis is associated with severe oligohydramnios and is usually detectable after 16 weeks of gestation but bilateral fetal multicystic or polycystic kidney disease may not be detectable sonographically until late in the second trimester and is usually associated with less severe oligohydramnios. Unilateral urinary obstruction rarely causes measurable decrement in amniotic fluid volume. Because urinary tract abnormalities are commonly found in aneuploid fetuses (especially pyelectasis but also obstructive uropathy), amniocentesis should be discussed if these findings are present.

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Predictive values of AFI vs SDP for abnormal perinatal outcome</th>
</tr>
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<tbody>
<tr>
<td><strong>AFI vs SDP</strong></td>
<td><strong>Relative Risk</strong></td>
</tr>
<tr>
<td>NICU admission</td>
<td>1.04</td>
</tr>
<tr>
<td>Umbilical artery pH &lt;7.1</td>
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</tr>
<tr>
<td>Diagnosis of oligohydramnios</td>
<td>2.39</td>
</tr>
<tr>
<td>Induction of labor</td>
<td>1.92</td>
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<tr>
<td>Cesarean delivery</td>
<td>1.09</td>
</tr>
<tr>
<td>Cesarean delivery for fetal distress</td>
<td>1.46</td>
</tr>
</tbody>
</table>

Assess Placental Function

In the absence of premature rupture of membranes and urinary tract anomalies, uteroplacental insufficiency is a common cause of oligohydramnios and may arise from uncontrolled maternal hypertension, renal compromise, chronic placental abruption, systemic lupus, and the antiphospholipid syndrome. Underperfusion of the placenta leads to reduced nutrient and water delivery to the fetus and secondarily reduced fetal urine output. Intrauterine growth restriction almost always accompanies the oligohydramnios of placental insufficiency and accounts for up to 20% of all cases of oligohydramnios. Abnormal umbilical and middle cerebral artery Doppler studies help corroborate the diagnosis of oligohydramnios due to poor placental function.

Treatment Options for Oligohydramnios

Amnioinfusion

In cases of severe oligohydramnios, transabdominal infusion of normal saline into the amniotic cavity improves sonographic imaging. In a series by Fisk and colleagues, they were able to confirm renal agenesis in 90% of patients using amnioinfusion to better visualize the fetal structures. However, 13% of the etiologic diagnoses were changed as a result of information obtained at amnioinfusion, including the finding of kidneys in some cases of suspected renal agenesis.

Butt and Ahmed recently reported a series of 17 cases of severe oligohydramnios (mean SDP 1.8 cm) managed with second-trimester amnioinfusion to reduce the frequency of pulmonary hypoplasia and improve survival. The mean infusion to delivery interval was 31 days, however, and perinatal mortality was 88%. There were 3 cases of chorioamnionitis and only 1 baby survived the neonatal period.

Thus diagnostic, but not therapeutic, amnioinfusion can be recommended for pregnancies complicated by severe oligohydramnios.

Expectant fetal monitoring or delivery

Treatment of oligohydramnios should be designed with fetal maturity in mind. Cases of posterior urethral valves require intervention (ie, indwelling catheter and drainage) prior to 20 weeks if pulmonary hypoplasia is to be avoided. In the third trimester, oligohydramnios has frequently been used as an indication for immediate initiation of delivery procedures. Such interventions have not been convincingly demonstrated to improve outcome, however. In many cases, labor inductions for oligohydramnios may prolong labor and increase chorioamnionitis, cesarean delivery, and admission to the NICU without necessarily improving outcome.

When severe oligohydramnios develops before 33 to 34 weeks, close monitoring of fetal growth and biophysical state is usually the best choice and delivery is reserved for fetuses not tolerating intrauterine environment, regardless of the AFI or SDP. Beyond 34 weeks, oligohydramnios increases the likelihood of fetal asphyxia or demise and, consequently, intensive fetal testing and delivery planning should be considered. With mild or even moderate degrees of oligohydramnios (SDP >2 cm, AFI >3 cm), however, intervention is unlikely to benefit and should be approached with caution.

Maternal hydration

The interrelationship between low AFV and reduced maternal intravascular volume has been demonstrated experimentally and clinically (discussed previously). In women with low AFI associated with chronic hypertension and dehydration associated with illness, fever, or low oral fluid intake, hydration results in increased fetal urine output and a consequent rise in AFI. In a systematic review of randomized trials of maternal hydration by Hofmeyr and Gülmezoglu, the AFI increased significantly in
women with oligohydramnios undergoing hydration (mean difference 2.01 cm; 95% CI, 1.43–2.60). Intravenous isotonic infusion is less effective than oral hydration because hypotonic fluids restore reduced AFV more efficiently. Maternal oral hydration with 2 L of water at least 2 hours before performing AFI may reduce false-positive diagnoses of oligohydramnios.

**MANAGEMENT OF POLYHYDRAMNIOSES**

**Evaluation of Polyhydramnios**

Polyhydramnios is usually defined as an AFI or SDP greater than the 95th percentile (16 cm or 6 cm, respectively, at term, according to Magann and colleagues,20 or AFI >24 cm or MVP of >8 cm, according to Moore and Cayle12). Others have advocated a more restrictive definition, such that only 1% to 2% of cases are defined. Using the SDP, polyhydramnios is diagnosed when the deepest amniotic fluid pocket is more than 8 cm and with the AFI 24–30 cm (mild), 31 to 35 cm (moderate), or above 35 cm (severe). Regardless of gestational age, polyhydramnios is associated with increased fetal structural anomalies and adverse pregnancy outcomes (Table 4).30,31

**Assess fetal swallowing**

Fetal anatomic abnormalities that interfere with fetal swallowing, such as esophageal atresia, congenital diaphragmatic hernia, and thoracic masses, are associated with polyhydramnios. Fetuses with central nervous system lesions, such as anencephaly, may develop polyhydramnios from decreased swallowing. The link between polyhydramnios and maternal diabetes is well recognized although the pathophysiology is not well understood. Fetal conditions associated with fetal anemia, cardiac overload, or congestive failure often develop polyhydramnios although the relationship to fetal urine production and swallowing is also not clear.

**Laboratory evaluation**

One study of polyhydramnios reported that the risk of aneuploidy was 10% when the fetus had coexisting sonographic anomalies and only 1% when no anomalies were noted.32 Although the risk of aneuploidy was low in the absence of sonographic anomalies, the aneuploidy risk of 1% is still greater than the risk of fetal loss with an amniocentesis.

**Treatment Options for Polyhydramnios**

It is not clear that any medical intervention improves the outcome of most cases of polyhydramnios. When a clear-cut etiology is evident, for example, maternal diabetes or

<table>
<thead>
<tr>
<th>Clinical associations with polyhydramnios</th>
<th>Hill, 1987 (n = 107)</th>
<th>Many, 1995 (n = 275)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idiopathic</td>
<td>66%</td>
<td>69%</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>15%</td>
<td>18%</td>
</tr>
<tr>
<td>Congenital malformations</td>
<td>13%</td>
<td>15%</td>
</tr>
<tr>
<td>Rh incompatibility</td>
<td>1%</td>
<td>—</td>
</tr>
<tr>
<td>Multiple gestation</td>
<td>5%</td>
<td>—</td>
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</tbody>
</table>

fetal anemia from isoimmunization, the underlying problem should be addressed. When polyhydramnios is caused by a congenital anomaly or is idiopathic, treatment is expectant and focused on closely monitoring the fetus and intervening for maternal complications. A significant number of cases of mild polyhydramnios resolve spontaneously.

**Monitor for preterm labor**
Because polyhydramnios is associated with increased risk of premature rupture of membranes and preterm birth, maternal awareness of signs of preterm labor may be helpful. If increased uterine contractions are noted, sonographic assessment of cervical length may help guide the timing of administration of corticosteroids. Finding a cervical length less than 1.5 to 2.0 cm, especially with a positive cervical fetal fibronectin with gestational age less than 34 weeks, should prompt evaluation for hospitalization and steroid administration.

**Amnioreduction**
Amnioreduction refers to reducing the amount of amniotic fluid through a large volume amniocentesis, typically 800 mL to several liters. Indications include maternal respiratory compromise or severe abdominal pain/contractions. Amnioreduction is commonly performed to manage the polyhydramnios seen in stage 1 or stage 2 twin-to-twin transfusion syndrome; amnioreduction is at least as effective as laser photocoagulation in early stages. Amnioreduction has significant risks, however, including rupture of membranes, stimulation of labor, and abruption. In a series of 200 amnioreductions performed in 94 patients by Elliott and colleagues, the median volume removed was 1500 mL (range, 350 to 10,000 mL) with a goal to restore a high-normal fluid volume. They reported a low complication rate (1.5%) with delivery delayed to a median gestational age of 37 weeks.

**Indomethacin**
Indomethacin, a prostaglandin synthetase inhibitor that suppresses fetal prostacyclin, essential for maintaining low renal artery resistance and a normally high fetal urinary flow rate, can be used to reduce fetal urination. Prolonged maternal indomethacin administration has been used to treat hydramnios in several case reports. Unfortunately, an additional side effect of indomethacin is constriction of the fetal ductus arteriosus, especially after 30 weeks of gestation. The AFI should be monitored daily during treatment, which should be stopped when the AFI returns to the upper normal range.

**SUMMARY**
Owing to the frequent use of bedside ultrasound, much is known about the regulation of and normative values for AFV and the mechanisms by which this important fluid is regulated. The management protocols for conditions of extremes of AFV have become more exact, resulting in interventions more likely to improve outcome. Much is still unclear, however: there are no tools to measure AFV with precision and measurement of fetal urinary output is cumbersome and error-prone. Future research should focus on achieving a better understanding of this important fetal fluid, which is fundamentally related to the maintenance of maternal-fetal homeostasis. When applying cutoffs for oligohydramnios and polyhydramnios using AFI or SDP measurements, values from similar percentiles should be used. Currently, the 3rd percentile (AFI <3 cm or SDP <2 cm) seems to have the best predictive value for abnormal fetal outcome and should be adopted in antepartum testing protocols.
REFERENCES


