Assessment of amniotic fluid volume

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INTRODUCTION

Amniotic fluid volume (AFV) is routinely assessed sonographically during pregnancy because it is a marker of fetal health and thus useful for identifying, monitoring, and managing complicated pregnancies.

The sonographic assessment of AFV will be discussed here. Factors that influence AFV and specific disorders of AFV (oligohydramnios and polyhydramnios) are reviewed separately:

- (See "Physiology of amniotic fluid volume regulation".)
- (See "Oligohydramnios: Etiology, diagnosis, and management in singleton gestations".)
- (See "Polyhydramnios: Etiology, diagnosis, and management".)

WHEN TO ASSESS AFV

Qualitative or semiquantitative assessment of AFV is a standard component of every second- and third-trimester ultrasound examination, regardless of indication, because it is an indicator of fetal health and its assessment has been validated as useful for evaluation of pregnancies at risk for an adverse pregnancy outcome [1-3]. (See "Overview of ultrasound examination in obstetrics and gynecology", section on 'Obstetric sonography'.)

AFV assessment is also one of the components of the biophysical profile (table 1) and an adjunctive component of the nonstress test. (See "Biophysical profile test for antepartum fetal assessment" and "Nonstress test and contraction stress test", section on 'Nonstress test'.)

CLINICAL SIGNIFICANCE OF ABNORMAL AFV

Abnormal AFV (oligohydramnios, polyhydramnios) can be caused by a variety of pregnancy complications, including prelabor rupture of membranes, congenital anomalies (particularly those involving the fetal gastrointestinal or urinary tracts), aneuploidy (particularly trisomy 18), and uteroplacental insufficiency (particularly with fetal growth restriction). (See "Oligohydramnios: Etiology, diagnosis, and management in singleton gestations", section on 'Etiology' and "Polyhydramnios: Etiology, diagnosis, and management", section on 'Conditions associated with polyhydramnios'.)

In addition, abnormal AFV can increase the risk for a variety of adverse pregnancy outcomes, such as umbilical cord compression or prolapse; fetal deformation, malpresentation, or demise; and uterine atony after delivery [4-6]. (See "Polyhydramnios: Etiology, diagnosis, and management", section on 'Outcome' and "Oligohydramnios: Etiology, diagnosis, and management in singleton gestations", section on 'Prognosis and counseling by etiology'.)

AFV REFERENCE STANDARDS

In research studies, dye dilution techniques and collection of amniotic fluid at cesarean birth are the reference standards for assessment of AFV [7,8]. Normal AFV, as measured by these validated methods, varies across gestation (figure 1). These methods are not used clinically because dye dilution is invasive, cumbersome, and requires specialized technical skills and laboratory support, while collection of amniotic fluid is not an option for ongoing fetal assessment during pregnancy and can be contaminated by maternal blood at delivery. Sonographic reference standards for assessment of AFV have been developed for clinical use and are described below. (See 'Ultrasound estimation of AFV' below.)

ULTRASOUND ESTIMATION OF AFV

Ultrasound examination is the only practical clinical method of assessing AFV. One qualitative and two semiquantitative ultrasound methods are used; each has limitations in the detection of abnormal AFV.

Our approach — We perform a qualitative assessment of AFV at all ultrasound examinations. In selected cases, we also perform a semiquantitative measurement using the single deepest pocket (SDP) or amniotic fluid index (AFI). We obtain a SDP or AFI when the qualitative assessment is abnormal, in patients at increased risk for pregnancy complications, and in all third-trimester examinations. (See 'Qualitative assessment' below and 'Amniotic fluid index' below and 'Single deepest pocket' below.)

Both the SDP and AFI techniques are commonly used worldwide, and neither technique is clearly superior. In a systematic review of randomized trials comparing the two techniques, use of the AFI did not improve peripartum outcomes, although it increased the rate of diagnosis of oligohydramnios (relative risk [RR] 2.3), induction of labor (RR 2.1), and cesarean birth for fetal distress (RR 1.5) [9]. Subsequent trials have affirmed this finding [10]. However, we also appreciate that, in all but postterm pregnancies, all sonographic methods of assessing AFV poorly predict adverse pregnancy outcome.

Results from a large trial (>500 pregnancies) by one of the authors (EM) showed that both AFI and SDP identify normal AFV with sensitivity >90 percent, but both overly diagnose AFV abnormalities and thus lead to unnecessary intervention [11]. The SDP overly diagnoses polyhydramnios, while the AFI overly diagnoses oligohydramnios. Accordingly, a clinician may consider using the SDP in patients with low AFVs and the AFI for patients with high AFVs, though this approach may not be practical.

Qualitative assessment — Qualitative assessment of AFV refers to the subjective assessment of AVF by the sonographer, without sonographic measurements [12]. The amniotic fluid is imaged and subsequently reported as oligohydramnios, normal, or polyhydramnios based on the sonographer's clinical expertise.

- **Accuracy compared with semiquantitative techniques** — In a study of 63 pregnancies with dye-dilution determined AFV, qualitative assessment of AFV by an experienced examiner had similar sensitivity as semiquantitative techniques (AFI, SDP, and two-diameter pocket) [12]. Both qualitative and semiquantitative techniques identified normal volumes well, but concordance with dye-dilution determined low and high AFV was poor [12].

Semiquantitative techniques — When measuring fluid pockets for the AFI and SDP, most older studies have recommended holding the transducer perpendicular to the floor while others have recommended holding it perpendicular to the uterine contour [13,14]. More recent studies suggest that either transducer position is acceptable [15,16]. Regardless of the position used, the operator should be careful to avoid angling the transducer at the uterine periphery as a thin rim of amniotic fluid may be misdiagnosed as a pocket.

Single deepest pocket — The SDP (also called the maximum vertical pocket [MVP], deepest vertical pocket, or single deepest vertical pocket [SDVP]) is the vertical dimension in centimeters of the largest pocket of amniotic fluid not persistently containing fetal extremities or umbilical cord (on gray-scale examination). The horizontal component of the vertical dimension must be at least 1 cm.

A 2014 consensus panel at a fetal imaging workshop suggested the following interpretation of SDP [17]:

- Oligohydramnios – Depth <2 cm
- Normal – Depth ≥2 cm and <8 cm
- Polyhydramnios – Depth ≥8 cm

These thresholds are generally accepted, although slight variations are common (eg, <2 versus ≤2 to define oligohydramnios, >8 versus ≥8 cm to define polyhydramnios) [13].

In patients with a persistent single loop of cord in the SDP, the most accurate technique is to measure the largest vertical distance to the cord, either above or below but not through the cord [18].

Although we consider an SDP ≥2 and <8 cm normal and manage the pregnancy accordingly, there is limited information on the management of pregnancies with SDP between 2 and 3 cm. As with other borderline laboratory values, the clinician may elect closer follow-up (eg, twice weekly assessments) of patients with SDP values that approach the level of oligohydramnios or with SDP values derived from only a single visible pocket (in such cases, a simultaneously performed AFI may be ≤5 cm).

- **Accuracy compared with dye-dilution/direct assessment** — The SDP detects fewer pregnancies with low AFV than dye dilution and direct assessment methods.
  - In a study of 40 pregnancies that compared the SDP with dye-determined AFV, 94 percent of pregnancies with normal dye-determined AFV were identified by SDP, but none of the pregnancies with a low dye-determined AFV were detected (low dye dilution AFV was defined as ≤5th percentile) [19].
  - In another study of 45 pregnancies at term that compared SDP with direct measurement of AFV at cesarean birth, SDP identified only 18 percent of the pregnancies with low AFV (<200 mL) identified by collection of amniotic fluid [20].

Amniotic fluid index — The AFI is calculated by dividing the uterus into four quadrants using the linea nigra for the right and left divisions and the umbilicus for the upper and lower divisions. The maximal vertical amniotic fluid pocket diameter in each quadrant not containing fetal extremities or cord (on gray-scale examination) is measured in centimeters; the sum of these measurements is the AFI. A 2014 consensus panel at a fetal imaging workshop suggested the following interpretation of AFI [17]:

- Oligohydramnios – AFI ≤5 cm
- Normal – AFI >5 cm and <24 cm
- Polyhydramnios – AFI ≥24 cm (table 2)

These thresholds are generally accepted, although small variations are common. For example, polyhydramnios has been defined as AFI >18, >20, >24, and >25 cm [14,21,22].

Gestational age, which is not considered in interpretation, also has an effect: in the third trimester, an AFI of 24 is generally above the 95th percentile and an AFI of 5 cm is generally below the 2.5th percentile [23-25]. Gestational age is not considered, in part, because AFI criteria have been established with a greater focus on adverse outcomes [26] than distribution across gestation.

An AFI of 5.1 to 8 cm has been termed borderline, but the clinical implications are unclear, and no strong evidence exists to support additional antenatal assessment of these pregnancies [27]. We manage pregnancies with an AFI of 5.1 to 8 cm the same way as an AFI above 8 cm, without additional testing or hydration. However, it is also reasonable for the clinician to elect closer follow-up (eg, twice weekly AFV assessments) of patients with AFI values that approach the level of oligohydramnios.

The accuracy and prognostic value of the AFI has been examined in several studies, which have shown that an abnormal AFI (oligohydramnios or polyhydramnios) is neither highly accurate nor highly predictive of adverse outcome [4,7,19,28-30]. Many pregnancies with normal AFV are falsely characterized as abnormal, and a large number with truly abnormal AFVs will be missed. Use of percentiles rather than fixed cutoffs to identify low or high AFVs does not improve the accuracy of the method.

- **Accuracy compared with dye-dilution:**
  - In four studies that compared AFI with dye-dilution determined AFV, the two techniques were concordant in 70 to >90 percent of pregnancies with normal AFV by the reference standard [7,11,19,28]. AFI was less accurate with abnormal AFVs:
    - In one of these studies, at low AFV, the AFI overestimated dye-determined volumes by 89 percent, while at high AFV, the AFI underestimated dye-determined volumes by 54 percent [7].
    - In two of the studies, AFI identified only approximately 10 percent of pregnancies with low AFV by dye dilution [19,28].
  - In an alternate analysis, dye-dilution determined AFV was used to evaluate 291 singleton pregnancies with AFI and SDP <3rd and 5th percentiles and >95th and 97th percentiles, adjusted for gestational age [30]. The sensitivity of AFI or SDP <3rd and 5th percentiles to detect oligohydramnios ranged from 11 to 27 percent versus 33 to 46 percent for detecting polyhydramnios. Use of percentiles was no better than fixed cutoffs (eg, AFI ≤5 or >25, SDP <2 or >8 cm) for detecting oligohydramnios and polyhydramnios.

Use of concurrent color Doppler — The concurrent use of color Doppler has been proposed to identify umbilical cord in an amniotic fluid pocket that is not seen on gray-scale ultrasonography alone, given that pockets of amniotic fluid containing umbilical cord should not be used for measurement of AFV.

There is no consensus regarding use of color Doppler when assessing AFV. We caution against using color Doppler as a component of AFV assessment because the current sonographic standards for assessment of normal versus abnormal AFV were established without use of color Doppler and its use results in overdiagnosis of oligohydramnios [31-33], which may lead to more pregnancy interventions without an improvement in perinatal outcome and possible harm from the interventions.

As an example, a study of AFV assessment with and without concurrent color Doppler found that both AFI and SDP measurements were reduced by approximately 20 percent when color Doppler was used [33]. Importantly, the authors also measured AFV by dye dilution techniques and found that using color Doppler did not improve the diagnostic accuracy of oligohydramnios and misclassified 9 of 42 pregnancies with normal amniotic fluid as having oligohydramnios.

In a subsequent study of 428 patients comparing pregnancy outcomes when the AFV was classified as low by color Doppler and normal by gray scale ultrasound (group 1) versus low by both color Doppler and gray scale (group 2), both groups had similar composite perinatal complications, mode of delivery, and composite neonatal outcomes [34]. The use of color Doppler did not increase the detection of adverse intrapartum or perinatal outcomes, thus supporting our approach.

SPECIAL POPULATIONS

Gestational age 14 to 20 weeks — Modifications are necessary for pregnancies less than 20 weeks of gestation. There is limited information on the earliest gestational age that ultrasound measurements can be used to estimate AFV. One problem with using the amniotic fluid index (AFI) this early in gestation is that only two quadrants exist before 20 weeks (the fundus may be at or below the umbilicus). In one study of AFI in pregnancies from 16 to 44 weeks, this problem was addressed by dividing the uterus into four quadrants created by an imaginary vertical line along the maternal midline and another imaginary transverse line midway between the top of the uterine fundus and the symphysis pubis [35]. In another study of AFV in pregnancies from 14 to 41 weeks, AFV was estimated using the AFI, single deepest pocket (SDP), and two-diameter pocket techniques, but the AFI was calculated from the sum of the SDP of only two quadrants in those pregnancies in which the uterine size was below the umbilicus [36].

We suggest using the SDP technique to estimate AFV in pregnancies between 14 and 20 weeks. AFI reference ranges (table 3), SDP reference ranges (table 4), and two-dimensional pocket reference ranges (table 5) exist for normal pregnancies in this gestational age range [35,36]. However, the normal AFV at any point in gestation sometimes differs depending on the population being investigated; thus, the percentiles in these tables may not apply to patients in other clinical settings.

The correlation of these methods to dye-determined AFV in early pregnancies is uncertain. The only study that correlated ultrasound measurements with dye-determined AFV in 42 singleton pregnancies between 15 and 23 weeks found that the SDP correctly identified 3/8 with dye-determined oligohydramnios and 26/29 with normal dye-determined AFV compared with 2/8 with oligohydramnios and 22/29 with normal fluid volume using the AFI [37].

Racial/ethnic variances — Although there are small differences in the normal trend of sonographic AFV assessments among racial and ethnic groups within the United States, the absolute differences are minor and unlikely to be of clinical significance [38]. However, the potential remains that there may be clinically significant differences in criteria for normal versus abnormal amniotic fluid index and single deepest pocket in racial and ethnic groups in other nations due to differences in nutrition, climate, health care accessibility, and other socioeconomic factors.

Multifetal pregnancy — We suggest qualitative assessment of AFV in multifetal pregnancies. If a semiquantitative measurement is needed, we measure the SDP of each amniotic sac.

In twin pregnancies, the assessment of AFV is an important part of their overall evaluation since they have a perinatal mortality rate severalfold higher than singleton pregnancies. As with singleton pregnancies, normal AFV in diamniotic twin pregnancies has been determined by studies using dye dilution techniques [39]. These studies have noted that (1) the mean AFV in each sac of a twin pregnancy is slightly higher than that of a singleton pregnancy of the same gestational age, and (2) qualitative and semiquantitative sonographic techniques tend to underestimate abnormalities of AFV compared with dye dilution techniques [40].

Three ultrasound techniques have been used to estimate the AFV in diamniotic twin pregnancies. All three methods correlate poorly with dye-determined low or high volumes, in part because the position of the dividing membrane affects the interpretation if each twin is evaluated separately. The limited available evidence is reviewed below.

- **Qualitative assessment** – A study including 23 twin pregnancies subjectively and objectively evaluated AFV and then compared these results with the dye-determined volume [41]. There were no differences in the accuracy of the subjective versus the objective evaluation of AFV to identify abnormal volumes, and both techniques were equally poor in the identification of the extremes (high and low) of AFV.

- **SDP** – The SDP of each sac is measured and the results interpreted using the SDP criteria described above for singletons [40] (see 'Single deepest pocket' above). This is possible because the 2.5th and 97.5th percentiles for twins are 2.3 cm and 7.6 cm, respectively, which are similar to the singleton cutoffs of 2 cm and 8 cm to define oligohydramnios and polyhydramnios [17]. Using this technique, high SDPs have been correlated with abnormal fetal heart rate tracings in labor and an increased frequency of cesarean deliveries for fetal intolerance of labor [42].

- **AFI** – Although an AFI in twins can be performed using the same technique as in singleton pregnancies (see 'Amniotic fluid index' above), inaccurate assessments occur if the membrane separating diamniotic twins is not considered. In a study using the summated twin AFI (four-quadrant assessment) and dye-determined AFV, 94 percent of the twins were identified as normal by summated AFI, whereas only 52 percent had normal volumes by dye dilution. Summated AFI had only a 13 percent sensitivity in predicting abnormal AFVs [43].

  To improve the performance of AFI in twin pregnancies, one study located the dividing membrane and measured the AFI in four quadrants of each sac [44]; however, this approach has not been validated.

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Oligohydramnios and polyhydramnios".)

SUMMARY AND RECOMMENDATIONS

- Qualitative or semiquantitative assessment of amniotic fluid volume (AFV) is a standard component of every second- and third-trimester ultrasound examination. (See 'When to assess AFV' above.)

- Abnormalities of AFV are associated with a variety of pregnancy complications. In clinical practice, ultrasound estimation of AFV is used in conjunction with other clinical and sonographic assessments (eg, biophysical profile, nonstress test, ultrasound examination for estimated fetal weight, anatomic survey) to provide information for assessing fetal well-being and managing complicated pregnancies. (See 'Clinical significance of abnormal AFV' above.)

- The most common ultrasound techniques used to estimate the adequacy of AFV are the single deepest pocket (SDP), amniotic fluid index (AFI), and qualitative assessment. (See

'Ultrasound estimation of AFV' above.)

- Qualitative and semiquantitative ultrasound methods perform well in identifying pregnancies with normal AFVs but are less accurate for diagnosis of oligohydramnios and polyhydramnios. (See 'Qualitative assessment' above.)

- We perform a qualitative assessment of AFV in all ultrasound examinations. We also obtain an SDP or AFI measurement if the qualitative assessment is abnormal, in patients at increased risk of pregnancy complications, and in all patients examined in the third trimester. The SDP may perform better than the AFI in pregnancies with oligohydramnios, and the AFI may perform better than the SDP in pregnancies with polyhydramnios. (See 'Our approach' above and 'Single deepest pocket' above and 'Amniotic fluid index' above.)

- Ultrasound estimates of AFV in multifetal pregnancies correlate poorly with dye-determined low or high volumes. We suggest qualitative assessment in multifetal pregnancies and use of the SDP for each amniotic sac if a semiquantitative measurement is needed. The results for each fetus are interpreted using the same SDP criteria used for singletons. (See 'Multifetal pregnancy' above.)

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Topic 462 Version 37.0

Components of the full biophysical profile test

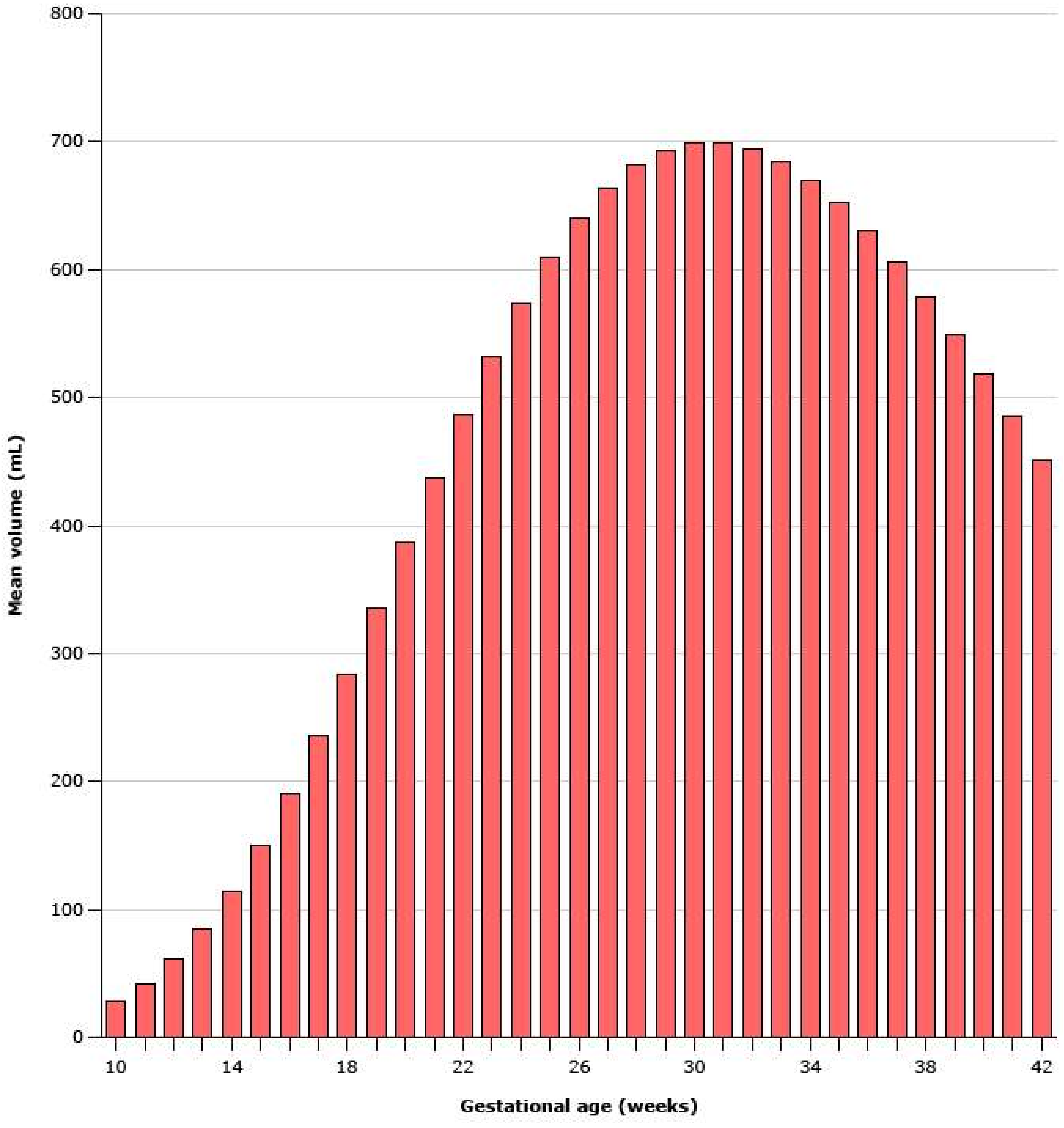
Fetal movement: 2 points if three or more discrete body or limb movements within 30 minutes of observation. An episode of active continuous movement is counted as one movement.
Fetal breathing movements: 2 points if one or more episodes of rhythmic breathing movements of ≥30 seconds within a 30-minute observation period.
Fetal tone: 2 points if one or more episodes of extension of a fetal extremity or fetal spine with return to flexion, or opening and closing of the fetal hand.
Amniotic fluid volume: 2 points if a single deepest vertical pocket ≥2 cm is present. The horizontal dimension should be at least 1 cm.
Nonstress test: 2 points if reactive, defined as at least 2 episodes of FHR accelerations of at least 15 bpm and at least 15 seconds duration from onset to return associated with fetal movement.

Zero points are assigned for any criteria not met (1 point is not an option). The BPP report should provide the number of points for each component and the total score. The NST is not always performed when the ultrasound portion of the BPP is 8/8. Refer to UpToDate content on the fetal biophysical profile for additional information.

FHR: fetal heart rate; bpm: beats per minute.

Graphic 79813 Version 12.0

Mean amniotic fluid volume across normal pregnancy



These values represent the 50th percentile. There is considerable variability around the mean. The 5th, 50th, and 95th percentiles at 30 weeks of gestation are approximately 260, 700, and 1900 mL, respectively.

Data from: Ounpraseuth ST, Magann EF, Spencer HJ, Rabie NZ, Sandlin AT Normal amniotic fluid volume across gestation: Comparison of statistical approaches in 1190 normal amniotic fluid volumes. J Obstet Gynaecol Res; 2017: 43:1122.

Graphic 59704 Version 9.0

Criteria for mild, moderate, and severe polyhydramnios

	Mild	Moderate	Severe
Single deepest pocket	8.0 to 11.9 cm	12.0 to 15.9 cm	≥16.0 cm
Amniotic fluid index	24.0 to 29.9 cm	30.0 to 34.9 cm	≥35.0 cm

Graphic 89351 Version 3.0

Amniotic fluid index (AFI) from 14 to 20 weeks of gestation

Weeks of gestation	5th percentile	10th percentile	50th percentile	90th percentile	95th percentile
14	2.8	3.1	5.0	8.0	8.6
15	3.2	3.6	5.4	8.2	9.1
16	3.6	4.1	5.8	8.5	9.6
17	4.1	4.0	6.3	9.0	10.3
18	4.6	5.1	6.8	9.7	11.1
19	5.1	5.6	7.4	10.4	12.0
20	5.5	6.1	8.0	11.3	12.9

These values are based on findings in singleton pregnancies with reliable gestational age assessment, no known fetal anomalies, and no medical or obstetric complications. At each gestational age, 50 patients were recruited, and only one examination was used per pregnancy.

Data from: Magann EF, Sanderson M, Martin JN, Chauhan S. The amniotic fluid index, single deepest pocket, and two-diameter pocket in normal human pregnancy. Am J Obstet Gynecol 2000; 182:1581.

Graphic 107646 Version 2.0

Single deepest pocket (SDP) at 14 to 20 weeks of gestation

Weeks of gestation	5th percentile	10th percentile	50th percentile	90th percentile	95th percentile
14	1.7	1.9	2.9	4.7	5.0
15	2.0	2.2	3.4	5.1	5.5
16	2.3	2.5	3.6	5.4	5.9
17	2.5	2.7	3.9	5.7	6.2
18	2.7	2.9	4.1	5.9	6.4
19	2.8	3.1	4.3	6.1	6.6
20	2.9	3.2	4.4	6.2	6.7

These values are based on findings in singleton pregnancies with reliable gestational age assessment, no known fetal anomalies, and no medical or obstetric complications. At each gestational age, 50 patients were recruited, and only one examination was used per pregnancy.

Data from: Magann EF, Sanderson M, Martin JN, Chauhan S. The amniotic fluid index, single deepest pocket, and two-diameter pocket in normal human pregnancy. Am J Obstet Gynecol 2000; 182:1581.

Graphic 107647 Version 2.0

Two-dimensional pocket at 14 to 20 weeks of gestation

Weeks of gestation	5th percentile	10th percentile	50th percentile	90th percentile	95th percentile
14	4.3	4.7	9.5	18.3	22.6
15	5.8	6.4	13.0	23.8	28.3
16	7.3	8.1	16.6	29.2	33.7
17	8.7	9.6	19.8	33.8	38.5
18	9.8	10.9	22.5	37.6	42.4
19	10.6	11.9	24.3	40.3	45.3
20	11.0	12.6	25.4	42.0	47.4

These values are based on findings in singleton pregnancies with reliable gestational age assessment, no known fetal anomalies, and no medical or obstetric complications. At each gestational age, 50 patients were recruited, and only one examination was used per pregnancy.

Data from: Magann EF, Sanderson M, Martin JN, Chauhan S. The amniotic fluid index, single deepest pocket, and two-diameter pocket in normal human pregnancy. Am J Obstet Gynecol 2000; 182:1581.

Contributor Disclosures

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