

1-1-2011

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## Recommended Citation

Shanks, Anthony; Tuuli, Methodius; Schaecher, Caren; Odibo, Anthony O.; and Rampersad, Roxane, "Assessing the optimal definition of oligohydramnios associated with adverse neonatal outcomes." *Journal of Ultrasound in Medicine*.30,3. 303-307. (2011). [http://digitalcommons.wustl.edu/open\\_access\\_pubs/1818](http://digitalcommons.wustl.edu/open_access_pubs/1818)

# Assessing the Optimal Definition of Oligohydramnios Associated With Adverse Neonatal Outcomes

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**Objectives**—The purpose of this study was to compare the use of an amniotic fluid index (AFI) less than 5 cm to the use of an AFI less than the fifth percentile for gestational age in predicting adverse perinatal outcomes.

**Methods**—This was a retrospective cohort study from 1998 to 2008. Patients with an AFI less than 5 cm and those with an AFI less than the fifth percentile were compared to patients with a normal AFI. The primary outcome measure was neonatal intensive care unit (NICU) admission.

**Results**—A total of 17,887 patients had complete information for analysis. There were 145 NICU admissions in patients with an AFI less than 5 cm (relative risk, 2.2) compared to 235 in patients with an AFI less than the fifth percentile for gestational age (relative risk, 2.37). The sensitivity and specificity for NICU admission using an AFI less than 5 cm were 10.9% and 95.2% compared to 17.6% and 92.5% for an AFI less than the fifth percentile for gestational age.

**Conclusions**—Oligohydramnios defined as an AFI less than the fifth percentile better predicts fetuses at risk for adverse perinatal outcomes compared to an AFI less than 5 cm.

**Key Words**—amniotic fluid index; fetal surveillance; obstetrics; oligohydramnios

Received August 9, 2010, from the Division of Maternal-Fetal Medicine (A.S.), Department of Obstetrics and Gynecology (A.S., M.T., C.S., A.O.O., R.R.), Washington University, St Louis, Missouri USA. Revision requested August 30, 2010. Revised manuscript accepted for publication October 2, 2010.

This study was presented in part at the Society for Maternal-Fetal Medicine 30th Annual Meeting, February 1–6, 2010; Chicago, Illinois.

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## Abbreviations

AFI, amniotic fluid index; CI, confidence interval; NICU, neonatal intensive care unit; RR, relative risk

Amniotic fluid surrounds the developing fetus, and its presence plays an essential role in normal fetal development.<sup>1</sup> Formal measurements of amniotic fluid are reported as the deepest vertical pocket<sup>2</sup> or as the summation of 4 quadrants to produce an amniotic fluid index (AFI).<sup>3</sup> The assessment of amniotic fluid volumes, both quantitatively and qualitatively, serve important functions because decreased volumes have important pregnancy implications. Reduced amniotic volumes can be suggestive of rupture of membranes, and, importantly, amniotic fluid volumes can also be used to monitor fetal well-being as part of a biophysical profile.<sup>4</sup>

Oligohydramnios, or decreased amniotic fluid, has since been correlated with increased risks of intrauterine growth restriction, congenital abnormalities, postdate pregnancy, meconium passage, abnormal fetal heart rate patterns, and lower Apgar scores in multiple studies.<sup>5,6</sup> Other studies have associated oligohydramnios with an increased perinatal rate of morbidity and mortality,<sup>7,8</sup> and many clinicians use the presence of oligohydramnios as an indication for delivery at term.<sup>4,9</sup>

Amniotic fluid indices vary with gestational age,<sup>10</sup> and published charts exist that define low volumes. Oligohydramnios has been defined as an AFI less than 5.0 cm<sup>11</sup> or an AFI less than the fifth percentile for a specific gestational age,<sup>12</sup> and these definitions have been used interchangeably in the literature. It is unclear whether adverse perinatal outcomes are different between the groups depending on how oligohydramnios is defined. The objective of this study was to use a large sonographic database to determine the rate of adverse fetal outcomes in patients with oligohydramnios as defined using the two criteria mentioned above.

## Materials and Methods

This was a retrospective cohort study of pregnancies presenting to our prenatal ultrasound units over 10 years (1998–2008). Approval from the Institutional Review Board at our center was obtained. Dedicated and trained sonographers performed the sonographic examinations and calculated the AFI. The AFI was calculated by dividing the uterus into 4 quadrants using the linea nigra vertically and a transverse line through the maternal umbilicus. The deepest vertical pocket not containing fetal body parts or the umbilical cord was recorded for each quadrant and summed in centimeters to calculate the AFI. Data for all patients with a measured AFI were entered into our prenatal database. Patients were divided into 4 groups based on AFI. The groups included an AFI less than 5 cm, an AFI less than the fifth percentile for gestational age, an AFI greater than 5 cm but less than the fifth percentile for gestational age, and a normal AFI. Gestational ages were confirmed by first- or second-trimester sonography. Dedicated outcome coordinators routinely obtain outcome information on patients seen in our center, and these collected data were then available for analysis.

The primary outcome measure was admission to the neonatal intensive care unit (NICU). Secondary outcomes included the length of the hospital stay, mean AFI, and gestational age and fetal weight at the time of delivery. Maternal demographic information including age, height, weight, race, and parity was also collected.

Relative risks (RRs) for the primary outcome were calculated for oligohydramnios as defined by each criterion. The screening efficiency of each criterion of oligohydramnios for the primary outcome was determined. Maternal and neonatal characteristics between the groups were compared using analysis of variance for continuous variables and the McNemar and Pearson  $\chi^2$  tests for paired and unpaired categorical variables, respectively. All statistical analyses were performed with Stata version 9.0 software (StataCorp, College Station, TX).

## Results

A total of 17,877 patients had complete information for analysis. Characteristics of the study cohort are shown in Table 1. There were 904 patients with an AFI less than 5 cm, 1429 with an AFI less than the fifth percentile, and 525 with an AFI greater than 5 cm but less than the fifth percentile. There were 145 NICU admissions among the 904 patients with an AFI defined as less than 5 cm (RR, 2.2; 95% confidence interval [CI], 1.88–2.58) compared to 235 among the 1429 patients with an AFI defined as less than the fifth percentile for gestational age (RR, 2.37; 95% CI, 2.08–2.69).

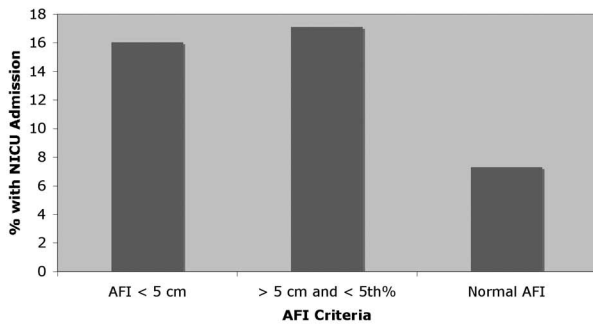
For pregnancies with an AFI greater than 5 cm but less than the fifth percentile for gestational age, the RR for NICU admission was 2.3 (95% CI, 1.89–2.80). There was no difference in the RR for NICU admission between the group of patients with an AFI less than 5 cm and the group with an AFI greater than 5 cm but less than the fifth percentile for gestational age (RR, 1.1; 95% CI, 0.84–1.4). Figure 1 shows the percentage of patients with NICU admission based on AFI criteria. Patients with an AFI less than 5 cm had a 16.03% NICU admission rate compared to 7.3% for patients with an AFI greater than 5 cm. Patients with an AFI greater than 5 cm but less than the fifth percentile had the highest NICU admission rate of 17.1%.

The sensitivity and specificity for NICU admission using an AFI less than 5 cm were 10.9% (95% CI, 9.3%–12.7%) and 95.2% (95% CI, 94.9%–95.5%) compared to 17.6% (95% CI, 15.6%–19.8%) and 92.5% (95% CI, 92.1%–92.9%) for an AFI less than the fifth percentile for

**Table 1.** Characteristics of the Study Group (N = 17,887)

Characteristic	Value
Maternal age, y	28.76 ± 6.25
Maternal height, cm	61.55 ± 14.26
Maternal weight, kg	42.71 ± 28.05
Gestational age at sonography, wk	34.38 ± 3.04
AFI at sonography, cm	13.92 ± 5.24
Gestational age at delivery, wk	38.27 ± 2.86
Parity	
Nulliparity	7,069 (39.5)
Multiparity	10,818 (60.5)
Maternal race	
White	9,106 (50.9)
Black	5,909 (33.0)
Hispanic	435 (2.4)
Other	2,437 (13.6)

Values are mean ± SD and number (percent). AFI indicates amniotic fluid index.



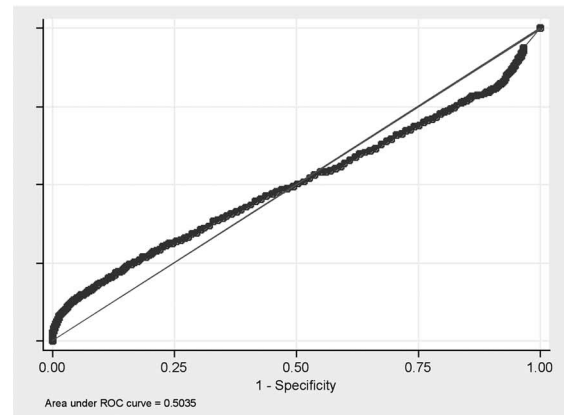
**Figure 1.** Neonatal intensive care unit (NICU) admissions (percentile) by amniotic fluid index (AFI) criteria.

gestational age (Table 2). An AFI less than the fifth percentile predicted NICU admission better than an AFI less than 5 cm (McNemar  $\chi^2$ ,  $P < .001$ ).

A receiver operating characteristic curve was created using the AFI as a continuous variable to predict the primary outcome (Figure 2). The mean gestational ages at delivery  $\pm$  SD were  $37.4 \pm 3.6$  weeks for an AFI less than 5 cm,  $37.0 \pm 3.7$  weeks for an AFI less than the fifth percentile, and  $36.3 \pm 3.6$  weeks for an AFI greater than 5 cm but less than the fifth percentile. In analysis of secondary outcomes, there were statistically significant differences in mean AFI, preterm labor, hospital stay, and fetal weight at delivery between the different AFI criteria (Table 3). There was a statistically significant increase in NICU admissions with an AFI greater than 5 cm but less than the fifth percentile even with stratification of gestational age at delivery of less than or greater than 34 weeks (Table 4).

## Discussion

The results of our study show that oligohydramnios defined as an AFI less than the fifth percentile for gestational age better predicts fetuses at risk for NICU admission compared to an AFI defined as less than 5 cm. Importantly, our data show that patients with an AFI greater than 5 cm but less than the fifth percentile had the highest percentage of NICU admissions of any of the criteria used. Although there is ample evidence of adverse perinatal outcomes in



**Figure 2.** Receiver operating characteristic (ROC) curve of the amniotic fluid index and prediction of neonatal intensive care unit admission.

pregnancies with an AFI less than 5 cm,<sup>5-8</sup> less is known about pregnancies with an AFI less than the fifth percentile despite the frequency of the diagnosis in clinical practice.

By definition, an AFI less than the fifth percentile will include all pregnancies with an AFI less than 5 cm. Conventional wisdom would seem to indicate that any adverse outcomes seen in the group with an AFI less than the fifth percentile would be predominately attributable to the patients with the lowest AFIs: namely, those who have measurable volumes less than 5 cm. Although pregnancies with an AFI less than 5 cm are known to have an increased risk for adverse perinatal outcomes, our study shows that pregnancies with an AFI greater than 5 cm but less than the fifth percentile for gestational age also possess an elevated risk, as evidenced by an RR of 2.3 for NICU admission.

The sensitivity of the two criteria for oligohydramnios also supported the use of an AFI less than the fifth percentile as the diagnostic criteria. Table 2 shows that an AFI less than the fifth percentile had increased sensitivity compared to an AFI less than 5 cm (17.6% versus 10.9%) with similar specificity (92.5% versus 95.2%). Post hoc power analysis revealed that we had greater than 99% power to detect a 2-fold difference in the risk of NICU admission, assuming a baseline NICU admission rate of 7% and type I error of 5% in a 2-tailed test.

**Table 2.** Screening Efficiency for Neonatal Intensive Care Unit Admission by Amniotic Fluid Index Definition

AFI	Sensitivity, %	Specificity, %	PPV, %	NPV, %
<5 cm	10.9	95.2	16.0	92.7
<5th percentile	17.6	92.5	16.4	93.0

AFI indicates amniotic fluid index; NPV, negative predictive value; and PPV, positive predictive value.

**Table 3.** Demographics by Amniotic Fluid Index Criteria

Characteristic	AFI >5 cm / <5th Percentile for Gestational Age			P
	AFI <5 cm	AFI >5 cm / <5th Percentile for Gestational Age	Normal AFI	
Gestational age at sonography, wk	33.5 ± 3.4	34.8 ± 3.0	34.4 ± 3.0	<.01
Maternal age, y	28.8 ± 6.2	28.6 ± 6.8	28.9 ± 6.7	.27
Maternal weight, kg	43.2 ± 28.6	42.1 ± 28.5	42.7 ± 28	.75
AFI, cm	1.1 ± 1.7	6.8 ± 1.1	14.9 ± 4.2	<.01
Preterm labor	153 (16.14)	83 (15.6)	1,902 (11.95)	<.01
Hospital stay, d	7.8 ± 14.9	10.8 ± 21.7	4.5 ± 10.2	<.01
Fetal weight at delivery, g	2745 ± 968	2409 ± 907	3027 ± 1378	<.01

Values are mean ± SD and number (percent). AFI indicates amniotic fluid index.

**Table 4.** Association between Neonatal Intensive Care Unit Admission and Reduced Amniotic Fluid Index Stratified by Gestational Age at Delivery

AFI	≤34 wk		>34 wk	
	n (%)	RR (95% CI)	n (%)	RR (95% CI)
<5 cm	66 (47.1)	1.14 (0.94–1.40)	79 (10.3)	1.75 (1.41–2.17)
<5th percentile	120 (48.4)	1.27 (0.99–1.51)	115 (9.7)	1.43 (1.04–1.96)
<5th percentile / >5 cm	54 (50.0)	1.23 (1.04–1.45)	36 (8.6)	1.67 (1.39–2.01)

AFI indicates amniotic fluid index; CI, confidence interval; n, number of patients; and RR, relative risk.

A receiver operating characteristic curve using the AFI as a continuous variable for the primary outcome was constructed in an attempt to define the optimal AFI cutoff. Figure 2 shows that no AFI cutoff can be determined from our data. This is likely attributable to the fact that the AFI does not perform well as a continuous measurement but rather as a categorical measurement. Given this finding, we support the use of an AFI less than the fifth percentile as a better predictor of adverse outcomes.

Strengths of our study include the large sample size and the use of a single institution. Using a single center minimizes variations in measurement training and ensures standardization among sonographers. The use of dedicated outcome personnel also ensures accurate outcome data for the variables of interest.

Our study was not without limitations. It was a retrospective design, and there was a possibility that AFI values may not have been accurately coded. It was also difficult to discern how the finding of oligohydramnios by either definition may have altered management of pregnancies. An AFI less than 5 cm at term is a frequent indication for delivery, whereas expectant management is typically undertaken when the AFI is greater than 5 cm. It is interesting to note that despite this typical management pattern, our data reveal that those with the lowest AFI cutoff (<5 cm) had lower mean gestational ages at diagnosis yet higher fetal weights at delivery. Gestational age alone may not account for the difference in NICU admissions between the groups,

and further research could investigate potential etiologies for this discrepancy.

The discovery of a decreased AFI in pregnancies should prompt the obstetrician to search for underlying causes and increase antenatal surveillance. Although heightened surveillance patterns in the form of weekly AFI checks and nonstress tests are frequently used in pregnancies with oligohydramnios defined as less than 5 cm, our results suggest that this strategy should be extended to patients with oligohydramnios defined as less than the fifth percentile for gestational age as well.

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