

CAROLYN L. GEGOR, CNM, MS, RDMS

LISA L. PAINE, CNM, DRPH, FAAN

KATHLEEN COSTIGAN, RN, MPH

TIMOTHY R. B. JOHNSON, MD

Interpretation of Biophysical Profiles by Nurses and Physicians

Objective: To determine the agreement between nurse and physician interpretation of biophysical profile scores.

Design: A prospective evaluation of videotaped biophysical profiles was independently scored by four nurse and four physician interpreters and compared to that of an expert physician.

Setting: The fetal assessment center of a large tertiary-care center; study included women from public and private practices.

Patients: Twenty-three women with high-risk pregnancies who were regularly scheduled for a biophysical profile. Women pregnant with multiple fetuses or whose fetuses were less than 28 weeks' gestational age or had severe fetal anomalies were excluded.

Main Outcome Measure: The proportion of agreement between the physicians and nurses and the physician expert was calculated for each biophysical profile criterion.

Results: The kappa statistic was used to evaluate the proportion of agreement with the "gold standard." When compared with the expert, physicians showed 60% moderate or substantial agreement, and the nurses showed 80% moderate or substantial agreement.

Conclusions: Nurses' interpretations of biophysical profiles were at least as reliable as physicians' when compared with an expert reviewer.

Accepted: April 1993

Third-trimester fetal assessment in high-risk pregnancies is well established in the evaluation of fetal health (Johnson, Besinger, & Thomas, 1988; Finberg, Kurtz, Johnson, & Wapner, 1990). The development of electronic fetal monitoring added a new dimension to the nurse's role (Afriat, 1983; Gegor & Paine, 1992), setting standards for the antepartum obstetric nurse to perform and interpret the nonstress test (NST) (Afriat, 1987; NAACOG, 1991). The biophysical profile (BPP) (Finberg et al, 1990; Manning, Platt, & Sipos, 1980), which includes the nonstress test with the addition of real-time ultrasound for imaging fetal behavior, is rapidly gaining popularity in antepartum testing, often being performed in fetal assessment centers (FAC) separate from the labor and delivery suite (Sabey & Clark, 1992; Fresquez & Collins, 1992). In most independent FACs, nurses conduct the NST, with physicians or sonographers conducting the ultrasound portion of the biophysical profile and interpreting the results. The biophysical profile was actually developed in a fetal assessment center where nurses performed the ultrasound portion of the examination (Manning, Platt, & Sipos, 1980).

The BPP is a time-intensive procedure that, like the NST, usually yields reassuring results that medical intervention is not required, and it offers an opportunity for patient education (Sabey & Clark, 1992). Nurses have become increasingly involved in the antenatal FAC, performing electronic fetal monitoring and evaluating and educating patients (Dauphinee, 1987). Just as the nursing role has expanded to include performance and interpretation of electronic fetal monitoring in collaboration with obstetricians and perinatologists, in some centers it now includes ultrasound skills (Fresquez & Collins, 1992; Sabey & Clark, 1992; Gegor & Paine, 1992). With directed teaching, nurses can use real-time ultrasound to recognize fetal anatomy and behavior evaluated in the BPP and to report nonreassuring results to the responsible physician.

With directed teaching, nurses can use real-time ultrasound to recognize fetal anatomy and behavior evaluated in the biophysical profile.

The "hands-on" approach of performing the BPP for a period of 15 to 30 minutes gives the testing nurse adequate time to answer questions from women and

their families and to impart information about high-risk pregnancy and antepartum testing. Women with high-risk pregnancies are often anxious or unable to assimilate all the information they receive during prenatal visits. The nurse's ability to reduce anxiety and to educate the patient is often an overlooked benefit of antepartum testing (Murray, 1988). Studies have shown increased compliance with appointments when sonographers interact with women and families (Craig, 1990). In addition, because of their knowledge of the physiology of pregnancy, nurses may be better suited to perform the biophysical profile than medical sonographers, whose knowledge is more specific to fetal anatomy (Sabey & Clark, 1992).

Medical involvement is the key to managing high-risk pregnancy. However, the increased use of the BPP and the extended time required for testing make it difficult for physicians alone to perform these assessments. Collaborative practice between highly skilled perinatal nurses and physicians may be the ideal approach to antepartum fetal assessment of women in the 3rd trimester of high-risk pregnancies. At an increasing number of centers, nurses now perform ultrasound examinations, including the biophysical profile (Gegor & Paine, 1992; Sabey & Clark, 1992; Fresquez & Collins, 1992).

Problem Statement

Nurse and physician similarity of interpretation of NSTs has been documented (Chez et al., 1990; Skurnick, Chez, & Chez, 1991). However, although more nurses are performing ultrasound procedures, no studies have been published that evaluate nurse and physician reliability in interpreting the biophysical profile. The purpose of this study was to determine the extent of agreement between fetal assessment nurses and obstetricians in interpreting the BPP. The hypothesis was that registered nurses are as reliable as physicians in interpreting the BPP.

Materials and Methods

An Aloka real-time ultrasound machine (Aloka, Corometrics Medical Systems, Wallingford, CT) with a 3.5-MHz linear-array transducer was used to perform all biophysical profiles in the study. Twenty-three women were scanned according to the usual protocol. To maintain patient confidentiality, an identification number on the monitor screen for each scan was the only patient identifier. The first 10 minutes of each

Nurse and physician similarity of interpretation of nonstress tests has been documented, but no studies have been published in the nursing or medical literature that evaluate nurse and physician similarity in interpretation of the biophysical profile.

BPP was videotaped for study purposes, regardless of what biophysical parameters had been visualized. The NST was performed by the antepartum fetal assessment nurse in accordance with usual criteria and was copied with no identifiers. No change was made in the scanning technique, and patient care was unaffected by the study. Identification numbers were assigned to coincide with the BPP videotapes. Copies of the videotapes and the NSTs were distributed to the interpreters, who independently viewed and assigned scores to the BPPs and NSTs. The interpretation of the BPP used a modification of Manning criteria (see Table 1) (Gegor, Paine, & Johnson, 1991).

Subjects

All subjects were scheduled for BPPs at the Fetal Assessment Center at The Johns Hopkins Hospital, a large tertiary-care center. The women's ages ranged from 16 to 33 years, and gestational ages ranged from 29 to 42 weeks. Women's referral sources were the obstetric clinic, several private physician practices, and two health maintenance organizations. The women were selected sequentially during the study period; anyone pregnant with multiple fetuses or whose fetus had a severe fetal anomaly or a gestational age of 28 weeks or less was excluded.

Interpreters

The biophysical profile videotapes were interpreted independently by four physicians and four nurses. The interpretation of another physician, who was recognized as an expert in fetal assessment techniques and had 10 years' experience with real-time ultrasonography, was used as the "gold standard" for comparison. Each nurse had completed a 40-hour practicum of ultrasound skills for the BPP within the past year. Two were fetal assessment nurses who permanently staff the FAC, and two were certified nurse-midwives who

Table 1.
Biophysical Profile Criteria

Criteria	Score 2	Score 0
Fetal tone	One episode of flexion/extension of the fetal spine, limbs, or hand	Extremities in extension
Fetal movement	Three gross movements, includes rolling	Two or fewer episodes of fetal movement
Fetal breathing	30 Seconds continuous breathing	Absence of respiratory effort
Nonstress test (NST)	Two accelerations 15 bpm × 15 sec within 20 min	Nonreactive NST
Amniotic fluid volume (AFV)	Largest fluid pocket ≥ 2 cm vertically	Oligohydramnios

These criteria were evaluated within a 30-minute testing period.
JHH modification of criteria per F. Manning. From Geger, 1991. Used with permission.

assumed a nursing role for this study. Of the four physicians, three had attending perinatal responsibilities in the FAC, and one was a visiting clinician. The physicians' experience in performing real-time ultrasound ranged from 1 to 5 years.

Results

Twenty-three NSTs and videotapes of BPPs were evaluated by nine interpreters for a total of 207 observations for each of the five BPP criteria. The proportion of agreement between each physician and registered nurse and the physician expert was calculated for each

BPP criterion. The kappa statistic was used to evaluate the proportion of agreement with the gold standard beyond that expected to occur by chance. No attempt was made to evaluate agreement with the overall score, because similar or identical scores could result despite significant disagreement over scoring of the individual criteria.

Table 2 shows the proportion of observed agreement and the kappa for each BPP criterion for the physicians and nurses. When the physicians' observations were compared to the gold standard, 5% showed substantial agreement, 55% moderate agreement, and 40% slight agreement. When the nurses' observations

Table 2.
Proportion of Agreement for Each BPP Criterion for MDs and RNs

Interpreters	NST		Tone		Movement		Breathing		AFV	
	P _o *	Kappa†	P _o	Kappa	P _o	Kappa	P _o	Kappa	P _o	Kappa
MD	.87	.59	.65	.12	.61	.11	.83	.43	.83	.06
MD	.70	.27	.74	.19	.70	.16	.83	.43	.91	.44
MD	.74	.33	.96	.67	.87	.35	.61	.05	.83	.26
MD	.70	.19	.91	.47	.65	.12	.74	.32	.87	.35
RN	.82	.40	.91	.47	.91	.47	.96	.77	.82	.40
RN	.78	.45	.87	.35	.87	.35	.87	.35	.78	.31
RN	.91	.77	.91	.05	.96	.20	.74	.13	.78	.33
RN	.74	.33	.87	.35	.87	.35	.87	.52	.83	.41

NST = Non-stress test; AFV = amniotic fluid volume.

* Proportion observed agreement.

† .00 < Kappa < .20 = slight agreement.

.20 < Kappa < .60 = moderate agreement.

.60 < Kappa < 1.0 = substantial agreement.

were compared to the gold standard, 10% showed substantial agreement, 70% moderate agreement, and 10% slight agreement.

Discussion

Results suggest that nurses are as reliable as physicians in reviewing taped BPPs. The increased overall agreement between the nurses and the expert may reflect the high degree of daily collaboration the nurses have with physicians that validates their interpretation of the BPPs. Physicians, however, work more independently and rarely collaborate on interpreting biophysical profile results, which may explain their lower rate of agreement with a standard. These study results suggest that nursing care include complete performance of antepartum fetal assessment (NST and BPP) for the woman with normal test results and that it involve the physician when nonreassuring results are found.

These results suggest that independent performance of biophysical profiles by trained nurses can offer the same degree of accuracy as interpretation by physicians. Nursing care can include complete performance of antepartum fetal assessment (NST and biophysical profile) for the woman with normal test results and can involve the physician when nonreassuring results are found.

In those locations where there are no antepartum testing centers within a reasonable distance, skilled nurses can perform and interpret antepartum testing, including biophysical profiles, and thereby improve the quality of care. Collaborative communication between on-site nurses and physicians at a distance will allow women whose test results are reassuring to remain in their communities, whereas those whose results are nonreassuring can be transferred to a perinatal center.

Limitations of this study include the small number of nurse and physician reviewers. Although nurses and physicians demonstrated interpretive skills, their abilities to generate the scan directly were not evaluated. Because the images on the ultrasound screen are interpreted during the course of the scan, the two skills are closely integrated in actual practice. It is neces-

sary, therefore, that nurses be evaluated for both their interpretive and scanning skills before they independently perform biophysical profiles.

Nursing Implications

The opportunity for advanced-practice obstetric nurses to perform antepartum testing independently has potential benefits for nurses and for high-risk pregnant women. It allows nurses to use their education in maternal-fetal physiology, in the psychosocial needs of the woman with high-risk pregnancy, and in educational principles that support women's care for themselves and their unborn children. The increase in professional responsibility allows nurses to have a greater role on the health-care team and in the outcome of high-risk pregnancy.

With these opportunities come specific responsibilities. Nurses and their employers must insist upon standard policies, procedures, and education (NACOG, 1991; Fresquez & Collins, 1992; Sabey & Clark, 1992; Geger & Paine, 1992), the most important of which is adequate education. All nurses who participated in this study have completed the 40-hour "Practicum in Biophysical Profile and Doppler Velocimetry," which is comprised of 30 hours of supervised ultrasound scanning and 10 hours of classroom instruction in many aspects of antepartum fetal assessment. The same guidelines for nurses' roles in electronic fetal monitoring, such as documentation of education, evaluation, policies, and procedures (NACOG, 1991), must be maintained to assure optimal patient care with the least risk of legal liability. Compliance with state nurse practice acts is also essential.

More nurses are now in roles where they use ultrasound scanning skills. In a recent Committee Opinion (1991) from the American College of Obstetricians and Gynecologists (ACOG), the biophysical profile is included as an ultrasound study that may be of a limited scope. AWHONN has established guidelines for

Nurses will require policies, procedures, and education for this role. AWHONN, the organization of obstetric, gynecologic, and neonatal nurses, has established guidelines for nurses to perform limited ultrasound studies that include the biophysical profile.

nurses to perform limited ultrasound studies that include the biophysical profile (AWHONN, 1993). Throughout the United States and Canada, new courses to teach these skills are beginning to emerge (Fresquez & Collins, 1992; Geger & Paine, 1992; Sabey & Clark, 1992).

Adequate documentation of studies is an essential nursing role. This must include identification of the studies performed and results and follow-up regarding patient assessment. The scope of patient education must also be documented.

Future research may focus on whether the fetal assessment nursing role will increase pregnant women's participation in antepartum testing and other aspects of obstetric care, with the long-term goal of improving overall perinatal outcome.

Future Research

Replication of this study could include a sample large enough to determine how experience and training influence both nurse and physician interpretation of biophysical profiles. Future research may focus on whether the fetal assessment nursing role will increase compliance with antepartum testing and other aspects of obstetric care, with the long-term goal of improving overall perinatal outcome (Sabey & Clark, 1992). Additional studies may evaluate training for nurses in ultrasound skills, nurse-physician collaboration in managing nonreassuring test results, decreased or more efficient patient time in the testing center, and increased cost effectiveness.

Conclusion

Nurses have demonstrated competence in performing and interpreting electronic fetal monitoring (Chez et al., 1990; Skurnick, Chez, & Chez, 1991). This study shows reliable interpretation of biophysical profiles by nurses and demonstrates that the role of the fetal assessment nurse can be expanded to include BPP. The value of independent FACs lies in offering focused, high-quality, consistent care to women with high-risk pregnancies. The broad professional scope of today's advanced-practice obstetrics nurse is ideal to meet this challenge.

References

- Afriat, C. (1983). The nurse's role in fetal heart rate monitoring. *Perinatology Neonatology*, 7(3), 29-32.
- Afriat, C., (1987). Historical perspective on electronic fetal monitoring: A decade of growth, a decade of conflict. *Journal of Perinatal Neonatal Nursing*, 1(1), 1-4.
- American College of Obstetricians and Gynecologists. (1991). *Ultrasound imaging in pregnancy ACOG Committee Opinion Number 96*. Washington, DC: Author.
- AWHONN. (1993). *Nursing practice competencies and educational guidelines: Limited ultrasound guidelines*. Washington, DC: Author.
- Chez, B., Skurnick, J., Chez, R., Verklan, M. T., Biggs, S., & Hage, M. (1990). Interpretations of nonstress tests by obstetric nurses. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, 19, 227-232.
- Craig, M. (1991). Controversies in obstetrics and gynecologic ultrasound. In M. C. Berman (Ed.), *Diagnostic Medical Sonography, A Guide to Clinical Practice. Vol. 1. Obstetrics and Gynecology* (pp. 551-563). Philadelphia: J. B. Lippincott.
- Dauphinee, J. D. (1987). Antepartum testing: A challenge for nursing. *Journal of Perinatal Neonatal Nursing*, 1(1), 29-48.
- Finberg, H., Kurtz, A., Johnson, R., & Wapner, R. J. (1990). The biophysical profile: A literature review and reassessment of its usefulness in the evaluation of fetal well-being. *Journal of Ultrasound in Medicine*, 9, 583-591.
- Fresquez, M. L., & Collins, D. E. (1992). Advancement of the nursing role in antepartum fetal evaluation. *Journal of Perinatal Neonatal Nursing*, 5(4), 16-22.
- Geger, C. L., Paine, L. L., & Johnson, T. R. B. (1991). Fetal assessment: A nurse-midwifery perspective. *Journal of Nurse-Midwifery*, 36(3), 153-167.
- Geger, C. L., & Paine, L. L. (1992). Antepartum fetal assessment techniques: An update for today's perinatal nurse. *Journal of Perinatal Neonatal Nursing*, 5(4), 1-15.
- Johnson, T. R. B., Besinger, R. E., & Thomas, R. L. (1988). New clues to fetal behavior & well-being. *Contemporary Ob/Gyn*, 30, 108.
- Manning, F. A., Platt, L. D., & Sipos, L. (1980). Antepartum fetal evaluation: Development of a biophysical profile. *American Journal of Obstetrics and Gynecology*, 136, 787.
- Murray, M. L. (1988). *Antepartal and intrapartal fetal monitoring*. Washington, DC: NAACOG.
- NAACOG. (1991). *Nursing practice competencies and educational guidelines: Antepartum fetal surveillance and intrapartum fetal heart monitoring*. (2nd ed.). Washington, DC: Author.
- Sabey, P. L., & Clark, S. L. (1992). Establishing an antepartum testing unit: The nurse's role. *Journal of Perinatal Neonatal Nursing*, 5(4), 23-32.
- Skurnick, J. H., Chez, R. A., & Chez, B. F. (1991). Effect of explicit criteria on nonstress test evaluation by obstetric

nurses. *American Journal of Perinatology*, 8(2), 139-143.

Address for correspondence: Carolyn L. Geger, CNM, MS, RDMS, Department of Gynecology and Obstetrics, The Johns Hopkins University School of Medicine, Houck 228, 600 N. Wolfe St., Baltimore, MD 21205.

Carolyn L. Geger is director of Nurse-Midwifery Services and assistant professor of gynecology and obstetrics at The Johns Hopkins University School of Medicine, and clinical director of the Fetal Assessment Center at The Johns Hopkins Hospital, Baltimore.

Lisa L. Paine is director of the Nurse-Midwifery Education Program and associate professor of maternal-child health at the Boston University School of Public Health, Health Services Department, Massachusetts.

Kathleen Costigan is the research coordinator for fetal assessment at The Johns Hopkins Hospital, Baltimore.

Timothy R. B. Johnson is chair and Bates Professor of Diseases of Women and Children, Department of Obstetrics and Gynecology, University of Michigan Medical Center, Ann Arbor.

JOGNN REVIEWERS

Rebecca Attenborough, RN, MN
 Patricia Beachy, RN, MS
 Cheryl Tatano Beck, CNM, DNSc
 Pamela Butler Beeman, RN, PhD
 Joan Rosen Bloch, RNC, MSN
 Mary C. Brucker, CNM, DNSc
 Judith A. Carveth, RN, CNM, PhD
 Judith M. Collinge, RNC, MSc(A), MBA
 Beth A. Collins, RNC, PhD
 Kathryn V. Deitch, RNC, PhD
 Patricia A. Dunn, RNC, MSN
 Barbara Horn Frentzen, RN, MSN
 Catherine Garner, RNC, MSN, MPA
 Peggy Gordin, RNC, MS

Jeanne T. Grace, RNC, PhD
 Maureen Heaman, RN, MN
 Mary Henrikson, RNC, MN, ARNP
 Pamela D. Hill, RN, PhD
 Diane Holditch-Davis, RN, PhD
 Patricia A. Jamerson, RNC, MSN, CCE, CBE
 Susan Dow Johnson, RNC, MSN
 Pamela L. Jordan, RN, PhD
 Marilyn Robbie Jossens, RN, DrPH
 Margaret H. Kearney, RNC
 Maud B. Low, RNC, MSN
 Vicki A. Lucas, RNC, PhD
 Lynn E. Lynam, RNC, MS

Judith Maloni, RN, PhD
 Linnea J. Mead, RN, MSN, PNP
 Barbara Medoff-Cooper, PhD, CRNP, FAAN
 Paula Meier, RN, DNSc
 Mary Ann Miller, RN, PhD
 Susan Nolte, RN, MSN, CRNP
 Rita H. Pickler, RN, PhD
 Nancy Prince, RN, MS
 Deborah Ann Raines, RNC, PhD
 Jaque Repke, RNC, MS
 Sharleen H. Simpson, PhD, ARNP
 Susan E. Trippet, RN, DSN
 Nan H. Troiano, RN, MSN