The Relationship Between Assessed Obstetric Risk and Maternal-Perinatal Outcome

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The relationship between antepartum risk assessment and subsequent maternal and perinatal outcome was examined in a retrospective study of 430 randomly selected deliveries at the Oregon Health Sciences University during the 1986 calendar year. Antepartum risk scores at the initial prenatal visit and at 37 weeks' gestation were positively correlated with each other. Antepartum risk scores were correlated with maternal length of stay and maternal hospital charges, but not with gestational age, birth weight, or Apgar scores. Increased intrapartum risk scores were strongly correlated with increasing length of stay for mother and baby, lower birth weight, and lower estimated gestational age at birth. The ability of the risk-scoring system to predict selected adverse outcomes was then assessed using a high-risk cutoff score of 5 or greater. Sensitivity and positive predictive value were found to be quite low while specificity and negative predictive value were reasonably high.

The results suggest that the risk-scoring system used at this institution is effective in identifying low obstetrical risk and that prenatal care reduces the probability of poor neonatal outcome among infants of women at high obstetrical risk identified through antepartum multivariate assessment. Two antepartum risk assessments, each measuring different factors, may be redundant. Not yet known are which specific factors by their identification result in more effective prenatal care.

Obstetrical risk scoring is used to identify and quantify antepartum and intrapartum factors that place the mother and fetus at risk for later complications. A recent review of existing risk-scoring systems highlighted the difficulties associated with their use.[1] A useful multivariate screening instrument should first contain factors predisposing to risk that can be identified early and acted upon to reduce subsequent morbidity or mortality; it should reflect the dynamic character of pregnancy with its changing level of risk; and finally, it should be easy to use and reasonably predictive of outcomes important in pregnancy. Measured against these criteria, the ability of existing risk-scoring systems to identify, quantify, and therefore predict risk of adverse outcomes better than conventional clinical judgment has been questioned.[1–3]

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The obstetric risk-scoring system currently in use at the Oregon Health Sciences University is based on the popular scales developed by Hobel et al[4–6] and Goodwin et al.[7] Risk factors are weighted from 1 to 5, and added together to produce a cumulative risk score. Formal risk assessment occurs at three points during the antenatal period. The antepartum initial risk score is recorded at the time of the first prenatal visit. Factors assessed include socioeconomic status, prior obstetric and gynecologic problems, present medical problems, family history of heritable defects or diabetes, and current substance or drug use. A second assessment occurs at 37 weeks' gestation and includes problems followed during the present pregnancy including weight gain, bleeding, preeclampsia, and others (Figure 1). A third assessment occurs during the intrapartum period and surveys the actual progress of events during labor and delivery (Figure 2). In reality, this intrapartum assessment is often recorded retrospectively, after the delivery has been completed.

The purpose of this study was to determine the relationship between obstetric risk assessed at these three times and subsequent maternal and perinatal outcomes. It was

INITIAL RISK SCORE

Risk	General
1	Low socioeconomic status
1	Age <17 or >35 years
1	1st visit >20 weeks or unsure dates
1	Weight <100 or >200 pounds
1	Nulliparous (if yes, skip to Gynecologic History)
☐	SUBTOTAL (maximum score 2)

Obstetric History

2	Parity ≥5
2	Repeated spontaneous abortions (≥3)
5	Premature <35 weeks
3	Growth retarded infant (IUGR)
2	Infant ≥10 pounds
1	Midforceps or difficult delivery
___	Cesarean delivery: low transverse plans Cesarean section = 1 low transverse plans labor = 3 low vertical = 2 classical = 3
5	Neonatal death or stillborn
1	Infant with congenital anomaly
2	Ante - or postpartum hemorrhage
3	Eclampsia or severe pregnancy induced hypertension
1	Mild pre–eclampsia
5	Isoimmunization (eg, Rh)

Gynecologic History

2	DES exposure
2	Herpes
2	Uterine surgery (other than Cesarean section)
1	Uterine or cervical malformation

Medical History

2	Chronic anemia (Hematocrit <.30)
2	Asymptomatic heart disease
5	Symptomatic heart disease
5	Chronic hypertension
5	Thromboembolic disease
2	Pulmonary disease
5	Renal disease
5	Diabetes
1	Epilepsy
1	Psychiatric problem

Family History

1	Inheritable defect
1	Parent or sibling with diabetes

Substance/Drug Use

3	Alcohol abuse
1	Tobacco >1 pack per day
3	Narcotics or Intravenous drug abuse
1	Drug with known fetal effect (eg,dilantin, lithium, thiazides, propylthiouracil, tetracycline)

Other

☐ = **TOTAL INITIAL RISK SCORE**

Signature and Date

PRENATAL COURSE (Total at 37 weeks)

Risk	Maternal factors
1	Weight gain >50 pounds
2	Weight gain <20 pounds - exclude obesity
2	Severe anemia (Hematocrit <.30)
5	Insulin–dependent diabetes
2	Non–insulin–dependent diabetes
3	Mild preeclampsia

Infections

3	Herpes
___	Acute hepatitis (1st & 2nd trimester =1; 3rd = 3)
3	Pyelonephritis
1	Urinary tract infection
3	Syphilis
1	Gonorrhea
___	Rubella (1st trimester = 5; 2nd =1)
3	Toxoplasmosis or Cytomegalovirus

Uterine factors

5	Placenta previa
3	Other significant bleeding
5	Premature labor
5	Premature rupture of membranes
5	Oligo - or polyhydramnios
3	Cerclage
1	Abnormal Papanicolaou smear

Fetal factors

5	Documented intrauterine growth retardation (IUGR)
5	Multiple gestation
5	Isoimmunization requiring transfusion
3	Isoimmunization not requiring tranfusion
5	Abnormal oxytocin challenge test or falling estriols

Other

☐ = **37 WEEK RISK SCORE**

Signature and Date

Figure 1. Antepartum risk assessment. IUGR—intrauterine growth retardation; DES—diethylstilbestrol

RISK	OBSTETRICAL COMPLICATIONS
3	No prenatal care
4	Premature labor (34-36 Wks.)
5	Premature labor (<34 Wks.) RX: ☐ B-Mimetic ☐ Glucocorticoids ☐ Mg SO_4 ☐ Bed Rest ☐ _____ ☐ Antibiotics
2	Post term pregnancy (>42 Wks.)
3	Pre-Eclampsia-Mild (>30 MM Systolic. >15 MM Diastolic. Protein 1 + /2 +) } Pregnancy Induced Hypertension
4	Pre-Eclampsia-Severe (≥160/110, Protein ≥2 +) } Pregnancy Induced Hypertension
5	Eclampsia (≥1 Seizures)
	Other (Specify) _____
	DIAGNOSTIC FACTORS
2	Low/Falling Estriols
2	Abnormal CST/NST (Suspicious Or Positive)
2	Normal CST/NST, low or falling estriols
4	Abnormal CST/NST, low or falling estriols
	Other (Specify) _____
	BLEEDING FACTORS
5	Abruptio Placenta
5	Placenta Previa
3	Other Vaginal Bleeding
	Other (Specify) _____
	INFECTIOUS FACTORS
3	Active Herpes @ Time of Labor
5	Active Herpes Rupture of Membranes ≥4 Hrs. Prior to Delivery
4	Amnionitis
2	Maternal Fever (38°C or 100.4°F) - Exclude Amnionitis & Pyelonephritis
3	Pyelonephritis (38°C or 100.4°F)
3	Prolonged (Rupture of Membranes ≥24 Hrs. Prior to Delivery)
	Other (Specify) _____
	UTERINE FACTORS
1	Induction of Labor with confirmed maturity
	Specify Measures _____
2	Induction of Labor without confirmed maturity
1	Precipitate Labor (<3 hours Total)
5	Uterine Rupture
2	Uterine Anomaly (Bicornuate Uterus, Leiomyoma)
	Other (Specify) _____
	LABOR FIRST STAGE
1	Prolonged Latent Phase (>20 Hrs. Nullipara, >13 Hrs. Multipara)
2	Protracted Active Phase (Cervix Dilated ≥1.5 CM/Hr.)
3	Secondary Arrest of Dilatation (No Dilatation in 2 Hrs. ≥5 CM)
	Other (Specify) _____
	LABOR SECOND STAGE
3	Prolonged Second Stage (≥20 Hrs.)
	Other (Specify) _____
	FETAL FACTORS
3	Abnormal Presentation (other than breech)
4	Prematurity (34-36 Wks. Gestation With Delivery Imminent) Exclude Premature Labor
3	Intrauterine Growth Retardation (IUGR)
3	Multiple Pregnancy
3	Rh Sensitization (<.15 O.D. @ 450 MU)
5	Rh Sensitization (>.15 O.D. @ 450 MU)
4	Major Fetal Anomaly (Specify)
1	Thin Meconium Staining
3	Thick Meconium Staining
5	Prolapsed Cord
	Other (Specify) _____
	FETAL MONITORING FACTORS
2	Persistent Loss of Baseline Variability
2	Fetal Tachycardia (>160 BPM >30 Min) - Exclude with Maternal Fever
2	Prolonged Deceleration Related to: ☐ Anesthesia ☐ Hypertension ☐ Hypertonus ☐ Other (Specify) _____
1	Bradycardia <120 BPM
3	Persistent Severe Variable Decelerations
5	Late Decelerations Unresponsive to Therapy
5	Fetal pH <7.20
	Other (Specify) _____
	◀ TOTAL INTRAPARTUM RISK SCORE

Figure 2. Intrapartum risk assessment. CST/NST—contraction stress test/nonstress test

hypothesized that the assessment occurring closest in time to the delivery itself would correlate best with a variety of outcomes typically chosen as measures of perinatal morbidity and mortality. It was also hypothesized that there would be little or no correlation between assessment scores because the set of factors assessed at two points during the pregnancy were different.

METHODS

The medical records of 430 women who gave birth at the Oregon Health Sciences University Hospital during the 1986 calendar year were randomly selected for study from a total of 2,219 women. Charts were audited for risk-assessment scores (initial, 37th week, and intrapartum) and selected outcomes of care. Maternal care outcomes of interest included length of hospital stay, total hospital charges, length of the first and second stages of labor, whether labor was spontaneous or induced, and whether cesarean section was performed. Neonatal outcomes included 1- and 5-minute Apgar scores, birth weight, estimated gestational age at birth (Ballard et al method[8]), and length and cost of hospital stay.

RESULTS

It was not possible to collect all of the above data for each of the 430 mother-baby pairs. Statistical comparisons and descriptive statistics were performed on the largest possible number of patients who had recorded values in all data fields being examined.

The mean length of hospital stay was 2.8 days for mothers (n = 425) and 3.6 days for babies (n = 423). Median hospital charges were $1,976 for mothers (n = 422) and $630 for babies (n = 411). Sixty-two women (14 percent) were reported to have undergone elective postpartum tubal ligations. Hospital charges for these mothers were adjusted for this procedure by subtracting the additional expense (estimated at $1,000) from the total charge. The adjusted median hospital charge was $1,841 (n = 422).

The onset of labor was spontaneous for 222 women (65 percent) and induced in 72 (21 percent) (Table 1). Electronic fetal monitoring was utilized in 95 percent of laboring women. The mean lengths of first and second stages of labor were 6 hours 25 minutes (n = 314) and 44 minutes (n = 324), respectively. The cesarean section rate was 22 percent in this population. Ninety-one percent of pregnancies were at term (36 to 40 weeks). The mean estimated gestational age at delivery (Ballard et al[8]) was

TABLE 1. CHARACTERISTICS OF LABOR AND DELIVERY FOR STUDY POPULATION

Characteristics	No. (%)*
Onset of labor	
Spontaneous	222 (65)
Augmented	49 (14)
Induced	72 (21)
Unreported	87 —
Electronic fetal monitoring	
Elective	122 (35)
Indicated	208 (60)
None	14 (04)
Unreported	86 —
Fetal presentation	
Vertex	344 (97)
Breech	11 (03)
Unreported	85 —
Delivery	
Unassisted	304 (92)
Assisted	26 (08)
Unreported	100 —
Shoulder dystocia	
No	403 (99)
Yes	6 (01)
Unreported	21 —
Episiotomy	
No	255 (61)
Yes	160 (39)
Unreported	15 —
Cesarean delivery	
No	355 (78)
Yes	92 (22)
Unreported	3 —
Pregnancy at term	
No	38 (09)
Yes	365 (91)
Unreported	27 —
Weight for gestational age	
Average	269 (90)
Small	14 (05)
Large	15 (05)
Unreported	132 —

** Percentages are based on the number of subjects for whom there was an appropriate response*

39.1 weeks (n = 421). The mean birth weight for infants delivered in this sample was 3,249 g (n = 426).

Pearson product-moment correlations were performed between all continuous outcome data and the prenatal risk scores. Table 2 displays the correlation matrix between all variables. The initial and 37-week antepartum risk scores were associated strongly ($r = .43$, $P < .0001$), although each included different risk factors. The initial antepartum risk score showed significant association with the mother's cost and length of hospitalization ($r = .18$ and .19, respectively, $P < .01$). The 37-week risk score was associated with the length of hospitalization for mother and baby ($r = .21$ and .19, respectively, $P < .01$) and the mother's cost of hospitalization ($r = .21$, $P < .01$). The 37-week risk score was also positively correlated with the intrapartum risk score ($r = .22$, $P < .01$).

Student *t* tests for unpaired samples with unequal variances were performed on dichotomous outcomes, using the risk scores as dependent variables. Thirty-seven-week antepartum risk scores were significantly lower ($P < .01$) when the onset of labor was spontaneous (mean score = 1.3, n = 117) rather than induced (mean score = 3.6, n = 31). Intrapartum risk scores were significantly lower ($P < .001$) for deliveries at term (mean score = 2.2, n = 295) compared with those not at term (mean score = 5.4, n = 32). Intrapartum risk scores were also significantly lower ($P < .001$) when the onset of labor was spontaneous (mean score = 2.2, n = 191) rather than induced (mean score = 4.3, n = 60). They were higher ($P < .01$) when cesarean section was performed (mean intrapartum risk score = 4.1, n = 65) than for nonoperative deliveries (mean score = 2.5, n = 287).

While the above analysis was in progress, a statewide system of prenatal risk assessment based on the same risk-scoring system used at the Oregon Health Sciences University was endorsed by the Oregon Academy of Family Physicians and the Oregon Chapter of the American College of Obstetricians and Gynecologists. This assessment utilizes a cutoff score of 5 or greater as indicating high obstetric risk warranting mandatory obstetric consultation. Table 3 reports the predictive ability of the scoring system in the sampled population. The sensitivity and positive predictive value for most adverse outcomes were quite low, while the specificity and negative predictive value were reasonably high. This relationship was consistent for both the initial and the 37-week antepartum assessment.

DISCUSSION

The primary purpose of formal risk assessment in obstetrics is the prevention and consequent reduction of perinatal morbidity and mortality through early identification and intervention. Many determinants placing the mother and fetus at high risk are identifiable early during the antepartum and intrapartum periods from both historical and clinical data. At the same time the clinician's ability to intervene effectively varies with the type of risk factor and when it is identified. Many of the risks apparent during the early antepartum period are sociodemographic, constitutional, or are due to prior obstetric history. The positive correlation between the initial risk assessment and the 37-week antepartum assessment confirms an as-

TABLE 2. PRENATAL RISK FACTOR ASSESSMENT CORRELATIONS

	Risk Assessment		
	Antepartum Initial r (n)	Antepartum 37 Weeks r (n)	Intrapartum r (n)
Antepartum initial risk	—	.43 (182)*	—
Intrapartum risk	.03 (182)	.22 (182)**	—
Mother's length of stay	.19 (218)**	.21 (189)**	.33 (349)*
Mother's charges (adjusted)	.18 (213)**	.21 (185)**	.42 (343)*
Baby's length of stay	.04 (219)	.19 (190)**	.31 (346)*
Baby's charges	−.01 (210)	.16 (181)	.19 (335)***
1-minute Apgar	−.14 (219)	−.13 (190)	−.18 (350)***
5-minute Apgar	−.11 (220)	−.03 (191)	−.20 (351)***
Gestational age	.01 (215)	−.13 (186)	−.44 (344)*
Birth weight	−.11 (219)	−.19 (190)†	−.35 (348)*

* = $P < .0001$
** = $P < .01$
*** = $P < .001$
† = $P = .01$
Note: Adjustment to mother's charges was subtraction of $1,000 if tubal ligation was performed

TABLE 3. ABILITY OF RISK-SCORING SYSTEM TO PREDICT SELECTED ADVERSE OUTCOMES (HIGH-RISK CUTOFF > 4)

	Antepartum Risk Assessment: Initial (37 Weeks)			
Outcome	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
Cesarean section delivery	.34 (.19)	.81 (.88)	.26 (.20)	.87 (.87)
1-minute Apgar < 7	.31 (.21)	.81 (.89)	.26 (.28)	.84 (.84)
5-minute Apgar < 7	.25 (.00)	.79 (.87)	.02 (.00)	.98 (.98)
Birth weight < 2,500 g	.27 (.56)	.79 (.89)	.07 (.20)	.95 (.98)
Estimated gestational age at birth	.22 (.33)	.79 (.89)	.09 (.16)	.92 (.95)

sociation between the historical risks of previous pregnancies and the clinical risks present in the developing pregnancy. Since both of these factors were also associated with maternal length of stay and cost of hospitalization, it might be suggested that the earlier assessment serves as the sole predictor for these outcomes.

The time at which the assessment is made is critical. To predict poor outcome at a time when it is too late to attempt to modify it is of little use. Intrapartum assessment may alter the management of labor and delivery but cannot affect the management of the pregnancy itself. In this study, there was a strong correlation between intrapartum risk and most maternal and neonatal outcomes. A higher intrapartum risk score was recorded for pre- or post-term deliveries and induced and operative (cesarean section) deliveries. Length of stay and hospitalization costs were accordingly higher for high-risk mothers and their babies. Unfortunately, this effect may have been due to the fact that intrapartum risk assessment was often recorded retrospectively after the delivery had taken place.

If the purpose of screening for identification of high risk is to help reduce poor perinatal outcomes through provision of care, then the value of including unalterable variables, such as prior reproductive history and sociodemographic information, in the management of the obstetric patient might be questioned.[9] The lack of correlation of both initial and 37-week antepartum risk scores with most neonatal outcomes under study suggests, however, that the risk factors included these times are in some way compensated by subsequent prenatal care. Low- and high-risk scores from both periods appear to have an equal probability of accurately predicting an adverse neonatal outcome in this environment, where prenatal care continues after the risk is assessed. Effective care should indeed result in risk reduction. This reduction should be more pronounced for high-risk pregnancies but have little or no effect on low-risk pregnancies. Unfortunately, it could not be determined whether such care took place between the initial and 37-week assessment or between the latter and the intrapartum period.

Ryan et al[10] studied the relationship of prenatal care to perinatal outcome in a racially and socioeconomically homogeneous population. Even when demographic variables, prior obstetric history, and initial risk assessment were controlled, those receiving inadequate prenatal care had significantly higher perinatal mortality rates. Clearly there is something about the provision of prenatal care that reduces perinatal mortality and as such warrants expanded access to care for all pregnant women. Beyond the obvious services (nutritional support, stabilization or cure of concurrent medical conditions, and so on), it is still not quite clear what specific components of prenatal care are important in risk reduction.

There is an educational purpose in using an obstetric risk-scoring system. Comprehensive assessment promotes awareness of obstetric problems by requiring more complete data collection. Providing a consistent definition of risk should enable less experienced health care providers to reach decisions regarding obstetric risk similar to those

obtained intuitively by experienced clinicians.[11] Few, if any, studies to date have attempted to validate these assertions, and indeed, the present study did not address this issue. Rather than compiling a comprehensive checklist of risk factors to be assessed during pregnancy, formalized risk-assessment systems weight individual factors and aggregate them into summary scores that presumably convey some predictive meaning. The use of a cutoff score to discriminate between high and low obstetric risk may be helpful in identifying the low-risk patient. Unfortunately, the usual rationale for using risk-assessment systems is to identify the high-risk patient. The low positive predictive values in this study indicate that such is not occurring.

All obstetric risk factors may be said to be modifiable insofar as some component of care results in a reduction of the risk attributed to the particular factor. This study suggests that prenatal care can indeed modify risk, though it is not clear when this care takes place. The precise contribution of individual factors to adverse outcomes cannot be known in the absence of a study that correlates those factors with outcomes. Prospective studies would be necessary to compare risk modification using specific measures in a population receiving care with one where prenatal care is lacking. Without such studies, which on ethical grounds alone may be impossible to perform, it seems likely that obstetric risk assessment will remain a very coarse screening for high-risk pregnancies.

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