Dystocia in Primiparous Women

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TITLE

Dystocia in Primiparous Women

BACKGROUND

The problem

The US NIH has stated an objective of lowering the cesarean section rate from its 24% (US 1990) to 15% by the year 2000 (MMWR 1993). Cesarean section rates have increased dramatically in the past few decades. Cesarean sections are associated with maternal morbidity in the immediate post-operative phase (Wiener 1987, Paterson 1991) and increase the risk of obstetrical complications with subsequent pregnancies (Chazotte 1990). In the U.S., the cesarean section rate was 5.5% in 1970 (Taffe 1987), 14.8% in 1978 and 24.4% in 1987 (MMWR 1995 Apr. 21). In 1991, the cesarean section rate remained at 23.5% in the U.S. Dystocia is the leading cause of cesarean section in primiparous women. Through its direct effect on the primary cesarean section rate and its indirect effect on elective repeat cesarean sections it is the cause for over 50% of all cesarean births. Arrest of cervical dilatation and/or descent of the baby are the specific diagnoses in this group (Paul 1995, The Advisory Board, 1996).

Many factors, associated with an increased likelihood of cesarean section, have been identified. Maternal age, nulliparity, maternal height, maternal weight, birth weight, induction, epidural use, year of delivery and insurance status have all been implicated as risk factors for cesarean section (Handa 1993, Harlow 1995 Martel 1987, Morton 1994, Parrish 1994, Peipert 1993, Thorp 1993, Yudkin 1986). Variation in the tendency to diagnose labor progress as "too slow" and a wide variation in the efforts made to correct this also contribute to high cesarean rates for dystocia.

Safety of lowering cesarean rates for dystocia

There is widespread evidence that the cesarean section rates for this indication can be safely lowered (Paul RH 1995, MMWR 1993, MMWR 1995, Myers 1988, Sanchez - Ramos et al 1990). Myers and Gleicher reported a lowering from 4.3% to 2.3% and later to 1.5% with no change in perinatal mortality. Sanchez - Ramos reported a lowering of the rates from 7.2% to 2.1% with an improvement in the perinatal mortality rates. Furthermore numerous hospitals with equally good outcomes deliver obstetrical care with total cesarean rates of 16% or less. Finally the US Advisory Board estimated in the US that globally 50% of cesarean sections for dystocia are unnecessary (Coming to Term. Innovations in safely reducing cesarean rates - The Advisory Board 1996). The Advisory Board had recommended several techniques to lower cesarean rates. Their opinion of effectiveness is graded alphabetically (The Advisory Board 1996).

Providing physicians with individual and departmental statistics on cesarean section rates	*Grade A*
Developing diagnostic guidelines for Dystocia	*Grade A-*
Encouraging patients and physicians to perform VBAC	*Grade B+*
Avoiding early use of Epidural anesthesia	*Grade B-*
One to One labor support	*Grade B+*
Dedicated in house Obstetrician	*Grade B*

CURRENT PRACTICE

The intervention of cesarean section for dystocia is a clinical decision based on a combination of observations and the judgement of the physician. Clinical diagnosis of dystocia is based on: prelabor risk factors including primiparity, short stature and anticipated large fetal size, risk factors occurring during the

course of labor including lack of dilatation (for more than 2 hours in the presence of strong contractions in the active phase of dilatation), persistent high fetal station and observed fetal caput and cranial molding. Consideration is given to the use of epidural anesthesia (Morton 1993, Ramin 1995, Lieberman 1996). A current reference used for clinical diagnosis is the Friedman's curve, which is a two-dimensional model of cervical dilatation and station versus time. We have developed a mathematical model of cervical dilatation, which enables the clinician to compare the progress in dilatation of an individual woman in labor compared to an appropriate group from a reference population.

WHY USE A MATHEMATICAL MODEL?

A mathematical model is an attractive method to express how several variables interact and to allow one to see the effect of an infinite variety of combinations. The traditional Friedman curve is a model of limited usefulness because it is unidimensional (cervical dilatation versus time). Time is not the factor that promotes labor. Furthermore the range of normal responses is not depicted.

We used a statistical approach to create our model. This was important because we knew that we could not measure all of the factors that are related to cervical dilatation and even those available would be measured imprecisely. A statistical model allows ones to estimate dilatation or station with a defined degree of inaccuracy (residual or error). The model is updated as the factors change in labor.

WHAT DOES THE MODEL DO?

Given a patients parity, and her own collection of varaibles decribing how she entered laboe and the amount of uterine activity the model estimates what the dilatation would be for an average patient at this point in time. It can also supply a range covering the 10^{th} to the 90^{th} percentile of dilatations found in other similar women who delivered vaginally. The computer is triggered to run the model only when results from a pelvic exam are entered. It does **not** make predictions in the future. It can estimate based only on observations of accumulated contractions and the state of dilatation, effacement and station at the last exam and a few other factors associated with labor progress. When data is incomplete or out of range the model will not run. When incorrect data is corrected the model is rerun to incorporate the correct information.

WHAT IS THE CLINICAL USEFULNESS?

The usefulness lies in producing a meaningful reference range for each patient who has her own unique pattern of contractions and other features. The position of a given patient to this reference range can be quantified. This should improve the consistency of the assessment cervical dilatation which is one important aspect in the assessment of labor progress.

HOW IS IT USED?

The graphical display of cervical dilatation over time is well known to obstetricians. The addition of a reference band helps standardize the assessment of labor progress. The shape of our curve will be different for each patient reflecting her own combination of factors. The concept of a range defining normal behavior is also well known to clinicians. The outer limits chosen for display represent the 10^{th} and 90^{th} percentile which are commonly used delimiters in clinical medicine.

The mathematical expression contains a residual or an error estimate, which permits calculation of the range of expected values. The calculated or expected dilatation can be compared to the to the actual or observed dilatation. Furthermore, because the range of expected dilatation is defined, the difference between the actual and the expected can be expressed in percentiles. A percentile ranking should be interpreted in the usual fashion. A percentile of 90 means than the performance of this patient is at the level of, or is better than the lowest 90 out of 100 similar patients who delivered vaginally. This is much faster than average. A percentile ranking of 10 means that the performance of the patient at the level of, or is better than the lowest 10 of 100 similar patients who delivered vaginally.

Table 1. Sensitivity and specificity definitions

CLASSIFICATION BY A CLINICAL GOLD STANDARD

	TRULY ABNORMAL	**TRULY NORMAL**
Test result indicating Abnormal	True positives **a**	False Positives **b**
Test results indicating Normal	**c** False negatives	**d** True negatives

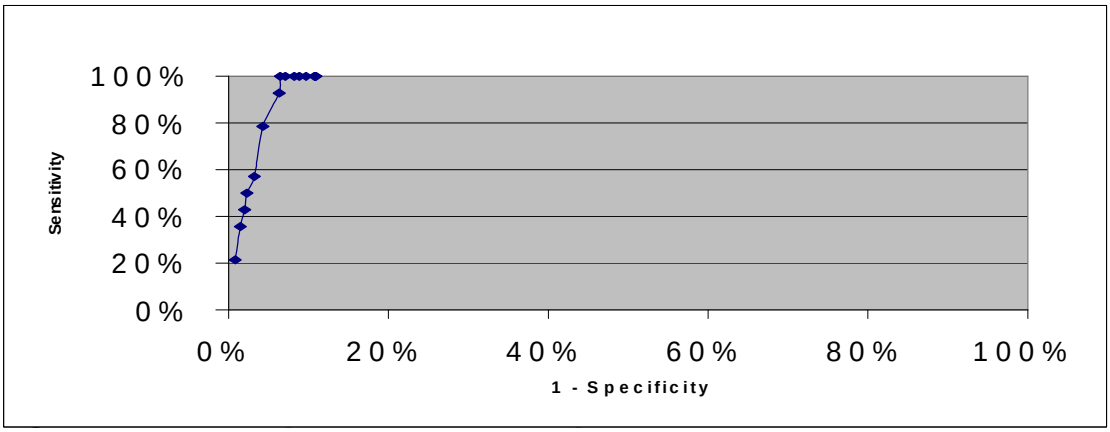
Sensitivity: a / (a + c) Specificity: d / (b + d)

In this application the cut off value or degree of deviation from the expected can be set arbitrarily and used to separate normal and abnormal. As is true in many medical tests there is a trade off between accuracy in detecting abnormal cases (sensitivity) and the accuracy in detecting the normal cases (specificity). For example as the deviation from expected is narrowed the rate of false positive falls however the rate of detection of truly abnormal also falls. The relationship of this trade off between sensitivity and false positives (1 - specificity) is expressed graphically in a format called a Receiver Operator Curve.

Results

The objective was to examine the sensitivity and specificity of various arbitrarily set limits and to determine an optimal threshold.

The cut off level we have chosen to use is -1.3 which translates to a percentile level of 9.7.



Using the clinical criteria with the cut off level of the 9.7th percentile the 2x2 table of sensitivity and specificity is shown below.

Table 2. Sensitivity and specificity for cut off level of 9.7th percentile with clinical criteria

	CLASSIFICATION BY A CLINICAL GOLD STANDARD	
	TRULY ABNORMAL	**TRULY NORMAL**
Test result indicating abnormal	13 **a**	47 **b**
Test results indicating normal	**c** 1	**d** 697

Sensitivity: 13 / 14 = 92.9% Specificity: 697 / 744 = 93.7%

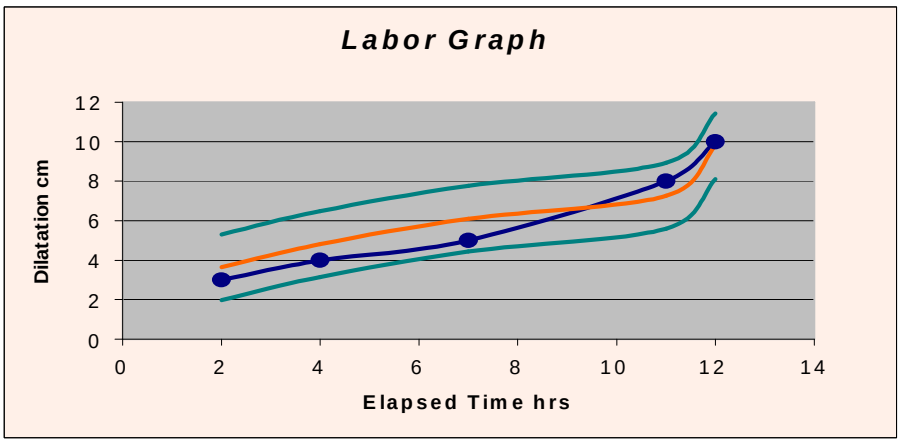
The use of this model in facilitated by graphical displays. The reference range includes the 10th to the 90th percentile and is shown by the fine outer lines. The average is depicted as the solid line in the middle. Superimposed upon this is the observed dilatation of the patient.

The graphical display of cervical dilatation over time is well known to obstetricians. The addition of a reference band l helps standardize the assessment of labor progress.

Examples:

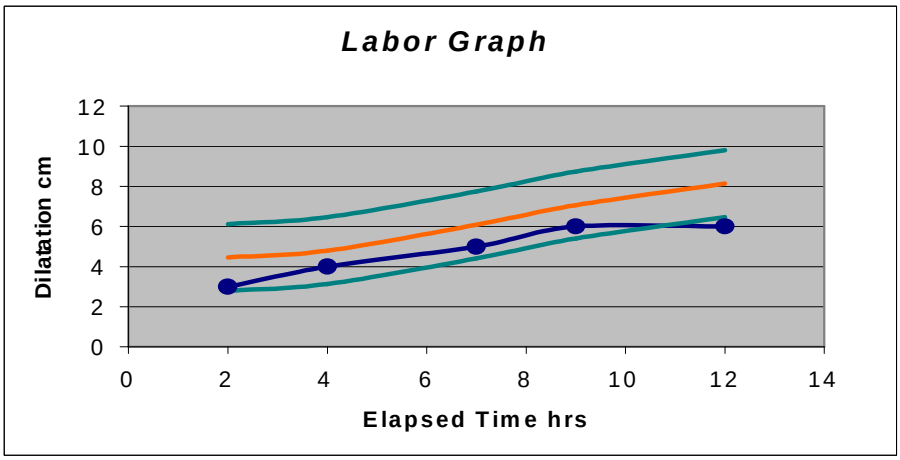
The first graph shows progress in cervical dilatation that is clearly within the 10th and 90th percentiles of the expected values.

TIME ELAPSED (IN HRS)	DIL	EFF	STN	CONTRACTION FREQ AVG INTERVAL MIN	PERCENTILE
0	2	75	-3	na	50.0%
2	3	90	-2	8	30.96%
4	4	100	-1	5	26.59%
7	5	100	-1	4	19.90%
11	8	100	-1	3	71.44%
12	10	100	0	3	57.08%



The second example shows results, which clearly fall below the 10th percentile

TIME ELAPSED (IN HRS)	DIL	EFF	STN	EPIDURAL	CONTRACTION FREQ (AVG INTERVAL IN MIN)	PERCENTILE
0	3	75	-3	no	na	50.0%
2	3	90	-2	no	8	13.23%
4	4	100	-1	yes	6	27.04%
7	5	100	-1	yes	4	20.28%
9	6	100	-1	yes	3	20.63%
12	6	100	-1	yes	3	5.01%



ONGOING RESEARCH

The efficacy of this model to reduce the rate of unnecessary cesarean section in healthy primiparous women is being is currently being measured in a randomized prospective clinical trial.

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