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Authors

Waks, Ashten B
Martinez-King, L Carolina
Santiago, Gisselle
et al.

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Developing a risk profile for spontaneous preterm birth and short interval to delivery among patients with threatened preterm labor

Ashten B. Waks, MD, MSPH; L. Carolina Martinez-King, MD, MS; Gisselle Santiago, BS; Louise C. Laurent, MD, PhD; Marni B. Jacobs, PhD, MPH

BACKGROUND: Threatened preterm birth is the most common reason for antepartum hospitalization in the United States, accounting for approximately 50% of these admissions. However, fewer than 10% of patients with inpatient evaluation for signs or symptoms of preterm labor ultimately deliver before term.

OBJECTIVE: This study aimed to generate predictive models to assess the risk of preterm delivery and time to delivery based on clinical signs and symptoms of patients evaluated in our institution for preterm labor concerns.

STUDY DESIGN: This was a retrospective cohort study of singleton pregnancies evaluated for signs and/or symptoms of preterm labor, including contractions, abdominal pain, vaginal bleeding, and short cervix, between 22 0/7 and 33 6/7 weeks of gestation. Inpatient evaluations were classified by patient presentation: (1) symptomatic with cervical findings (transvaginal cervical length of <2.5 cm or cervical dilation of ≥2.0 cm), (2) asymptomatic with cervical findings, and (3) symptomatic without cervical findings. The primary outcomes included incidence of spontaneous preterm birth and interval from presentation to delivery, compared between groups. The risk of preterm delivery was evaluated using log-binomial regression, and presentation to delivery timing was assessed by survival analysis and Cox proportional hazards modeling.

RESULTS: Of 631 patients with preterm labor concerns, 96 (16%) were symptomatic with cervical findings on evaluation, 51 (8%) were asymptomatic with cervical findings, and 466 (76%) were symptomatic without cervical findings. The occurrence of preterm birth was significantly higher among symptomatic patients with cervical findings (49%) than among those with cervical findings alone (31%) or symptoms alone (11%) (*P*<.0001). In addition, symptomatic patients with cervical findings were significantly more likely to deliver within 48 hours (20%), 1 week (30%), 2 weeks (33%), and 1 month (43%) of presentation than patients with cervical findings alone (2%, 2%, 6%, and 10%, respectively) or symptoms alone (0.4%, 1%, 1.5%, and 5%, respectively) (*P* value for trend<.0001). Adjusted for gestational age at presentation and previous preterm birth, the overall risk of preterm delivery was significantly higher among patients with symptoms and cervical findings than among patients with cervical findings alone (relative risk, 2.81; 95% confidence interval, 1.74−4.54) or symptoms alone (relative risk, 4.39; 95% confidence interval, 3.16−6.09). Adjusted for the same variables, symptomatic patients with cervical findings were also at higher risk of delivery over time after assessment than patients with cervical findings alone (hazard ratio, 2.06; 95% confidence interval, 1.47−2.90) or symptoms alone (hazard ratio, 2.16; 95% confidence interval, 1.74−2.70). The negative predictive value of these models suggested that only 1% of patients with isolated symptoms or cervical findings are at risk of preterm delivery within 1 week of initial presentation.

CONCLUSION: Symptomatic patients with cervical findings suggestive of preterm labor were at the greatest risk of preterm birth and a shorter interval from presentation to delivery. The study findings supported a risk profile that may facilitate the selection of patients most appropriate for admission and targeted management. Nonetheless, as nearly 50% of patients meeting this risk profile subsequently deliver at term, future research is needed to identify which of these patients will require intervention.

Key words: abdominal pain in pregnancy, antepartum hospital admission, delivery timing, incidence of preterm delivery, labor and delivery triage, premature cervical dilation, preterm contractions, preterm vaginal bleeding, short cervix

Preterm birth is defined as delivery between 20 and 37 weeks of gestation and represents >10% of all live-born deliveries in the United States.[1−4] Currently, preterm delivery is the leading cause of neonatal mortality in this country, with up to 66% of infant deaths observed in neonates born before 37 weeks of gestation.[5] Those that survive often require prolonged hospitalizations for complications of prematurity, such as respiratory distress, neurodevelopmental sequelae, and feeding difficulties.[6] Beyond its association with neonatal outcomes, threatened preterm birth is also the most commonly cited reason for antepartum hospitalization, encompassing 44% to 59% of all antenatal admissions and contributing to medical expenses exceeding $26 billion annually.[2,7,8]

Spontaneous preterm birth accounts for up to 70% of all preterm deliveries.[1−3] The recognition of risk factors for spontaneous preterm delivery—including previous preterm birth, previous cervical surgery, infection, short interpregnancy interval, maternal age, substance use, African American race, and low socioeconomic status[1,2,9−11]—has improved our ability to identify vulnerable patients. Furthermore, the identification of these patients has been enhanced by routine incorporation of strategies, such as serial vaginal examinations, transvaginal cervical length, and fetal fibronectin in the evaluation of preterm labor symptoms.

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AJOG MFM at a Glance

Why was this study conducted?

Threatened preterm birth accounts for 50% of antepartum hospitalizations in the United States; however, only 10% of these admissions result in preterm delivery. This study aimed to identify a risk profile for those patients who ultimately deliver before term.

Key findings

Patients with both symptoms (eg, uterine contractions) and cervical findings consistent with preterm labor are at high risk of preterm delivery. In the absence of both concerns, our models predicted that fewer than 1% of patients will deliver within 1 week of presentation.

What does this add to what is known?

Existing studies have examined associations between isolated symptoms and cervical findings concerning preterm labor. Our study expanded on the literature by generating predictive models to compare the risk of preterm delivery among those with isolated symptoms, isolated cervical findings, or a combination of the 2 concerns.

Nonetheless, although risk factors for or clinical findings consistent with preterm labor are present in up to 50% of patients who deliver before term, fewer than 10% of patients with an identified risk factor for or clinical finding consistent with preterm labor deliver before 37 weeks of gestation.[11,12]

Accordingly, we designed a study to predict the risk of preterm birth and the interval to delivery among patients presenting with preterm labor concerns. We hypothesized that patients with preterm labor symptoms and associated cervical findings would be at the greatest risk of preterm delivery and in closer proximity to initial presentation than patients with isolated symptoms or cervical findings.

Materials and Methods

Study population

We conducted a retrospective cohort study at the University of California, San Diego (UCSD), a tertiary referral center serving a metropolitan area. The study was approved by the UCSD Institutional Review Board. Electronic medical records (EMRs) were reviewed for all patients delivered at UCSD from July 1, 2015, to June 30, 2017, who had at least 1 documented labor and delivery triage or antepartum unit encounter between 22 0/7 and 33 6/7 weeks of gestation. The latter of these dates was established as the sampling endpoint because, after this time, our institution implemented new protocols for managing preterm labor between 34 0/7 and 36 6/7 weeks of gestation. In addition, records were screened, and patients whose encounters involved a chief complaint of contractions, vaginal bleeding, abdominal pain, or short cervix identified on outpatient ultrasound[1,9,10] were included in the study cohort. Patients diagnosed with morbidly adherent placentation or preterm premature rupture of membranes (PPROM) were excluded, as management of labor symptoms in these patients is different from the management of the same symptoms in the general obstetrical population.[13,14]

For patients with multiple eligible encounters within a pregnancy, only the first encounter was selected for the present analysis because of the concern that early findings and management had the potential to affect clinical decision-making in subsequent encounters. For patients with >1 delivery in the study period, the first eligible encounter in each pregnancy was included. Only 20% of study patients had >1 eligible encounter, and only 5% of study patients had >2 eligible encounters. Although included in preliminary screening, patients with multiple pregnancies were later excluded from this analysis given their 6-fold greater risk of preterm delivery compared with singleton pregnancies.[15]

Data collection

For each eligible encounter, data regarding patients' symptoms, cervical findings, and disposition status were extracted from the EMR. Cervical findings noted were cervical dilation by sterile vaginal examination and cervical length by transvaginal ultrasound, although included patients were required to have only 1 of these findings documented, as use of both assessments varied by provider. In addition, the following socioeconomic, obstetrical, and medical characteristics were abstracted: age at delivery, race and ethnicity, insurance coverage, parity, history of preterm delivery or cervical surgery, body mass index, and diagnosis of comorbid conditions (eg, hypertension or diabetes mellitus). Given the body of literature implicating these characteristics as risk factors for preterm birth,[1,2,9–11] they were considered potentially relevant confounders in multivariable regression models.

Using the abstracted data, patients were classified into 3 groups based on their symptoms and cervical findings on presentation. Across all groups, symptomatic was defined as a patient complaint of contractions, vaginal bleeding, or abdominal pain. Cervical findings were defined as a transvaginal cervical length of <2.5 cm or a cervical dilation of ≥2 cm on digital examination.[9,16] The first group consisted of symptomatic patients with cervical findings suggestive of preterm labor; the second group consisted of asymptomatic patients with incidental cervical findings suggestive of preterm labor; and the third group consisted of symptomatic patients without cervical findings suggestive of preterm labor. Of note, 33 patients had a chief complaint unrelated to preterm labor but were assessed because of findings of contractions on tocometry. As they could not be classified into 1 of 3 presentation groups, they were excluded from the analysis.

Outcomes

Of note, 2 primary outcomes were considered: (1) incidence of preterm birth before 34 0/7 weeks of gestation and (2) time from the initial encounter to delivery. The secondary outcomes included gestational age at the time of delivery and neonatal birthweight.

Statistical analysis

Analyses were completed using SAS (version 9.4; SAS Institute, Cary, NC), and a 2-sided *P* value of .05 was considered significant for all analyses. Demographic and clinical characteristics were compared across presentation groups using analysis of variance for continuous variables and chi-squared or Fisher exact test for categorical variables. Subsequently, the occurrence of preterm birth and delivery timing from the initial encounter were assessed. The relative risk (RR) of preterm delivery among groups was evaluated using log-binomial regression, alone and adjusted for relevant risk factors that differed significantly between groups at $P<.05$ in bivariate analyses.

Based on findings from logistic regression models, receiver operating characteristic (ROC) curves were constructed for preterm delivery and delivery within 1 week of presentation. The area under the ROC curve (AUC) was calculated to evaluate the diagnostic utility of the models generated. An AUC of >0.7 was taken to represent an accurate model. Predictive statistics were also calculated, including positive predictive value, negative predictive value (NPV), sensitivity, and specificity.

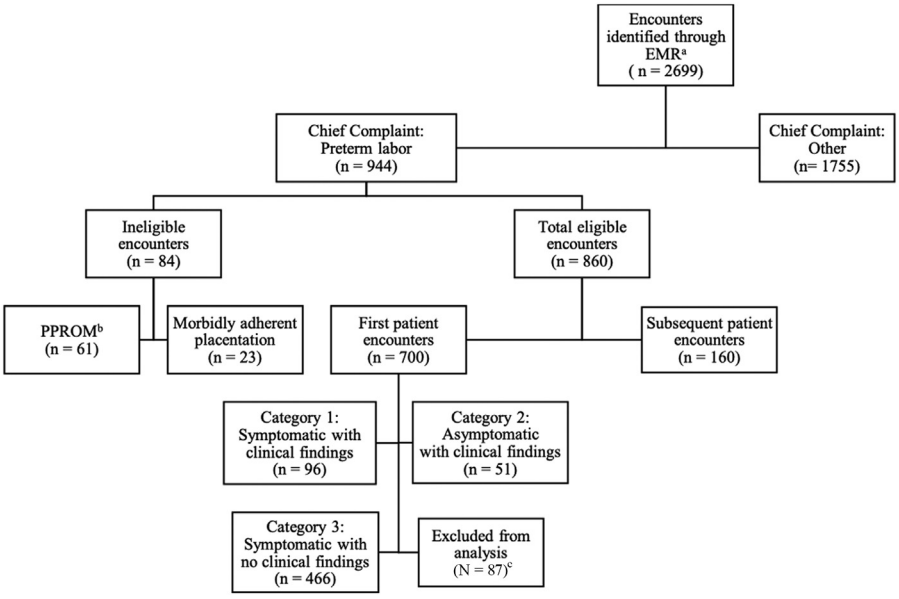
Time from the initial encounter to delivery between groups was examined using Kaplan-Meier survival curves, and associated hazard ratios (HRs) for delivery were estimated using Cox proportional hazards models. A review of the survival curves suggested that asymptomatic patients with cervical findings and symptomatic patients without cervical findings overlapped approximately 80 days from the initial encounter, potentially violating the proportional hazards assumption. As such, hazards models were run for all time points and for time points limited to 80 days from the initial encounter.

Results

Figure 1 outlines the selection of the study population. Of 2699 identified encounters, 944 (35%) involved a chief complaint worrisome for preterm labor between 22 0/7 and 33 6/7 weeks of gestation. Following the exclusion criteria, 84 encounters (9%) for preterm labor concerns were excluded for the diagnoses of PPROM or morbidly adherent placentation. Of eligible encounters, 160 (19%) were excluded because of the identification of an earlier encounter with the same patient. Of eligible first encounters, 87 (12%) were excluded because of multiple pregnancies or the inability to classify the patient into 1 of 3 presentation groups. This resulted in a cohort of 613 patients for analysis.

Of included patients, 96 (16%) were symptomatic with cervical findings at the time of initial evaluation, 51 (8%) were asymptomatic with incidental cervical findings, and 466 (76%) were symptomatic without cervical findings.

FIGURE 1
Flow diagram for derivation of the study population



[a]Electronic medical record (EMR); [b]Preterm premature rupture of membranes (PPROM); [c]Encounters for multiple pregnancies (n=54) and patients who could not be classified into 1 of 3 presentation groups (n=33).

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The characteristics of the study population are presented in Table 1. Patients with both symptoms and cervical findings and symptoms alone were evaluated at later gestational ages (*P*=.004), whereas patients with cervical findings alone were more likely to have a history of preterm birth (*P*<.0001). Slight differences in maternal age (*P*=.06) and insurance status (*P*=.05) were noted, although no significant difference in parity, race and ethnicity, history of cervical surgery, or obstetrical comorbidities were seen.

Patient symptoms and examination findings at the time of the initial encounter are presented in Table 2. Contractions were the most reported symptom among those with both symptoms and cervical findings (51%), whereas vaginal bleeding was the most reported symptom among those with symptoms alone (47%). Across presentation groups, 85% of all patients underwent transvaginal cervical length assessment, 32% had a digital examination to assess cervical dilation, and >9% had fetal fibronectin collected. Based on these examinations, shortened cervix was identified in 75% of patients with both symptoms and cervical findings and 100% of patients with cervical findings alone; premature cervical dilation was identified in 47% of patients with both symptoms and cervical findings and 14% of patients with cervical

TABLE 1
Baseline characteristics of the study population by presentation group

Characteristic	n (%) Symptomatic with cervical findings (n=96)	Asymptomatic with cervical findings (n=51)	Symptomatic without findings (n=466)	*P* value
Age, mean (SD)	29.6 (6.1)	31.3 (6.3)	31.1 (5.9)	.06
Gestational age,[a] mean (SD)	28.9 (3.6)	27.1 (3.4)	28.7 (3.4)	.004
Parity				.69
Nulliparous	42 (43.7)	21 (41.2)	204 (43.8)	
1–2	46 (47.9)	25 (49.0)	207 (44.2)	
3–4	6 (6.3)	3 (5.9)	47 (10.1)	
≥5	2 (2.1)	2 (3.9)	8 (1.7)	
Race or ethnic status				.60
White	32 (33.3)	11 (21.6)	164 (35.2)	
Hispanic	37 (38.5)	25 (49.0)	173 (37.1)	
Black	8 (8.3)	3 (5.9)	29 (6.2)	
Asian	7 (7.3)	7 (13.7)	45 (9.7)	
Other, unknown	12 (12.5)	5 (9.8)	55 (11.8)	
Insurance status				.05
Private	37 (39.4)	15 (29.4)	216 (47.1)	
Government funded	55 (58.5)	32 (62.7)	225 (49.0)	
Uninsured, other	2 (2.1)	4 (7.8)	18 (3.9)	
Previous preterm delivery	25 (26.0)	20 (39.2)	61 (13.1)	<.0001
Previous cervical surgery	10 (10.4)	4 (7.8)	24 (5.2)	.13
BMI, mean (SD)	28.9 (10.4)	28.4 (6.9)	28.2 (7.9)	.76
Obstetrical comorbidities				
Hypertensive conditions	14 (14.7)	10 (19.6)	87 (19.0)	.60
Diabetes mellitus[b]	17 (17.7)	16 (31.4)	88 (18.9)	.09

Data are presented as number (percentage), unless otherwise indicated.

BMI, body mass index; *SD*, standard deviation.

[a]Gestational age at first encounter.

[b]Preexisting or gestational.

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TABLE 2
Symptoms, examination strategy, and findings by presentation group

Variable	n (%)			
	Symptomatic with cervical findings (n=96)	Asymptomatic with cervical findings (n=51)	Symptomatic without findings (n=466)	Total (N=613)
Symptoms				
Contractions	51 (51.3)	0 (0.0)	132 (28.3)	183 (29.8)
Vaginal bleeding	27 (28.1)	0 (0.0)	263 (56.4)	290 (47.3)
Abdominal pain	22 (22.9)	0 (0.0)	102 (21.9)	124 (20.2)
Examination strategy				
Cervical length	74 (77.1)	43 (84.3)	403 (86.5)	520 (84.8)
Cervical dilation	65 (67.7)	22 (43.1)	110 (23.6)	197 (32.1)
Fetal fibronectin	27 (28.1)	3 (5.9)	23 (5.0)	53 (8.6)
Examination findings				
Short cervix[a]	72 (75.0)	51 (100.0)	0 (0.0)	123 (20.0)
Cervical length, IQR[b]	0.2−4.9	0.1−4.6	2.5−6.0	0.1−6.0
Premature cervical dilation[c]	45 (46.9)	7 (13.7)	0 (0.0)	52 (8.5)
Cervical dilation, IQR[b]	0−10	0−9	0−1	0−10
Positive fetal fibronectin	13 (48.2)	0 (0.0)	0 (0.0)	13 (2.1)

Data are presented as number (percentage), unless otherwise indicated.

IQR, interquartile range.

[a]Defined as a cervical length of <2.5 cm

[b]Minimum and maximum values in centimeters

[c]Defined as a cervical dilation of ≥2 cm on digital examination.

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findings alone; and a positive fetal fibronectin was identified in nearly 50% of patients with both symptoms and cervical findings but not in patients with isolated cervical findings or symptoms.

Table 3 depicts the primary outcomes. Patients with both symptoms and cervical findings were significantly more likely to deliver before term than those with isolated cervical findings or symptoms ($P<.0001$). Considering the interval from presentation to delivery, symptomatic patients with cervical findings were also more likely to deliver within 48 hours, 1 week, 2 weeks, and 1 month than those with isolated cervical findings or symptoms ($P<.0001$). Patients with both symptoms and cervical findings also had an earlier mean gestational age at delivery and a lower mean neonatal birthweight relative to patients with isolated cervical findings or symptoms ($P<.0001$).

The trend toward a greater incidence of preterm delivery and a shorter time to delivery among patients with both symptoms and cervical findings vs those with cervical findings or symptoms alone is further supported by the regression models presented in Table 4. Specifically, the risk of preterm delivery was nearly 3 to 4 times greater among patients with symptoms and cervical findings than among asymptomatic patients with cervical findings (RR, 2.8; 95% confidence interval [CI], 1.7−4.5) or symptomatic patients without cervical findings (RR, 4.4; 95% CI, 3.2−6.1). The risk of preterm delivery within 1 week of presentation—an interval crucial for optimal timing of antenatal corticosteroid administration—was 35 times greater among patients with both symptoms and cervical findings than patients with symptoms alone (RR, 35.2; 95% CI, 12.7−97.8). Adjusted for gestational age at presentation and history of preterm birth, both of which were significant in bivariate analyses, the risk of preterm delivery overall and within 1 week of presentation between patients with symptoms and cervical findings (adjusted RR [aRR], 4.1; 95% CI, 3.0−5.8) and patients with isolated symptoms (aRR, 35.3; 95% CI, 12.7−98.2) and between patients with isolated cervical findings (aRR, 2.4; 95% CI, 1.5−3.9) and patients with isolated symptoms (aRR, 2.2; 95% CI, 0.3−19.7) remained consistent. Additional adjustment for known risk factors for preterm delivery, including maternal age and socioeconomic status, did not materially alter these estimates and thus were not included.

Given the larger proportion of patients with both symptoms and cervical findings who delivered prematurely, this group was considered "positive" screening cases in the predictive modeling included in Table 4. The NPV for

TABLE 3
Delivery outcomes by presentation group

Outcome	n (%)			
	Symptomatic with cervical findings (n=96)	Asymptomatic with cervical findings (n=51)	Symptomatic without findings (n=466)	*P* value
Preterm delivery	47 (49.0)	16 (31.4)	52 (11.2)	<.0001
Presentation to delivery				
Days, mean (SD)	40.5 (34.0)	67.7 (30.7)	71.3 (26.8)	<.0001
Within 48 h	19 (19.8)	1 (2.0)	2 (0.4)	<.0001
Within 1 wk	29 (30.2)	1 (2.0)	4 (0.9)	<.0001
Within 2 wk	32 (33.3)	3 (5.9)	7 (1.5)	<.0001
Within 30 d	41 (42.7)	5 (9.8)	24 (5.2)	<.0001
Gestational age at delivery, mean (SD)	34.6 (5.5)	36.7 (4.2)	38.8 (2.0)	<.0001
Birthweight (g), mean (SD)	2502.4 (1100.5)	2740.2 (879.8)	3264.7 (601.7)	<.0001

Data are presented as number (percentage), unless otherwise indicated.

SD, standard deviation.

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the overall preterm birth model suggested that only 13% of patients with isolated symptoms or cervical findings of preterm labor will ultimately experience a preterm delivery. The NPV for the model focused on preterm delivery within 1 week of presentation suggested that only 1% of patients with isolated symptoms or cervical findings of preterm labor will experience a delivery within 1 week of their initial encounter. Additional ROC curves were generated to identify which specific cervical findings were most predictive of preterm delivery and demonstrated that a cervical length of ≤2.17 cm (sensitivity of 0.86 and specificity of 0.90) and cervical dilation of ≥2.0 cm (sensitivity of 0.71

TABLE 4
Risk of delivery by presentation group

Presentation category	Crude model		Adjusted model[a]		Predictive findings				
	RR	95% CI	RR	95% CI	AUC[b]	Sensitivity (%)[c]	Specificity (%)[d]	PPV (%)[e]	NPV (%)[f]
Preterm birth									
Symptomatic with cervical findings	4.4	3.2–6.1	4.1	3.0–5.8	0.66	40.9	90.2	49.0	86.9
Asymptomatic with cervical findings	2.8	1.7–4.5	2.4	1.5–3.9					
Symptomatic without cervical findings	Ref	—	Ref	—					
Preterm birth within 1 wk of presentation									
Symptomatic with cervical findings	35.2	12.6–97.8	35.3	12.7–98.2	0.87	85.3	88.4	30.2	99.0
Asymptomatic with cervical findings	2.3	0.3–20.1	2.2	03–19.7					
Symptomatic without cervical findings	Ref	—	Ref	—					

AUC, area under the receiver operating characteristic curve; *CI*, confidence interval; *NPV*, negative predictive value; *PPV*, positive predictive value; *Ref*, reference interval; *RR*, relative risk.

[a]RR ratios were adjusted for gestational age at presentation and before preterm birth

[b]AUC for the crude model among symptomatic patients with cervical findings

[c]Sensitivity of the crude model among symptomatic patients with cervical findings

[d]Specificity of the crude model among symptomatic patients with cervical findings

[e]PPV of the crude model among symptomatic patients with cervical findings

[f]NPV of the crude model among symptomatic patients with cervical findings.

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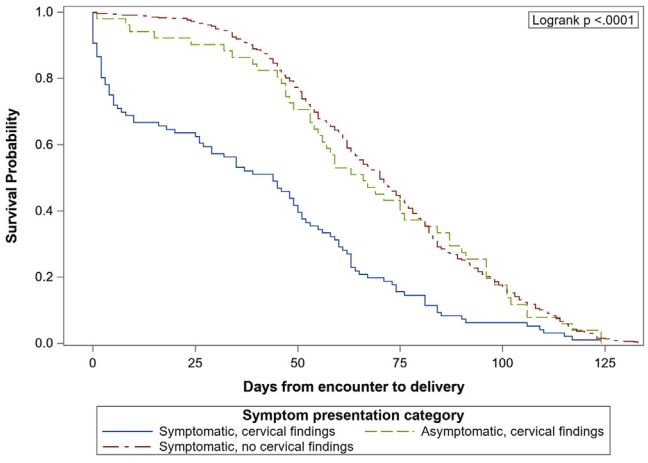
FIGURE 2
Kaplan-Meier survival curves for time to delivery by presentation category



At any time within the study period, patients with both symptoms and cervical findings consistent with preterm labor are at significantly increased risk of delivery relative to those with symptoms or cervical findings in isolation ($P<.0001$).

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and specificity of 0.87) at the initial encounter conferred the greatest risk.

To better understand the continuum of preterm labor for the highest-risk patients, latency was also evaluated among those with both symptoms and cervical findings who had not yet delivered within 48 hours of initial presentation. Only 17 (22%) of these patients had additional encounters for preterm labor concerns, with a mean latency period of 44.7 days between re-presentation and delivery for those with 1 additional encounter and 47.2 days for those with 2 additional encounters. Regarding preterm labor symptoms at re-presentation, contractions were associated with a mean latency period of 45.6 days, vaginal bleeding with a mean latency period of 56.5 days, and abdominal pain with a mean latency period of 39.2 days. Regarding cervical findings on re-presentation, sonographic short cervix was associated with a mean latency period of 50.8 days, whereas premature cervical dilation was associated with a shorter mean latency period of 39.0 days.

To further explore the time to delivery across presentation groups, Kaplan-Meier survival curves are presented in Figure 2. The survival time for patients with both symptoms and cervical findings was significantly shorter than that for patients with either isolated symptoms or cervical findings ($P<.0001$). Specifically, at any given time from their initial encounter, symptomatic patients with cervical findings were more than 2 times more likely to deliver than those with cervical findings (HR, 2.06; 95% CI, 1.47−2.90) or symptoms alone (HR, 2.16; 95% CI, 1.74−2.70). Associations were slightly attenuated, but remained significant, following the adjustment for gestational age at presentation and history of preterm birth (symptoms and cervical findings vs cervical findings alone: adjusted HR [aHR], 1.43 [95% CI, 1.01−2.01]; symptoms and cervical findings vs symptoms alone: aHR, 1.91 [95% CI, 1.53−2.39]). The results were similar when limiting deliveries within 80 days and censoring deliveries beyond 80 days after the encounter.

Discussion

Principal findings

We analyzed the incidence of preterm birth and the interval to delivery in 613 patients evaluated for preterm labor concerns between 22 0/7 and 33 6/7 weeks of gestation. As hypothesized, patients with a combination of symptoms and cervical findings threatening preterm labor were at the greatest risk of preterm delivery and within a shorter time from the initial encounter. Nearly 50% of these patients experienced preterm birth, and more than 30% of these patients delivered within 1 week of presentation.

Results and clinical implications

Earlier studies interrogating the natural history of preterm labor focused on the association between premature cervical dilation or short cervix and interval to delivery. Both How et al[17] and Tommaso et al[18] evaluated patients presenting with preterm contractions between 22 0/7 and 34 0/7 weeks of gestation and identified an inverse relationship between cervical dilation and delivery interval. Specifically, they found that 6% to 48% of patients with 0 to 2 cm of cervical dilation delivered within 48 hours compared with at least 85% of patients with cervical dilation of ≥3 cm.[17,18] Although our results supported a similar trend between cervical dilation and delivery timing, a cervical dilation of 2.0 cm was sufficient to confer an increased risk of preterm delivery among our patient population.

Hiersch et al[19] and Tsoi et al[20] expanded on this research by assessing the predictive value of transvaginal cervical length in women with preterm contractions. Their findings suggested that a cervical length <2.5 cm is associated with a significantly increased risk of preterm delivery and delivery within 14 days of presentation.[19,20] Our results indicated a comparable relationship between a short cervix and the likelihood of preterm delivery, although we found that a shorter cervical length of 2.17 cm was more predictive of delivery timing.

Strengths and limitations

The differences in our findings relative to those cited in the literature may be attributed to 2 study strengths. First, we

captured a larger and more diverse population than was included in the previously conducted analyses. Second, although the previously published studies focused exclusively on contractions as a symptom of threatened preterm labor, we expanded our definition to include other commonly observed symptoms of preterm labor, such as abdominal pain and vaginal bleeding.

A potential limitation of this study was the inclusion of 51 patients (7.9%) transferred to our institution for higher level of care. As only patients who delivered at our institution were eligible for study selection, lower-risk patients who were transferred but ultimately discharged to deliver with an outside provider were excluded. Accordingly, our sample may overrepresent those patients with preterm labor concerns who ultimately delivered before term. Another limitation may involve our approach to multiple patient encounters within a pregnancy. The decision to include only the first encounter may have caused us to overlook later encounters with clinical findings more predictive of a patient's later delivery outcome. However, we felt that examination of the first encounter provided the most relevant assessment for directing decision-making in these patients.

Further limitations arose from differences in the examination techniques and tools used among providers (attending physicians, midwives, and trainees) at our institution. This manifested as limited uniformity in our evaluation of preterm labor, such that up to 15% and 68% of patients had no documented cervical length or cervical dilation, respectively. Similarly, we observed substantial variability in the use of fetal fibronectin across providers, with <9% of study patients undergoing fetal fibronectin assessment. Therefore, we decided to exclude fetal fibronectin results from our predictive modeling and were unable to compare our findings with those of prominent studies by Boots et al[21] and DeFranco et al,[22] which have found that the combination of cervical length and fetal fibronectin is a strong short-term predictor of preterm delivery.

Conclusions and research implications

Regardless of the study limitations, we hope that establishing a risk profile for preterm birth based on the patient's initial presentation will facilitate targeted future management of threatened preterm labor. Our results suggested that the risk profile should include chief complaints of uterine contractions; vaginal bleeding; or abdominal pain paired with cervical dilation of >2.0 cm, shortened cervix of <2.2 cm, or both. Despite strong evidence to support these conclusions, it must be stated that nearly 50% of our patients meeting the highest risk profile for spontaneous preterm birth subsequently delivered at term. Therefore, further research is needed to identify which patients with this profile will benefit the most from the intervention. ■

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Author and article information

From the Department of Obstetrics, Gynecology, and Reproductive Sciences, University of California, San Diego; San Diego, CA (Dr Waks, Ms Santiago, and Drs Laurent and Jacobs); Department of Obstetrics and Gynecology, The University of Texas Rio Grande Valley; Edinburg, TX (Dr Martinez-King).

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Corresponding author: Ashten B. Waks, MD, MSPH. abwaks@gmail.com