



# United States Multicenter Clinical Usage Study of the STAN 21 Electronic Fetal Monitoring System

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## Abstract

**OBJECTIVE:** The STAN S21 EFM system (Neovanta Medical, Moelndal, Sweden) combines standard fetal heart rate (FHR) tracings with automated fetal ECG analysis that determines ST-segment changes predictive of myocardial hypoxemia: increased T wave height relative to QRS height (T:QRS ratio) or biphasic ST waveforms. The STAN system has been shown to improve intrapartum outcomes in other countries. We aimed to assess the ability of US obstetricians to use this system effectively in American labor units.

**STUDY DESIGN:** A prospective nonrandomized trial was conducted in 6 sites. All investigators underwent mandatory education and credentialing. Enrollment required singleton vertex fetus > 36 weeks' gestation with indications for direct fetal monitoring. Primary endpoints for assessing effective usage were (1) Negative predictive value (NPV) of nonintervention for fetuses with nonreassuring (NR) FHR patterns with normal STAN readings and umbilical cord arterial pH > 7.12; (2) Percent agreement (PA) for intervention decisions with those of 3 STAN experts who independently reviewed all cases retrospectively. The study was powered for NPV > 75%, requiring a minimum enrollment of 527 patients.

**RESULTS:** 530 patients were enrolled (site range: 25 – 161). NPV of 95.2% (similar across all sites) was based on 189 fetuses with NRHR, normal STAN readings and available umbilical arterial blood gases. Between investigators and experts, PA for intervention was 84% (31/37), for nonintervention, 90% (444/491), and for overall clinical decision making, 90% (475/528). No fetus with metabolic acidosis requiring intervention was missed. Rates of operative delivery (11.7%) and fetal metabolic acidosis (0.21%) were similar to those from prior randomized and observational European trials.

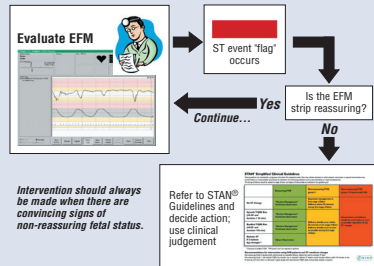
**CONCLUSIONS:** US clinicians, trained with an established education program, used the STAN S21 system for intrapartum clinical decision support effectively and in a manner similar to that of experienced STAN users.

## Device Description

- Standard EFM capabilities:
  - External ultrasound or fetal spiral electrode (FSE)
  - TOCO or IUPC and:
- Fetal ECG (ST) Analysis
- Automatically records and analyzes ST waveform of fetal ECG (FECG)
- ST analysis result displayed in real-time
- ST log



## Principles of the STAN® Clinical Guidelines



## U.S. Clinical Use Study Design and Statistical Considerations

### U.S. Clinical Use Study Design

- Multi-center, non-randomized
- Objective: Demonstrate that implementation of STAN by US clinicians who received standardized education and certification yields results similar to those expected from prior RCTs and user trials

### U.S. Clinical Use Study INVESTIGATIONAL SITES

SITE	TYPE	INVESTIGATORS	CASES
Salt Lake City, UT: St. Mark's Hospital	Community hospital	10	161
Augusta, GA: Medical College of Georgia	Tertiary teaching hospital	11	117
Los Angeles, CA: Harbor-UCLA Medical Center	Tertiary teaching hospital	5	105
Walnut Creek, CA: Kaiser Permanente	Community hospital (HMO)	5	64
Mineola, NY: Winthrop University Hospital	Tertiary teaching hospital	6	58
Dallas, TX: Medical City Hospital	Community hospital	2	25

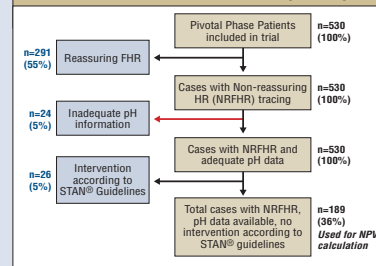
### U.S. Clinical Use Study Design and Statistical Considerations (continued)

- Primary Outcome Measure: Negative Predictive Value (NPV)**
- Probability that non-intervention with NRHR + reassuring STAN data results in normal outcome (pH > 7.12)
  - Hypothesis: NPV > 75% in NRHR cohort
- Sample Size : 527 patients**

## U.S. Clinical Use Study

- Primary Outcome Measurement: Agreement**
- NPA (Negative Percentage Agreement): Percent agreement US Clinicians / STAN Experts for decision not to intervene
  - PPA (Positive Percentage Agreement) percent agreement US Clinicians / STAN Experts for decision to intervene
- Agreement Calculations: PPA and NPA: > 75%**

### Pivotal Phase CUS Database (n=530)



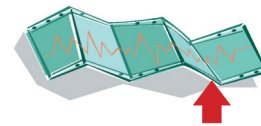
### U.S. Clinical Use Study NVP BY CORD ARTERY pH

CORD ARTERY pH (n=189)	CASES	NPV	95% CI	p-VALUE**
< 7.10	4	97.9%	(94.7%, 99.4%)	< .0001
< 7.11	5	97.4%	(93.9%, 99.1%)	< .0001
< 7.12	7	96.3%	(92.5%, 98.5%)	< .0001
< 7.13	9	95.2%	(91.2%, 97.8%)	< .0001
< 7.14	11	94.2%	(89.8%, 97.1%)	< .0001
< 7.15	14	92.6%	(87.9%, 95.9%)	< .0001

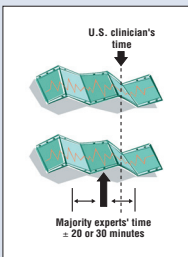
\*Total NRHR and No Intervention according to STAN guidelines with Cord Artery pH Available  
\*\*Based on the null hypothesis that NPV = 75%

## U.S. Clinical Use Study: Agreement Analysis

- (1) The US clinician manages the case with STAN – indicates the time and reason for decision to intervene



- (2) 3 Experts receive the STAN recordings and independently view the strips in 30 minute segments as if they were managing the case. Experts have basic case information only and are blinded to out come. After reviewing each segment Expert decides to continue (view next 30 mins) or express concern and need for intervention at a specific time. Majority of Expert opinions used in agreement analysis



- US clinician's decision is compared to the majority opinion of Experts.
- For intervention agreement the reason must match and the timing should be:
  - +/- 30 mins in first stage
  - +/- 20 mins in second stage or SVD within 20 mins

## U.S. Clinical Use Study

### Study Findings: Agreement

• Overall Agreement	90% (475/528)	CI (88.5%, 93.2%)
• Positive PA	84% (31/37)	CI (68.0%, 95.7%)
• Negative PA	90% (444/491)	CI (87.8%, 93.0%)

### Conclusions: Clinical Significance of PPA

- No cases of fetal acidemia missed
- No evidence that US clinicians ignored ST information
- Appropriate rationale for the clinical action of the US clinicians

### STAN Clinical Studies COMPARISON OF OUTCOME

	Swedish RCT		CUS		Gothenburg			
	FHR	FHR + ST	FHR + ST	FHR + ST	n	%		
<b>OUTCOME</b>	<b>2447</b>	<b>2519</b>	<b>530</b>	<b>2773</b>				
Operative delivery for non-reassuring fetal status	227	9.3	193	7.7	62	11.7	285	10.3
Umbilical cord acid base data available	2079	85%	2159	86%	468	88%	2503	90%
Cord artery metabolic acidosis	31	1.49	15	0.69	1	0.21	14	0.56

## Conclusions

### Conclusions Drawn From STAN Clinical Studies

- All RCTs and prior clinical use studies show reduction in rates of adverse perinatal outcomes and operative deliveries
- STAN® education and technology has been used successfully in many countries
- US educational and clinical usage studies demonstrated successful technology transfer