



A Taiwanese-American's View of 40 Years of Electronic Fetal Monitoring

Sze-Ya Yeh*, M.D., F.A.C.O.G.

*Chairman Emeritus, Department of Obstetrics & Gynecology, Albert Einstein Medical Center;
Honorary Professor of Obstetrics & Gynecology, Thomas Jefferson University Jefferson Medical College,
Philadelphia, Pennsylvania, USA*

Electronic fetal monitoring (EFM) has been widely used in the United States for 40 years. It has been available commercially since 1969.

After completing residency in obstetrics and gynecology at the National Taiwan University Hospital, I came to the United States to pursue my clinical research at Yale University in 1967 through the recommendation of late professor Chien-Tien Hsu, one of the founders of Taipei Medical College. Professor Edward H. Hon, a pioneer researcher in fetal surveillance methods, directed the perinatal research unit at Yale. At the time of my arrival at New Haven, he and his associates were finalizing definitions of fetal heart rate (FHR) patterns. I soon became an integral part of the research team. In 1968, he and Dr. Fred Kubli published a monumental study on correlations between fetal tissue pH and FHR patterns.¹ Corometrics Medical Systems, Inc. introduced the first EFM unit for clinical use the following year.

As we look back over the past 40 years, there have been numerous studies published on EFM. They range from improving perinatal outcome to lack of correlation with perinatal outcome. Due to the conflicting nature of these results, I would like to offer my viewpoints on the validity of EFM application.

Most of the publications in the initial phase of EFM were in the establishment of positive correlations between perinatal outcome and EFM. Many of them came from the University of Southern California where Professor Hon and I later moved to. In 1982, we published the results of our 10-year experience with intrapartum fetal monitoring at the Los Angeles County/University of Southern California Medical Center

(LAC/USC), which showed that EFM had actually improved perinatal outcomes, especially in a hospital with a large number of deliveries.²

We also appreciated that EFM relied on personal, subjective interpretation of the FHR tracings. Several attempts were made to automate the interpretation processes with computer devices: computer pattern recognition,³ FHR variability numerical indices,⁴ and FHR deceleration areas,⁵ hoping that a warning device could be developed for application in clinical settings. Unfortunately, none of them were of practical use because of the nature of FHR signals and the complexity of fetal physiological responses. At present, human bedside evaluation of FHR tracings remains the gold standard of EFM.

The first negative report on EFM came from Haverkamp et al in 1979.⁶ They conducted a controlled prospective study on the outcome of patients with EFM, auscultation, or EFM with options of fetal tissue pH analysis. They concluded that there were no differences in immediate infant outcomes by measurements of Apgar scores, neonatal blood gases, and neonatal mortality/morbidity. They also concluded that the cesarean section rate was markedly increased in the EFM group. This study posed a key question as to whether or not EFM in labor is justified.

More recently, a Cochrane Collaboration study from England concluded that "*Continuous cardiotocography during labour is associated with a reduction in neonatal seizures, but no significant differences in cerebral palsy, infant mortality or other standard measures of neonatal well-being. However, continuous cardiotocography was*

*Corresponding author. 2011 Elkins Place, Arcadia, CA 91006, USA.
E-mail: nobumasa@champmail.com

associated with an increase in caesarean sections and instrumental vaginal births.”⁷

Although these studies showed a lack of perinatal benefit from intrapartum EFM, most hospitals around the world continue to provide EFM for patients in labor, because EFM during labor is a complicated issue. Its benefit cannot be evaluated simply by statistical analysis alone without considering the actual clinical situation. In my personal view, the following issues need to be considered:

- 1) EFM is not a laboratory test and it cannot be analyzed simply by correlating it with the outcome. It is a complement to the auscultation method, and it is the best noninvasive method available for obtaining fetal information during labor.
- 2) Haverkamp et al showed that fetal auscultation in labor provided similar outcome compared to EFM;⁶ however, fetal auscultation required more manpower, and it was subject to more human errors. At present, very few hospitals in the United States can afford to hire sufficient medical personnel to provide auscultation services to all patients in labor.
- 3) FHR variability is one of the crucial parameters on fetal wellbeing. An unofficial study done at LAC/USC showed that auscultation was not able to detect changes in heart rate variability.
- 4) The critical issue in EFM is the correct interpretation of FHR patterns. From my personal observation, there were numerous incidences of poor perinatal outcome due to inadequate interpretation of FHR tracings. During my tenure as residency program director, I always emphasized proper training in FHR interpretation by conducting daily morning rounds with residents to review all FHR tracings from the previous day.
- 5) In general, EFM is a self-correcting process. When non-reassuring FHR patterns occurred, we always tried to eliminate these patterns or to improve fetal condition by giving oxygen to mothers. Under this condition, the outcome data cannot be analyzed with the simple statistical methods that are used in most studies.
- 6) Studies showed an increased rate of cesarean births associated with the use of EFM. However, one should

realize that the indications for cesarean births have changed. The legal climate of medical practice has also contributed to the marked increase in the rate of cesarean section.

- 7) In statistical analysis, the *p* value indicates the probability of a condition occurring. However, due to the severity of perinatal damage, a statistical probability of less than 5% or 1% may, in reality, mean 100% to the patient. For hospitals, a single case of poor outcome could potentially amount to multi-million-dollar compensation packages.

Due to these reasons, most hospitals continue to provide EFM for patients in labor despite these publications. The premium for hospital insurance is reduced if it provides continuous EFM for all patients in labor. Until a better, noninvasive fetal surveillance method becomes available in the future, EFM will remain an essential part of intrapartum care. The most significant factor in EFM is to provide timely and accurate interpretation of FHR tracings.

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