

Experiences with the HeRO System for the Past Ten Years

By Stefan R. Maxwell, MB BS, FAAP

Despite reported reductions in rates of CLABSIs,^{1, 2, 3} infection and sepsis remain important and feared complications within the NICU.⁴

HeRO monitoring has been shown to predict infection in the NICU.⁵ In a 3000-patient Randomized Controlled Trial, researchers reported a 22% reduction in mortality through HeRO monitoring of Very Low Birth Weight (VLBW) NICU patients.⁶

While the benefit of HeRO monitoring to VLBWs is now well-studied, the question remains as to the benefit to other NICU patients, especially feeder-growers.

Approximately ten years ago I received a phone call from a venture capitalist friend who was at the time Chairman of the WV Symphony Board, of which I was a member. He was also (and still is) a venture capitalist always looking for small companies to invest in, with the hope that such companies would eventually become profitable. He asked my opinion about a system which was non-invasive, that was hooked up to a baby's monitor, which somehow would analyze the heart rate and come up with a real-time tracing that would give a "snapshot" of the beat-

to-beat variability, which could be visualized over days at a time. The hypothesis was that since normal "beat-to-beat variability" was evidence of fetal well-being, and that "loss of this beat-to-beat variability," was associated with "fetal distress" in utero, perhaps a baby that was becoming ill due to bacteremia or sepsis may have the same pattern of "loss of beat-to-beat variability" which could be an early warning sign for us in the neonatal unit. This hypothesis was originally conceived by a neonatologist and a cardiologist at the University of Virginia, and the technology was created by MPSC (Medical Predictive Sciences Corp) and tested in a pilot at Wake Forest University on a small scale.⁷ The system was called HeRO, and I was asked to offer an opinion re the efficacy of such a system, as these investors were looking at the company as a proposed venture.

I said that I thought it was far-fetched, and that I did not believe that the system would help us in our quandary of trying to diagnose infection in newborns. I explained that our armamentarium of tests was not very helpful, for the most part, unless a baby was clearly overwhelmed with infection, in which case the tests were merely confirmatory, but not predictive. Blood cultures took time, and many times the yield was poor; the complete blood count (WBCs and differential) were equivocal and the acute phase reactants (C

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reactive protein) lagged behind sometimes for greater than 24 hours before becoming positive. Other tests such as IL6, IL8, Haptoglobins, and others were simply not available quickly, and could take up to 3 days for the results to be available. My friend asked if I would be willing to try this system in my unit, free of charge, for a few months, and then offer an opinion. I agreed.

The system was installed in the NICU and I began the process of observing the tracings on all my babies. I was taught by the staff at MPSC that "normal" beat-to-beat variability was equated to a HeRO score of $< \text{or} = 1$. If the score was 1 and suddenly started to rise to multiples of 1, that this was associated with a "flat" tracing, or loss of variability. I was also taught that there were some conditions such as a Patent Ductus Arteriosus, or a post-operative state, or an infant who was critically ill, that were associated with a high HeRO score. It became obvious to me early on, that new admissions that were sick with RDS, or PPHN or congenital anomalies requiring surgery all had high HeRO scores, and that the system really had no utility for me there. And it wasn't very helpful in "early onset" sepsis at all. I really could not judge length of therapy in a newborn who was started on antibiotics at birth, because the scores were affected by too many other concomitant conditions. So I still relied on blood counts and the C-reactive protein values at



Figure 1. HeRO Patient View. The Patient View displays a five-day trend of the HeRO Score and a 30-minute trend of heart rate data. In this example, a positive blood culture is preceded by a rising HeRO trend, while the heart rate trend shows low variability punctuated by very subtle decelerations.

24 hours to help me gauge therapy in early onset infection.

One afternoon as I was examining the HeRO tracings, there was one that caught my eye. It was a "feeder/grower" lying in a crib waiting to be discharged the next day. There was an indwelling Broviac catheter which had just been "heparin-locked", and the surgeon that inserted it was on her way to remove it before discharge. The HeRO score had tripled in a period of 3 hours. I examined the baby, and she was normal-appearing, was nipple feeding and seemed perfectly fine. I sent a C-reactive protein which came back within an hour. The value was 110. Normal values in our institution then were <10. I sent an immediate blood culture, and checked the CBC and differential. The latter was normal. I decided to start antibiotics because of the (+)CRP, (procalcitonin was not available then). The next day, the blood culture came back positive for *Klebsiella* sp. Needless to say, the baby was treated with IV antibiotics for another 10 days.

This was not an isolated incident. I have had many more instances over the years where the HeRO system has diagnosed "late-onset" infection in my babies, and has preceded the rise in CRP and procalcitonin on many occasions. I have relied on this system to help me to decide regarding antibiotics in babies with symptomatology that is not clear-cut, and in my opinion, has saved lives. The infant described above could have been discharged home, and may have succumbed to her infection.

Until there are new methods devised or lab investigations that are more precise in diagnosing infection, it is my opinion that the HeRO system is an invaluable tool in the management of our infants, especially those that are chronic feeding and growing infants that are always prone to developing indolent, slow-growing bacterial infections.

References

1. Ceballos, Waterman, Hulett, Makic. Nurse-drive quality improvement interventions to reduce hospital-acquired infection in the NICU. *Adv Neonatal Care*. 2013 Jun; 13(3): 154-63.
2. Chandonnet, Kahlon, Racch, Degrazia, Dewitt, Flaherty, Spigel, Packard, Casy, Rachwal, Agrawal. Health care failure mode and effect analysis to reduce

- NICU line-associated bloodstream infections. *Pediatrics*. 2013 Jun; 131(6).
3. Schulman J, Stricof R, Stevens TP, Horgan M, Gase K, Holzman IR, Koppel RI, Nafday S, Gibbs K, Angert R, Simmonds A, Furdon SA, Saiman L. Statewide NICU central-line-associated bloodstream infection rates decline after bundles and checklists. *Pediatrics*. 2011 Mar;127(3):436-44.
 4. Comacho-Gonzalez, Spearman, Stoll. Neonatal Infectious Diseases: Evaluation of Neonatal Sepsis. *Pediatr Clin N Am*. 2013. 367-389.
 5. Griffin, Lake, O'Shea, Moorman. Heart rate characteristics and clinical signs in late-onset neonatal sepsis. *Pediatric Research*, 61: 222-227, 2007.
 6. Moorman, Carlo, Kattwinkel, Schelonka, Porcelli, Navarrete, Bancalari, Aschner, Whit Walker, Perez, Palmer, Stukenborg, Lake, Michael O'Shea. Mortality reduction by heart rate characteristic monitoring in very low birth weight neonates: a randomized trial. *J Pediatr*. 2011 Dec;159(6):900-6.
 7. Griffin, O'Shea, Bissonette, Harrell, Lake, Moorman. Abnormal heart rate characteristics preceding neonatal sepsis and sepsis-like illness. *Pediatric Research*, 53: 920-926, 2003.

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