Editorial

Heart rate corrected QT interval in newborn electrocardiogram

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Comment on: Stramba-Badiale M, Karnad DR, Goulene KM, *et al.* For neonatal ECG screening there is no reason to relinquish old Bazett's correction. Eur Heart J 2018;39:2888-95.

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There have been numerous debates on the best formula for heart rate (HR) correction of QT interval on electrocardiograms (ECG). Many previous studies have compared different commonly used correction formulae in adults (1-4), children and adolescents (5,6). Lately, we have also seen studies on the QT correction formulae in even younger populations, such as infants (7,8), but there has been no study on newborns (younger than 30 days of age). An interesting paper by Dr. Stramba-Badiale and colleagues was recently published in the *European Heart Journal*, titled "For neonatal ECG screening there is no reason to relinquish old Bazett's correction" (9). The study was based on the ECGs collected in a previous prospective study on ECG screening of 44,596 healthy neonates conducted in Italy between 2001 and 2006. In the paper, the researchers evaluated 5,000 newborns, including 17 with long QT syndrome (LQTS)-causing mutation identified by genotyping, and compared four QT correction formulae (Bazett's, Fridericia's, Framingham, and Hodges). Two criteria were used to determine the best choice of QT correction formula for newborn ECG—(I) QT correction across different HR by linear regression analysis of corrected QT interval (QTc) *vs.* HR; (II) ability of the formula to identify 17 newborns with LQTS out of a total of 5,000 samples. The authors found that the Bazett's correction provided an effective HR independent QT correction and was able to accurately identify the neonates affected by LQTS. Therefore, it was concluded that Bazett formula can be used with confidence in neonates.

The most commonly used QT correction formula, Bazett formula ($QTc = QT/RR^{0.5}$), has been widely criticized for over-correction of QT intervals at high HRs (10), thus may not be suitable for use in younger populations. Phan *et al.* reported that in a group of 702 young children (majority under 2 years old), Bazett formula resulted in the most consistent QT correction across a wide range of HRs (70–189 bpm). The study by Stramba-Badiale *et al.* came to the same conclusion in an even younger population—newborns at 15 to 25 days of age. Remarkably, these two studies have very similar results—the "perfect" QT correction formula for newborns by Stramba-Badiale *et al.* was $QTc = QT/RR^{0.467}$ and for infants/young children by Phan *et al.* was $QTc = QT/RR^{0.48}$, both of which are very close to Bazett $QTc = QT/RR^{0.5}$. Furthermore, both studies identified 460 ms as the cutoff value for prolonged QTc.

The authors correctly pointed out that the study has many important strengths, including a large sample size, prospectively collected samples of high-resolution newborn ECGs, measurements by expert cardiologists, and validation by QTc and HR regression as well as by distinction between healthy newborns and newborns with LQTS. One limitation not listed by the authors is that the samples were collected from a relatively homogeneous population of predominantly white newborns in Northern Italy.

As the authors indicated, the results of this study have important implications. First, for clinical interpretation of newborn ECGs, clinicians should consider that Bazett formula is the choice for HR correction of QT intervals. Identifying the most suitable QT correction formula also helps to determine the effects of some medications frequently used in newborns on QT prolongation, such as methadone. It will also be important for the development

of new pharmaceutical products, especially ones targeted for pediatric use. Another implication is for the increasingly heated debate on the topic of universal ECG screening of newborns for LQTS.

It is now widely recognized that up to 10–15% of sudden infant death syndrome (SIDS) or sudden unexplained infant death (SUID) victims carry LQTS or other channelopathy mutations (11,12). Given that medical therapy for LQTS is generally effective, it is logical to hypothesize that ECG screening of newborns can identify babies with LQTS thus may prevent sudden death or SIDS. The efficacy of newborn ECG screening has been demonstrated by Schwartz *et al.* in Italy (13-15). The debate regarding universal LQTS screening has since been ongoing (16,17). In a 2007 survey of 363 pediatric cardiologists in North America, only 11% supported mandatory screening (18). As more data have become available, such as the link between SIDS and LQTS, and a higher prevalence of LQTS than previously estimated, universal newborn screening is gaining more support (19-24).

From those who oppose universal ECG screening of newborns (16,21,25), the concerns include: (I) gaps in knowledge in epidemiology and natural history of LQTS in different populations; (II) sensitivity, reliability and reproducibility of newborn ECGs (21,24); (III) cost-effectiveness of mass screening is not clear (21,22,26-28). As more studies from different countries on newborn screening, such as Japan (29), are published, studies on newborn ECGs for LQTS screening (such as the paper by Stramba-Badiale *et al.*) are available, and new technologies that make ECG screening on newborns more accessible, reliable and cost-effective, we are getting closer to a serious policy discussion on ECG screening of all newborns.

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Footnote

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Conflicts of Interest: Dr. Chang is Founder and CEO of QT Medical, Inc. (www.qtmedical.com), which manufactures electrocardiogram (ECG) devices and provides ECG services.

Ethical Statement: The author is accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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