SHORT REPORT

Cardiorespiratory stability during echocardiography in preterm infants

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Blood pressure, heart rate, and oxygen saturation were monitored prospectively during 40 echocardiography recordings on 17 preterm infants (25–29 weeks; 510–1430 g), to examine whether echocardiography can be performed without disturbing cardiorespiratory status in preterm infants. There was no impact on absolute blood pressure. Heart rate increased by a mean of 4 beats per minute, and oxygen saturation decreased by a mean of 1% during echocardiography. While these changes reached statistical significance they are not of clinical significance as they remained well within ranges seen during control rest periods. All readings had greater minute-to-minute variability during echocardiography but differences were small and again remained within physiological ranges.

Echocardiography is being used increasingly on the neonatal unit, and has been shown to have a high yield for both structural and functional cardiac abnormalities.[1] Repeated examinations in the preterm infant provide information on haemodynamic status which is of practical clinical value.[2] However, such examinations involve repeated handling which conflicts with the widely recommended principles of minimal handling of preterm infants.[3] Handling episodes such as care procedures and chest radiographs have been shown to impact on both oxygen saturation and blood pressure.[3 4] There are currently no published data on the cardiorespiratory effects of trans-thoracic echocardiography in the preterm infant. The purpose of this study was to examine whether cardiorespiratory status was disturbed during carefully performed echocardiography in preterm infants.

METHODS

Infants <31 weeks gestation were part of an ongoing research cohort where haemodynamic status was examined repeatedly at 5, 12, 24, and 48 hours of postnatal life by trans-thoracic echocardiography. Efforts were made to keep infants' cardiorespiratory status stable during echocardiography, including using warm coupling gel, minimising study duration, and using swaddling where necessary.

Infants were included in this study if they had continuous intra-arterial blood pressure (BP) recordings and had an undisturbed control period immediately prior to or following echocardiography. Echocardiography was performed immediately before or after routine nursing care to minimise the number of discreet handling episodes. Infants were not muscle relaxed or sedated during the study period. Recordings of BP, heart rate, and oxygen saturation (SpO_2) were downloaded every 60 seconds during both echocardiography and the undisturbed control period using Marquette Solar 8000 monitors (GE Medical Systems, Wisconsin, USA) and Bedmaster V1.3 software (Excel Medical Electronics Inc., Florida, USA).

Absolute values were averaged separately over the echo and control periods. Echo and control absolute values were compared using a paired *t* test. Stability within each study was assessed by coefficient of variation (standard deviation/mean). Impact of demographic and postnatal factors on stability was assessed by univariate analysis. Echo and control stabilities were compared with a Wilcoxon signed rank test. The Regional Ethics Committee approved the study and informed parental consent was obtained.

RESULTS

Seventeen infants with a median gestation of 27 weeks (range 25–29 weeks), and median birth weight of 880 g (range 510–1430 g) were studied. A median of 2 (range 1–4) echocardiography recordings per infant had continuous intra-arterial blood pressure monitoring and an adjacent rest period, such that 40 consecutive paired recordings were available. In 28 recordings infants were intubated and mechanically ventilated; the remainder were supported by continuous positive airway pressure. Median echo duration was 10 minutes (range 7–19 minutes), and a control period of a matched duration was studied in each case. Therefore, for each variable a median of 10 (range 7–19) readings were compared in each echo and control group, creating a total of 870 readings per variable.

Impact of echocardiography on blood pressure

During echocardiography there were no significant differences in blood pressure when compared with the control periods. Mean differences: systolic BP, −0.1 mm Hg, $p = 0.82$; diastolic BP, 0.5 mm Hg, $p = 0.25$; mean BP, 0.3 mm Hg, $p = 0.56$ (fig 1).

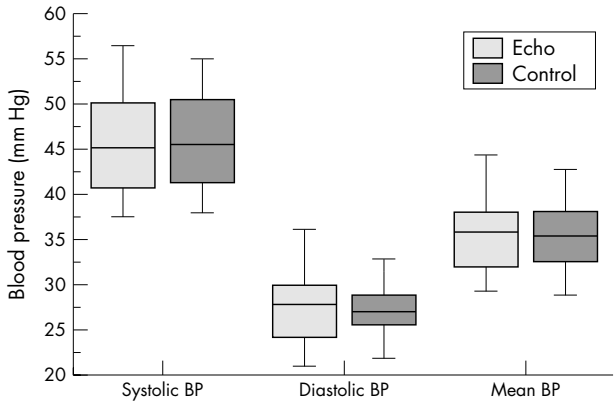

Figure 1 Box and whisker plot of blood pressure during echo and control periods (10th, 25th, 50th, 75th, and 90th centiles).

Table 1 Coefficients of variation for blood pressure, heart rate, and oxygen saturation during echo and control periods, compared using the Wilcoxon signed rank test

	Systolic BP		Diastolic BP		Mean BP		Heart rate		SpO_2	
	Median	Range	Median	Range	Median	Range	Median	Range	Median	Range
Echo CV	5.5%	1.9–11.3	6.3%	2.0–13.5	5.2%	1.5–12.0	3.4%	0.9–12.4	2.1%	0.0–11.9
Control CV	4.5%	2.0–12.8	4.8%	2.1–14.0	4.1%	1.5–12.3	2.4%	0.4–8.2	1.2%	0.0–8.9
p value	0.02		0.006		0.009		0.006		0.005	

Impact of echocardiography on heart rate and oxygen saturation

Mean (SD) heart rate when averaged over the study period was 152 (12) beats/minute, and 148 (12) beats/minute during the control period (mean difference 4 beats/minute, $p < 0.0001$). Mean (SD) oxygen saturation when averaged over the study period was 92% (3%), and 93% (3%) during the control rest period (mean difference −1%, $p = 0.0033$).

Impact of echocardiography on stability

Coefficients of variation (CV) of BP, heart rate, and oxygen saturation within the periods of echocardiography were statistically significantly higher than during the matched rest periods (table 1).

Univariate analysis showed that stability during echocardiography was not significantly affected by birth weight, mode of ventilation, postnatal age at scan, or whether echocardiography occurred before or after the control rest period. Infants ⩽26 weeks gestation had significantly increased blood pressure variability during echocardiography when compared to infants >26 weeks gestation (CVs: systolic BP −6.9% *v* 5.1%, $p = 0.01$; diastolic BP −7.9% *v* 5.4%, $p = 0.01$; mean BP −6.6% *v* 4.9%, $p = 0.03$). However infants ⩽26 weeks gestation also had a trend towards increased variability during control periods (CVs: systolic BP −4.7 *v* 4.4%, $p = 0.22$; diastolic BP −5.0 *v* 4.6%, $p = 0.24$; mean BP −4.2 *v* 4.0%, $p = 0.28$).

DISCUSSION

As the use of echocardiography on the neonatal unit increases it is important that the handling involved in the technique neither worsens outcomes for infants nor alters haemodynamic status so as to produce measurements which do not reflect the infant's true condition. This study has shown that trans-thoracic echocardiography, when performed with due care, has no effect on absolute blood pressure in preterm infants.

The data also suggest that the effect of echocardiography on heart rate and oxygen saturation is not of clinical significance. The absolute differences in heart rate and oxygen saturation during echocardiography were only a third of the standard deviations of values seen during control rest periods—absolute differences in these measures during echocardiography are therefore considerably less than spontaneous fluctuations seen at rest in preterm infants. The identical standard deviations for both heart rate and oxygen saturation during echo and control periods also show that the ranges of these measures were not different. Despite showing *statistically* significant differences in absolute heart rate and oxygen saturation, echocardiography has no *clinically* significant impact on these variables in preterm infants.

Minor increases in coefficients of variability of these measures are also unlikely to be of clinical significance. Bada *et al* have previously measured mean arterial blood pressure variability on a minute-to-minute basis over 15 minute periods in 72 very low birth weight infants who did not develop periventricular haemorrhage (PVH) and found a mean CV of 7.8%.[5] The mean BP CV of 5.8% during echocardiography in this cohort compares favourably with this, and no infant in our cohort had a mean BP CV above 13%, which Bada and colleagues found to be associated with PVH. Although the least mature infants in this study had the highest variability in blood pressure during echocardiography, these infants also tended to have higher variability during rest periods, and it is again reassuring that all values were within ranges previously shown to not be associated with PVH.

Previous studies have shown that Doppler echocardiographic indices of cardiac output and pulmonary artery pressure have repeatability indexes (coefficient of repeatability/mean value) in the order of 15%.[6] This present study confirms that echocardiography can be performed in preterm infants without disrupting parameters of cardiorespiratory status to influence such repeatability measures.

With due care it is possible to perform echocardiography in the preterm infant to gain valuable haemodynamic information without significantly disturbing cardiorespiratory status.

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