Reliability of respiratory function monitor interpretation for neonatal resuscitation

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A respiratory function monitor (RFM) is a potential tool to enhance the quality of positive pressure ventilation (PPV) inflations in the delivery room.[1] The RFM calculates, displays and records data about tidal volumes, mask leak, airway obstruction and presence of spontaneous breathing. Although visual interpretation of respiratory signals is integral to this methodology, the reliability of these assessments is unknown. The study objectives were to determine the intrarater and inter-rater reliability of RFM signal interpretation.

This was an observational study of RFM files recorded during PPV resuscitation of preterm infants using the NewLife Box RFM (Advanced Life Diagnostics, Weener, Germany). Four raters reviewed 16 RFM recordings twice using Pulmochart (Advanced Life Diagnostics) software. Raters manually confirmed or adjusted automated triggers indicating start and end of each inflation. Pressure and flow waveform patterns were assessed to characterise each inflation as follows: PPV inflation without a coinciding spontaneous breath (default); PPV inflation with a superimposed spontaneous breath (with initial expiration during the inflation); PPV inflation with a superimposed spontaneous breath (with initial inspiration during the inflation); spontaneous breath on continuous positive airway pressure (CPAP); mask removal or displacement.

Using R V.4.1.0, overall and category-specific kappa values of inflation classification assessed intrarater and inter-rater reliability.[2] We used a linear mixed-effects model to estimate fixed effects of raters, review order and their interactions. The intrarater reliability for exhaled tidal volume (Vte) measurements was assessed using the intraclass correlation (ICC). A p value <0.05 was considered statistically significant.

The analytical data set had 8368 inflations. Intrarater kappa values for inflation categorisation ranged from 0.597 to 0.655 (table 1). Overall kappa for inflation classification across raters was 0.402 and ranged by inflation type. There was substantial intrarater agreement for identifying spontaneous breaths on CPAP (kappa 0.797) and moderate agreement for classifying PPV inflations without spontaneous

Table 1 Overall and category-specific kappa values for types of inflations

Rater	Overall kappa	Category-specific kappa				
		PPV inflation, no spontaneous breath	PPV inflation with spontaneous breath (initial expiration)	PPV inflation with spontaneous breath (initial inspiration)	Spontaneous breath on CPAP	Mask removal
1	0.636	0.709	0.353	0.484	0.800	0.661
2	0.621	0.614	0.974	0.479	0.878	0.798
3	0.655	0.654	0.842	0.541	0.918	0.798
4	0.597	0.604	0.876	0.360	0.908	0.628
All (inter-rater reliability)	0.402	0.409	0.629	0.265	0.797	0.226

Measures of intrarater reliability are provided for each rater. Agreement between all raters (inter-rater reliability) is shown in the bottom row.
CPAP, continuous positive airway pressure; PPV, positive pressure ventilation.

breathing (kappa 0.409). Kappa values were 0.629 for PPV inflations coinciding with a spontaneous breath (initial expiration) and 0.265 for PPV inflations coinciding with a spontaneous breath (initial inspiration).

Intrarater reliability of Vte values was high for all raters (ICC values 0.963–0.995), and the inter-rater reliability was 0.974. The absolute difference in mean Vte values between raters ranged from 0.01 mL (95% CI −0.02 to 0.05) to 0.15 mL (95% CI 0.11 to 0.19).

Respiratory function monitoring is a growing tool with potential clinical and research applications for delivery room resuscitation.[3 4] We demonstrated poor inter-rater reliability of inflation classification using visual assessment of RFM waveforms, while reliability of Vte values was high. These results have important implications for the generalisability of research relying on RFM; our findings suggest that studies relying on visual interpretation of RFM signals may not yield reproducible results. Improved methods to detect and classify PPV inflations are needed to improve RFM research methodology.

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Contributors EEF conceptualised the study, contributed to data collection and analysis and wrote the first draft of this manuscript. ABtP, JD and DW collected data, interpreted the data and critically revised the manuscript. JH contributed to the statistical design, analysed the data and critically reviewed the manuscript. Each named author has read and approved the final draft of this manuscript and agrees to be accountable for all aspects of the work.

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