

Selecting a reference standard for evaluating respiratory rate devices to detect symptoms of pneumonia in children under five: Lessons from resource-poor settings in sub-Saharan Africa and Asia

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Key messages

- We recommend that video panel review remains as the best practice reference standard for evaluating respiratory rate (RR) devices.
- Further studies should aim to reduce human counting error in the video panel, for example by assisting counters with video annotation software.

Introduction

- Manually counting a child's RR for 60 seconds using an acute respiratory infection (ARI) timer is the WHO-recommended method for diagnosing symptoms of pneumonia in resource-poor settings.
- Evaluating new respiratory rate diagnostic aids is challenging due to the absence of a gold standard.
- The study objective was to compare RR agreement between different reference standards.

Methods

- Four RR devices were tested by community health workers (CHWs) on children 0-59 months across four countries in sub-Saharan Africa and Southeast Asia.
- Three reference standards were used: 1) simultaneous video recording of child's chest movements with independent RR assessment by a three-person expert panel; 2) contemporaneous expert clinician (EC) counting RR with a manual stopwatch; and 3) simultaneous continuous RR with a Masimo capnography CO2 module on a patient monitor.
- Agreement was calculated using the proportion of observations that were ± 2 and ± 5 breaths per minute (bpm). Bland-Altman plots with limits of agreement (LOA) were used for analysis of agreement between methods.



Evaluating the accuracy of selected RR devices in the hands of CHWs in Mpigi Hospital, Uganda, using three reference standards.
Photo: Tine Frank

Results

- A total 120 of 146 videos (82%) were readable, of which 97 (81%) had video expert panel agreement between any two of three panel members. Of 97 video panel rates, corresponding comparator information could be analysed for 90 (93%). For the continuous monitor, 20 comparisons were excluded due to connection failures. For the EC, nine comparisons were excluded due to failure to get a reading.
- Agreement ± 2 bpm between references is lowest for the continuous monitor versus EC (29%). Agreement ± 2 bpm with the video panel is higher at $\sim 40\%$ for both comparators. Agreement ± 5 bpm is similar between all references (55-59%) (Table 1).

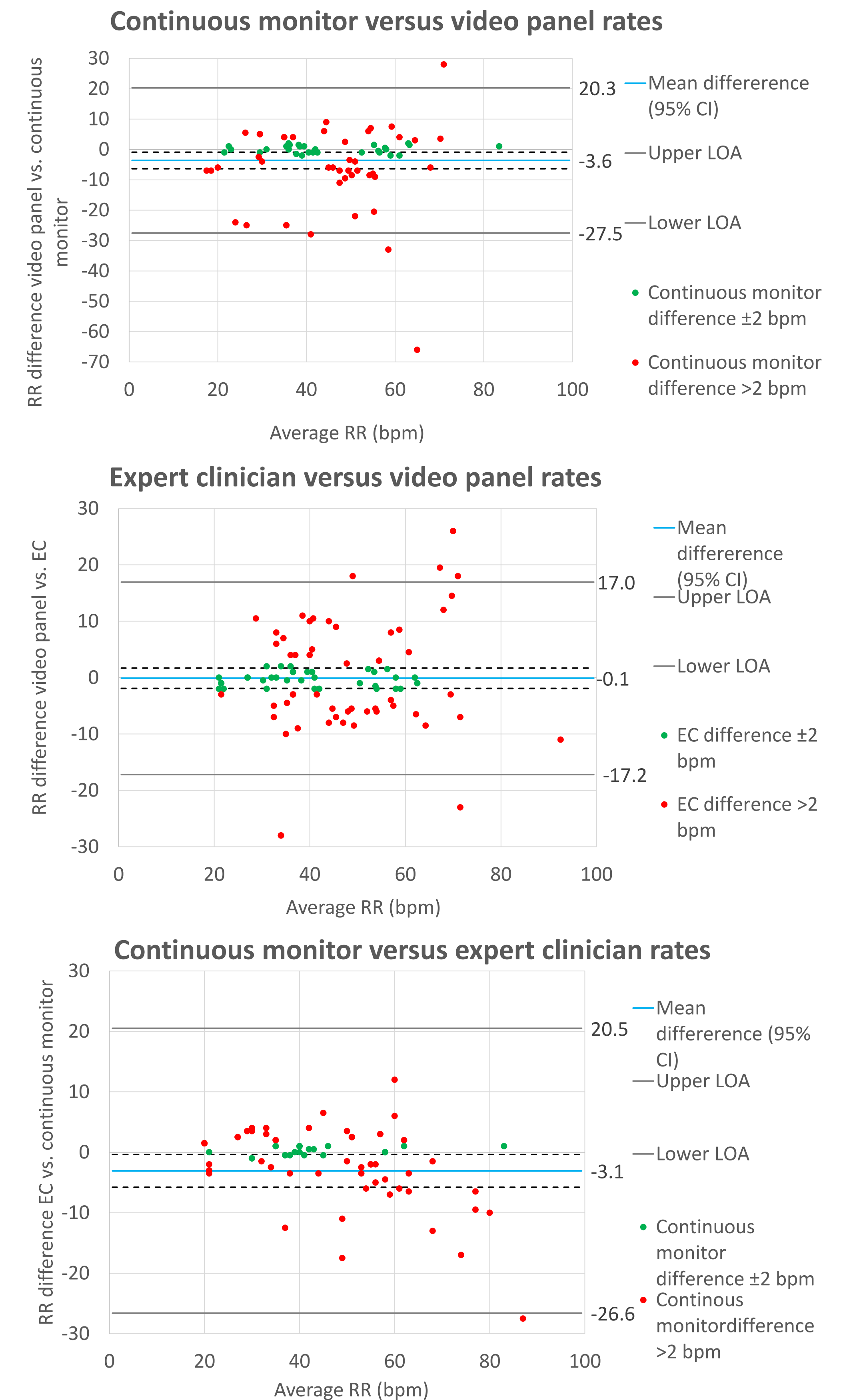
Table 1: Agreement between reference standards

Level of agreement	Continuous monitor versus video panel (n=77)	EC versus video panel (n=88)	Continuous monitor versus EC (n=75)
	N; Freq. (%)	N; Freq. (%)	N; Freq. (%)
± 2 bpm	31 (40.3%)	34 (38.6%)	22 (29.3%)
± 5 bpm	45 (58.4%)	48 (54.6%)	42 (56.0%)

- Agreement between reference standards tends to decrease as average RR between reference standards increases (Figures 1, 2 and 3). On average, continuous monitor RRs were lower than the video panel rate and EC rate (mean difference -3.6 bpm and -3.1 bpm, respectively) (Figures 1 and 3).

Conclusion

Agreement between all reference standards was low. Continuous monitor RR readings are consistently lower in comparison to EC and video panel RR readings.



Figures 1 (top), 2 (middle) and 3 (bottom): Bland-Altman plots of the absolute difference (with limits of agreement) between reference standards

For more information

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Acknowledgements

This study has been funded by Bill & Melinda Gates Foundation. However, the views expressed do not necessarily reflect the organisations official policies. The authors thank all organisations and individuals who participated in and supported this project. We are particularly thankful to the Malaria Consortium country teams in South Sudan, Ethiopia, Uganda and Cambodia for their support in data collection.