Finding the Balance: A Comparative Analysis of Paediatric ALS CPR Escalation Models and Evaluating Their Performance Against Evidence-Based Metrics

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INTRODUCTION

Paediatric Out-of-Hospital Cardiac Arrests (pOHCA) are rare; however, when Advanced Life Support (ALS) measures are performed well, they have higher survival rates than adults (1). Most pOHCA occur due to hypoxia (2-4), making effective ventilation (4, 5) and high-quality Chest Compressions (CC) (4, 6, 7) critical for survival and positive neurological outcomes. Maintenance of cerebral perfusion pressure by ensuring high Chest Compression Fractions (CCF) (6-8) is a vital metric when assessing optimal paediatric Cardiopulmonary Resuscitation (pCPR) ratios.

$$CCF\ (\%) = \left(\frac{(Total\ Time\ of\ Arrest - Total\ Time\ OFF\ Chest)}{Total\ Time\ of\ Arrest}\right) \times 100 \quad (10)$$

In adults, a CCF above 80% is well established (9), but the optimal target in paediatrics is less clear (10-13). A threshold of >60% has been recommended (10, 11) to account for the higher ventilation rates needed in children due to the more likely hypoxic aetiology. Despite ANZCOR's ratio guidelines of 15:2 for dual officer and 30:2 for single officer (14), it remains unclear whether crews should maintain 15:2 or switch to 30:2 during brief periods when one officer steps away for ALS interventions. Creating uncertainty about the best approach to sustaining CCF and ventilation delivery in these moments (15).

Thus, the aim was to compare two ALS escalation models in a simulated, resource-constrained two-officer pOHCA – one maintaining 15:2 throughout and one transitioning to 30:2 during ALS – by evaluating their impact on CCF, ventilation frequency, and drug administration timing, identifying the optimal evidence-based approach.

METHODS

A non-randomised quasi-experimental simulation-based pilot study was conducted to compare two ALS escalation models during pCPR in a resource-constrained, two-officer setting. Final-year paramedicine students completed scenarios using a Laerdal® MegaCode Kid™ ALS manikin (Figure 1). In the 15:2 model, crews maintained a 15:2 Compression-to-Ventilation (C-V) ratio throughout. In the 30:2 model, crews used 15:2 during two-officer CPR but transitioned to 30:2 when one officer performed ALS tasks (e.g. IV access, drug administration), reverting to 15:2 when both officers were available. Scenarios commenced in asystole and progressed to ventricular fibrillation after one CPR cycle (~2 minutes), concluding after the third defibrillation. Simulations were video recorded, and key outcomes (e.g. CCF, total ventilations, scenario duration, and timing of IV access and adrenaline) were analysed retrospectively via timestamped review. A paired-samples t-test compared metrics between models.

Figure 1: Paramedicine students conducting modelled scenario

RESULTS

Two participants (n = 2) performed three scenarios for each of the two ALS escalation models of pCPR, resulting in six simulation recordings in total for comparison. Scenario durations were comparable, with all scenarios ceasing at the third defibrillation. The 15:2 model averaged 13 minutes and 4 seconds (M = 784.3sec, SD = 22.9sec), while the 30:2 model averaged 13 minutes and 1 second (M = 781.3sec, SD = 4.1sec) (Table 1). When comparing the 15:2 to the 30:2 model, the 15:2 model delivered a statistically higher rate of ventilations, 50.7 vs. 41.0 (p = 0.008) respectively (Figure 2).

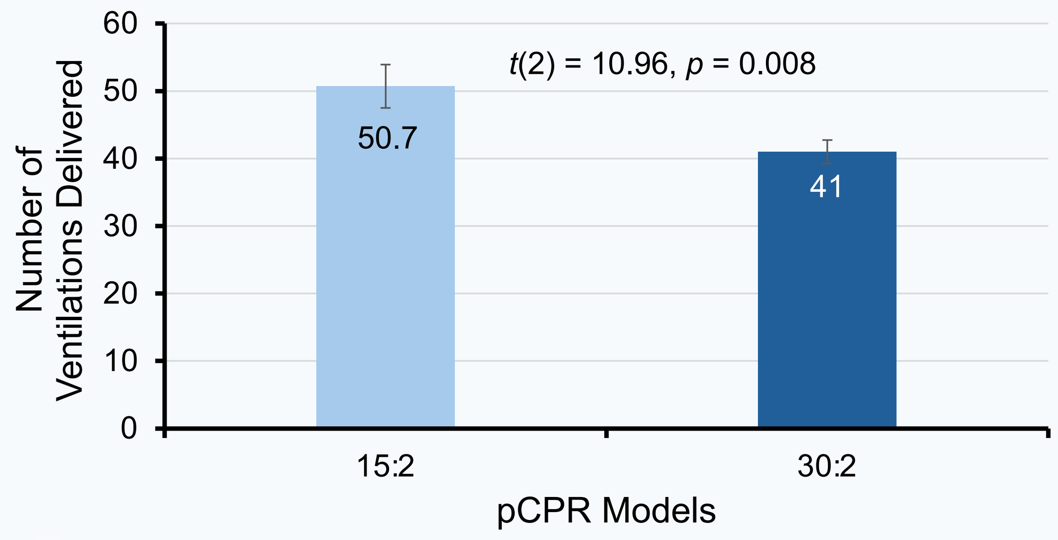

Figure 2: Comparison of Ventilation Rates Between Escalation Models

Conversely, the 30:2 model achieved a statistically higher CCF, 73.8% vs. 65.9% (p = 0.002) respectively (Figure 3).

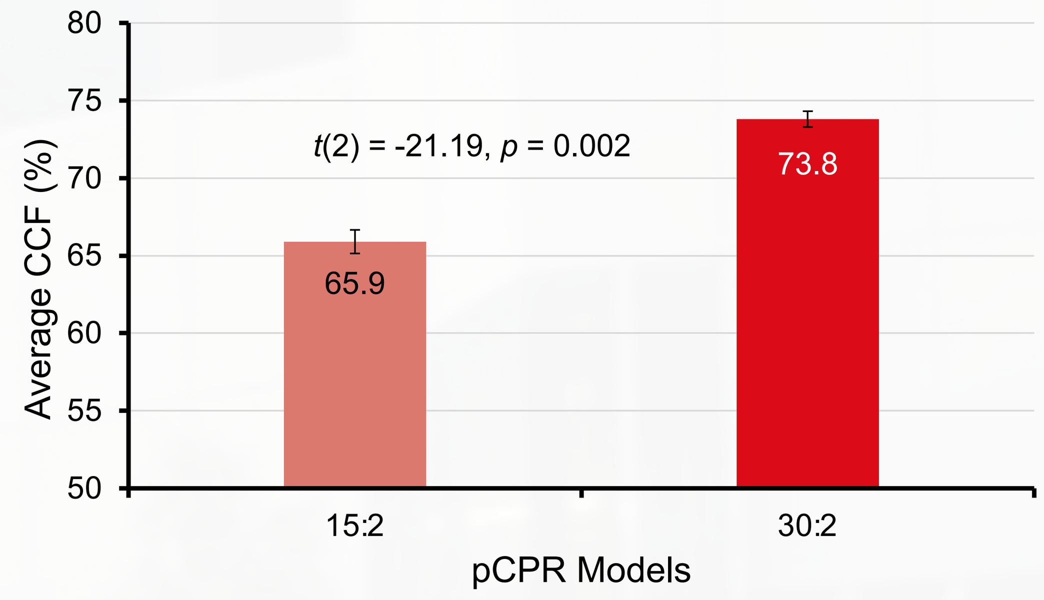

Figure 3: Comparison of CCF Between Escalation Models

Timing of IV access and drug administration was near-identical between models, suggesting that neither escalation approach delayed ALS interventions (Table 1).

Table 1: Comparison of ALS Interventions Between Escalation Models

	15:2 Model		30:2 Model		Significance
	Avg.	SD	Avg.	SD	p value
Ventilations	50.7	2.6	41.0	1.4	0.008**
CCF	65.9%	0.6%	73.8%	0.4%	0.002**
IV	342s	2.2s	341.3s	9.9s	Identical
1st Adrenaline	485.3s	4.2s	479.7s	15.3s	Identical
2nd Adrenaline	704.3s	9.5s	703.3s	18.3s	Identical
Duration	784.3s	22.9s	781.3s	4.2s	Identical

Note: Levels of statistical significance: * p<0.05; ** p<0.01; *** p<0.001

DISCUSSION

This simulation-based pilot study compared two ALS escalation models of pCPR within a resource-constrained two-officer response. Notably, both models exceed the >60% CCF threshold suggested in paediatric literature (10, 11) (15:2 = 65.9%, 30:2 = 73.8%), reflecting the balance between compression continuity and paediatric ventilation requirements. Although Advanced Airway Management (AAM) can provide asynchronous compressions and ventilations, thus a potentially higher CCF, a recent meta-analysis found AAM did not affect the outcome of pOHCA (16) with basic airway techniques improving survival due to earlier, consistent ventilations (17, 18).

As literature remains somewhat unclear regarding paediatric CCF thresholds of >60% (10, 11) or >80% (12, 13), this study and the 15:2 pCPR model is supported when reviewed with current ventilation recommendations against pOHCA outcomes (17, 18). The study achieved an acceptable CCF while ensuring a higher rate of ventilations (15:2 = 50.7 vs. 30:2 = 41.0). However, as these results stem from a small, high-performance, simulated cohort, further real-world studies are required to determine clinical applicability.

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Please scan the QR code to access the full reference list, sample videos of the pCPR models, and the authors' contact information.