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A cross-over study of continuous tracheal cuff pressure monitoring in critically-ill children

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Dear Editor,

Recent guidelines have recommended the use of cuffed endotracheal tubes (C-ETT) in children after the neonatal period, with a rigorous monitoring of cuff pressure (CuffPress) that should not exceed 25 cmH₂O [1]. CuffPress can be adjusted manually [2] or using cuff pressure regulators (PR), as reported in an adult intensive care unit (ICU) [3]. Extreme values of CuffPress are a risk for tracheal ischaemic lesions and/or inhalation pneumonia [4]. Our objective was to assess variability in CuffPress when using a PR in Paediatric ICU (PICU).

This study was conducted in the PICU of Robert-Debre Hospital, Paris. Patients eligible were C-ETT ventilated, non-paralysed children weighing less than 15 kg, with a predicted duration of ventilation longer than 48 h. Patients were admitted consecutively. This cross-over study was approved by the Ethics Committee of the French Intensive Care Society. Written consent was obtained from both parents before inclusion.

During the 24-h inclusion period, patients were assigned alternatively

to 12-h periods with conventional nursing (PR−) or with a mechanical PR (Nosten, Leved, France) (PR+) before cross-over. The cuff was initially deflated and reinflated manually by a paediatric intensivist to the lowest CuffPress required to suppress audible air leaks (Initial CuffPress). During PR− and PR+, CuffPress was checked manually every 3 h by a nurse using a manometer and readjusted to the initial value when necessary. CuffPress was recorded continuously (10 Hz) using a calibrated pressure sensor (DV100A Niche Sensor, France). CuffPress variations were characterised by: (1) the relative standard deviation (RSD = $100 \times \text{standard deviation} / \text{mean}$) and (2) the percentage of time spent outside of the initial CuffPress ± 2 cmH₂O range. PR− and PR+ variables were reported as medians (IQR) and compared using a Wilcoxon–Mann–Whitney test (R, www.r-project.org).

Thirty children were included; five were excluded due to technical problems during data acquisition. In the remaining 25 children, age was 172 days (84–627) and weight was 5.6 kg (3.9–10.4). The C-ETTs diameter ranged between 3.0 and

4.5 mm. The PICU staff did not report any difficulty using the PR.

The Initial CuffPress was 12.1 cmH₂O (10.8–13.3) in PR− and 13.0 cmH₂O (11.5–14.2) in PR+ ($p = 0.08$). The CuffPress during the entire period of monitoring was 11.6 cmH₂O (9.5–13.9), similar to the 10.6 cmH₂O value reported in children before surgery [5]. CuffPress exceeded 25 cmH₂O only during short periods of time, accounting for 0 % (0–0.02) of time in PR− and 0 % (0–0) in PR+. The use of a PR significantly reduced RSD ($p < 0.0001$; Fig. 1). The percentage of time spent out of range was reduced from 48 % (29.8–67.0) in PR− to 0 % (0–0) in PR+ ($p < 0.0001$).

The main expected advantage of the use of a PR is potentially to prevent weaning failures by reducing the incidence of airway mucosal necrosis and ventilator-acquired pneumonia. These adverse effects could be caused by over- and under-inflation, respectively, and may be exacerbated in PICU. Furthermore, the use of PR may alleviate nursing staff workload and prevent pressure drops caused by manual monitoring of CuffPress [3]. Further investigation is now required in PICU to test the possible benefit of CuffPress regulation.

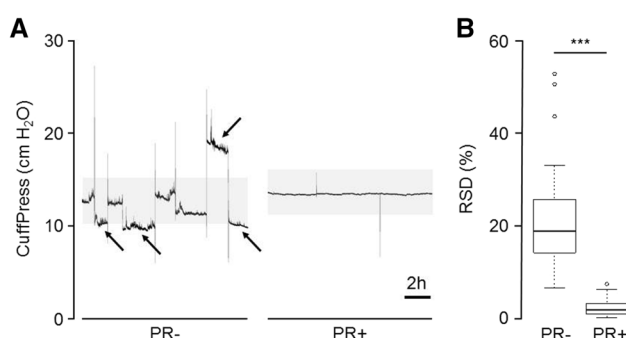


Fig. 1 **a** A representative cuff pressure (CuffPress) individual tracing in a 16-month-old infant (12.2 kg) ventilated with a 4-mm-diameter cuffed endotracheal tube. On the left-hand trace (PR−), CuffPress is influenced by the periodical adjustment by the nurse with a manometer and subsequently by spontaneous ventilation and cough. On the right-hand trace (PR+), these variations were eliminated by the pressure regulator. Shaded areas define initial CuffPress ± 2 cmH₂O range. Note the presence of out-of-range periods in PR− (arrows). **b** CuffPress relative standard deviation (RSD) in 25 children during two consecutive 12 h periods of mechanical ventilation with (PR+) and without (PR−) cuff pressure regulator. *** $p < 0.0001$

Compliance with ethical standards

Conflicts of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

References

1. Kleinman ME, de Caen AR, Chameides L, Atkins DL, Berg RA, Berg MD et al (2010) Part 10: pediatric basic and advanced life support: 2010 International consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations. *Circulation* 122:S466–S515
 2. Krishna SG, Ramesh AS, Jatana KR, Elmaraghy C, Merz M, Ruda J et al (2014) A technique to measure the intracuff pressure continuously: an in vivo demonstration of its accuracy. *Paediatr Anaesth* 24:999–1004
 3. Duguet A, D'Amico L, Biondi G, Prodanovic H, Gonzalez-Bermejo J, Similowski T (2007) Control of tracheal cuff pressure: a pilot study using a pneumatic device. *Intensive Care Med* 33:128–132
 4. Nseir S, Zerimech F, Fournier C, Lubret R, Ramon P, Durocher A et al (2011) Continuous control of tracheal cuff pressure and microaspiration of gastric contents in critically ill patients. *Am J Respir Crit Care Med* 184:1041–1047
 5. Weiss M, Dullenkopf A, Fischer JE, Keller C, Gerber AC (2009) Prospective randomized controlled multi-centre trial of cuffed or uncuffed endotracheal tubes in small children. *Br J Anaesth* 103:867–873
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