Neonatal Ventilator Associated Pneumonia: Is Infection Control Enough?

Anouk Goerens¹, Dirk Lehnick², Michael Büttcher^{1,3}, Karin Daetwyler^{1,4}, Matteo Fontana^{1,4}, Petra Genet^{1,4}, Marco Lurà^{1,5}, Davide Morgillo^{1,4}, Sina Pilgrim^{1,4}, Katharina Schwendener-Scholl^{1,4}, Nicolas Regamey^{1,5}, Thomas J. Neuhaus¹ and Martin Stocker^{1,4}

¹ Department of Pediatrics, Children's Hospital Lucerne, Switzerland, ²Clinical Trial Unit, University of Lucerne, Switzerland, ³ Infectious Diseases Unit, Children's Hospital Lucerne, ⁴ Pediatric and Neonatal Intensive Care Unit, Children's Hospital Lucerne, ⁵ Pediatric Pulmonology Unit, Children's Hospital Lucerne

Background: Neonatal ventilator associated pneumonia (VAP) is a common nosocomial infection and a frequent reason for empirical antibiotic therapy in NICUs¹⁻³. Nonetheless, there is no international consensus regarding diagnostic criteria and management^{4,5}. However, in most recommendations radiographic changes are considered as one of the main criteria. Infection control measures are described decreasing incidence of VAP^{6,7}.

Objectives: Compare numbers of suspected vs. confirmed neonatal VAP episodes in our unit according to different published criteria. Analyze interrater-reliability of chest x-rays. Evaluate the development of VAP incidence and antibiotic use after implementation of antimicrobial stewardship and infection control measures (VAP-prevention-bundle, early-extubation policy, antimicrobial stewardship rounds).

Conclusions:

- Diagnosis of neonatal VAP is difficult, resulting in a great variance between suspected and confirmed episodes.
- Incidence of suspected VAP and concomitant antibiotic use is much higher than for confirmed VAP, highlighting the need for antimicrobial stewardship measures.
- Implementation of combined antimicrobial stewardship and infection control measures may lead to an effective decrease in VAP incidence and antibiotic use.

Fig. 1: Annual VAP incidence and antibiotic days

Fig. 2: Duration of antibiotic treatment (antibiotic days/VAP episode)

	2015	2016	2017
Newborns, n	302	299	291
Preterm infants <32 weeks of gestation, n (%)	63 (20.9%)	76 (25.4%)	82 (28.2%)
Preterm infants <28 weeks of gestation, n (%)	22 (7.3%)	23 (7.7%)	26 (8.9%)
Mechanically ventilated newborns, n (%)	97 (32.1%)	82 (27.4%)	82 (28.2%)
Ventilation days, n	730	436	404
Duration (days) of mechanical ventilation (mean)	7.5	5.3	4.9
Newborns with CPAP, n (%)	185 (61.3%)	199 (66.6%)	244 (83.8%)
CRIB II - Score	6.5 (+/- 2.8)	6 (+/- 2.8)	5.7 (+/- 2.5)
Hospitalization days, n	1968	1622	1622
Mortality newborns, n (%)	10 (3.3%)	6 (2%)	5 (1.7%)
Mortality preterm infants <32 weeks of gestation, n (%)	6 (9.5%)	3 (3.9%)	3 (3.7%)
Mortality preterm infants <28 weeks of gestation, n (%)	5 (22.7%)	3 (13%)	3 (11.5%)

Table 1: Characteristics of the NICU's population

Methods: Neonates until 44 weeks of gestation with suspected VAP, hospitalized at our level-III NICU in Lucerne from 09/2014 to 12/2017 were enrolled. Suspected VAP episodes were analyzed according to 4 diagnostic frameworks⁸⁻¹⁰. Agreement regarding chest x-ray interpretation done by 10 senior physicians was assessed. Annual incidence of suspected and confirmed neonatal VAP episodes and antibiotic days were calculated and compared for the years 2015, 2016 and 2017.

Results: Comparison of suspected vs. confirmed VAP episodes showed a great variance (20.4 vs. 4.5/1,000 ventilator-days). The interrater-reliability of x-ray interpretation was poor (intra-class correlation 0.25). Implemented changes resulted in a gradual decline in annual VAP incidence and antibiotic days from 2015 to 2017 (see Fig. 1). Duration of antibiotic treatment of suspected VAP episodes also declined over the years (Fig. 2). Characteristics of the NICU's patient population for 2015–2017 are shown in Table 1.

Fig. 3: Possible algorithm to approach suspected VAP

Discussion: Incidence of VAP is often used as quality indicator and the insecurity regarding diagnosis is a potential bias¹¹. This demands an adaption of current diagnostic criteria for the neonatal population. Fig. 3 shows a possible algorithm to approach suspected VAP.

¹Willson et al., *Pediatr Crit Care Med.* (2017) 18:e24–34. ²Cantey et al., *Lancet Infect Dis.* (2016) 16:1178–84. ³Cantey et al., *Pediatr Infect Dis J.* (2015) 34:267–72. ⁴Cernada et al., *Neonatology* (2014) 105:98–107. ⁵Bradley et al., *Clin Infect Dis.* (2010) 51(Suppl. 1):S136–43. ⁶Azab et al., *BMC Infect Dis.* (2015) 15:314. ⁷Weber, *Adv Neonatal Care* (2016) 16:178–90. ⁸van der Zwet et al., *J Hosp Infect.* (2005) 61:300–11. ⁹<https://www.cdc.gov/nhsn/pdfs/pscmanual/6pscvapcurrent.pdf>. ¹⁰<https://ecdc.europa.eu/sites/portal/files/media/en/publications/Publications/0512- TED- PPS- HAI-antimicrobial-use-protocol.pdf>. ¹¹Cordero et al., *Am J Infect Control* (2002) 30:32–9.