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VENTILATOR ASSOCIATED PNEUMONIA

Incidence of VAP

Pneumonia (VAP) is defined as nosocomial pneumonia in mechanically ventilated Ventilator-Associated patient that develops more than 48 hours after initiation of mechanical ventilation. VAP is the second most common hospital -acquired infection among neonatal intensive care unit patients 41.3%

Incidence of VAP 8.1 to 57.1 %

Bizaro et Al seminars in perinatology2012 : 36

NICU VAP rates In the range upto 37.2 per 1,000 ventilator days.

Garland Et Al 2010 clinic in perinatology 2010:37

Coffin Et Al 2008 infection control hospital epidemiology

Cernada Et Al Neonatlogy update 2014 :105

VAP rates were highest for the 1,001- to 1,500-g and<1,000-g birth weight categories.

Apisarnthanarak Et Al 2003 : 112 Pediatrics

Risk factors in VAP

Length of stay in NICU	OR 23.45
Reintubation	OR 9.18
Enteral feeding	OR 5.59
Mechanical Ventilation	OR 4.04
Low birth weight	OR 3.16
Premature infants	OR 2.66
BPD	OR 2.21
Tracheal intubation	OR 1.12

Bin tan European journal of Paediatrics 2014 : 173

Opiate Use in sedation

Blood stream infection

Steroid use

Cernada Et Al Neonatology 2014 2014:105

Risk factors in developing countries

- Prematurity(<28 wks)
- Birth weight (<1500grms)
- Poor immunity ()
- Duration of ventilation ()
- Reintubation
- Duration of NICU stay
- Hand hygiene compliance
- Ventilator related infection control measures

EVIDENCE BASED ANALYSIS OF VAP IN ELBW

Univariate Analysis of Extremely Preterm Intubated Neonates With and Without VAP

Factors Associated With VAP	VAP (n = 19), n (%)	No VAP (n = 48), n (%)	P* Value
Male	8 (42)	22 (46)	1.00
White	8 (42)	19 (40)	.85
Congenital heart diseases†	5 (26)	6 (13)	.27
Patent ductus arteriosus	10 (53)	24 (50)	.78
Respiratory distress syndrome	19 (100)	48 (100)	NA
Patent ductus arteriosus ligation	9 (47)	24 (50)	.84
Surfactant	19 (100)	48 (100)	1.00
Dexamethasone	3 (16)	14 (30)	.36
Indomethacin	9 (47)	21 (44)	.78
Histamine 2 receptor blockers	8 (42)	23 (48)	.68
Intravenous gamma globulin	5 (26)	6 (13)	.27
Skin lubricant (Aquaphor)	19 (100)	44 (92)	.57
Lipid emulsion	19 (100)	48 (100)	NA
Total parenteral nutrition	19 (100)	48 (100)	NA
Previous BSI‡	12 (63)	15 (31)	.02‡
Central venous catheters	17 (89)	43 (89)	1.00
Arterial catheters	9 (47)	14 (29)	.17
SNAP-PE (median; d)§	47 (20–69)	42 (7–70)	.15
No. of intubation attempts (median [range])§	4 (2–12)	4 (1–13)	.87
Duration of intubation (median; d)§	50 (5–160)	32 (2–110)	.06
Outcomes			
NICU LOS (median; d)§	138 (13–361)	82 (8–197)	.003
Death	9 (47)	9 (19)	.03

Apisarnthanarak Et Al 2003 : 112 Pediatrics

EVIDENCE BASED ANALYSIS OF VAP IN ELBW

Univariate Analysis of Factors Associated With Death in Extremely Preterm Intubated Patients

Factors Associated With Death	Nonsurvivors (n = 18), n (%)	Survivors (n = 49), n (%)	P* Value
Male	11 (61)	19 (39)	.26
White	6 (33)	21 (43)	.48
Congenital heart diseases	3 (17)	8 (16)	1.00
PDA	10 (56)	24 (49)	.63
RDS	18 (100)	49 (100)	NA
PDA ligation	9 (50)	24 (49)	1.0
Surfactant	18 (100)	49 (100)	NA
Dexamethasone†	10 (56)	44 (82)	.03
Indomethacin	9 (50)	21 (43)	.78
Histamine 2 receptor blockers	7 (39)	24 (49)	.58
Intravenous gamma globulin	4 (22)	7 (14)	.47
Skin lubricant (Aquaphor)	18 (100)	45 (92)	.57
Lipid emulsion	18 (100)	49 (100)	NA
Total parenteral nutrition	18 (100)	49 (100)	NA
BSI	7 (40)	20 (40)	1.00
Central venous catheters	18 (100)	42 (86)	.27
Arterial catheters	10 (56)	13 (27)	.04
VAP	10 (56)	9 (18)	.03
SNAP-PE (median [range])‡	54 (10–65)	48 (24–69)	.04

Apisarnthanarak Et Al 2003 : 112 Pediatrics

Description of the most relevant features of studies published in relation to VAP in the neonatal period

Description of the most of studies published in relation to VAP in the neonatal period

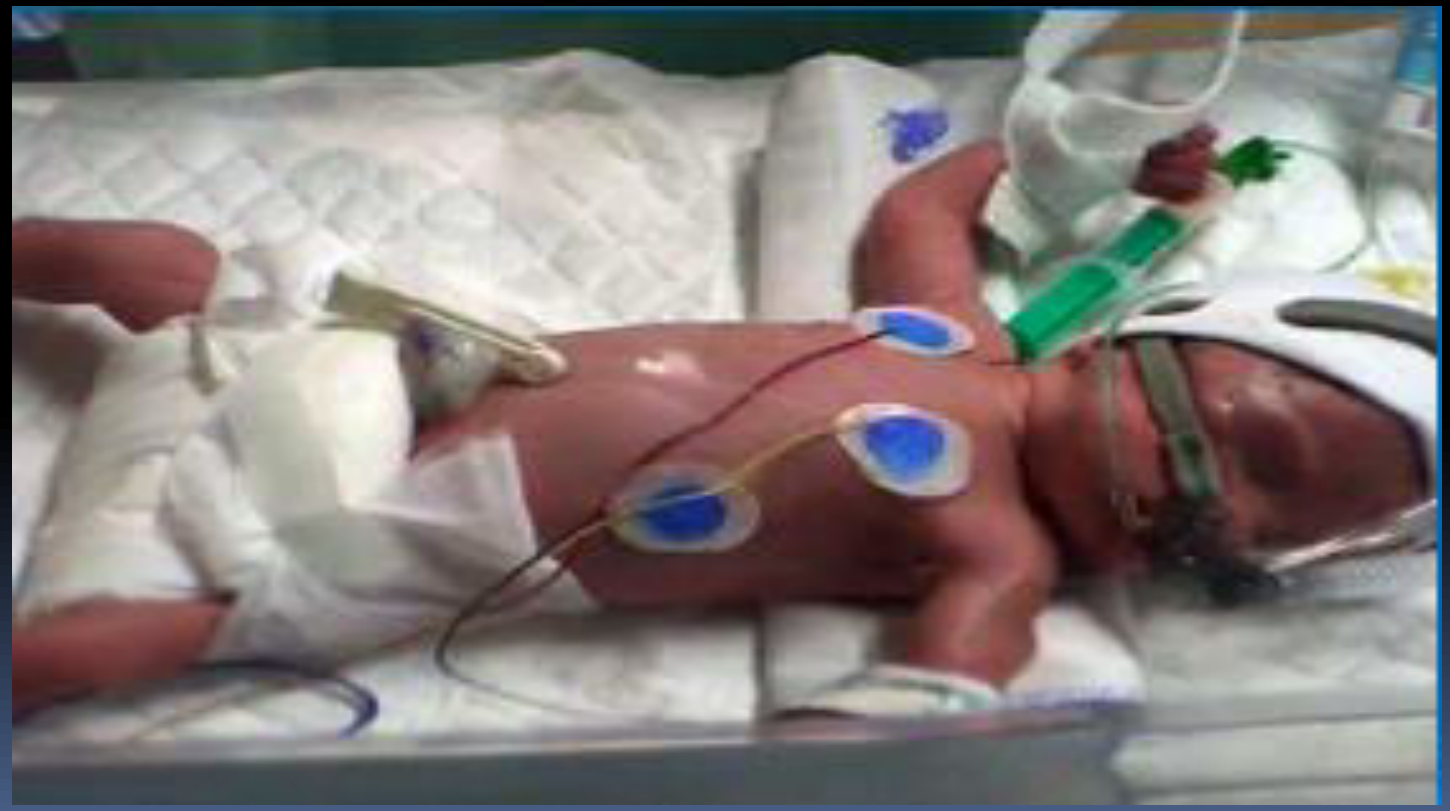
	Afjeh et al. [12]	Apisarnthanarak et al. [13]	Cernada et al. [10]	Deng et al. [18]	Geffers et al. [14]	Tripathi et al. [11]	Yuan et al. [15]
Study design	Prospective cohort	Prospective cohort	Prospective cohort	Retrospective case-control	Prospective surveillance	Prospective cohort	Retrospective cohort
Population	Newborn; MV >48 h	BW <2,000 g; MV >48 h	Newborn; MV >48 h	Newborn; MV >48 h	BW <1,500 g; MV >48 h	Newborn; MV >48 h	Newborn; MV >48 h
Diagnostic criteria	Radiographic Clinical	Radiographic Need for antibiotics	Radiographic Clinical Microbiologic (BAL)	CDC criteria for infants aged <1 year [7]	Radiographic Clinical Analytical	CDC criteria for infants aged <1 year [7]	Radiographic Clinical Purulent secretions
Incidence[1]	11.6 episodes	<28 weeks: 6.5 episodes >28 weeks: 4 episodes	10.9 episodes	Prevalence: 33.5%	2.7 episodes	37.2 episodes	Prevalence: 20.1%
Sampling method	ET aspirate	ET aspirate	Blind-protected BAL	ET aspirate	Not provided	ET aspirate	ET aspirate
Most common pathogen (mono-polymicrobial)	*E. coli* *K. pneumoniae*	*Pseudomonas* spp. *Enterobacter* spp. Polymicrobial 58%	*P. aeruginosa* *S. aureus* Polymicrobial 16.7%	*Klebsiella* spp. *A. baumanii* Polymicrobial 24.8%	CONS *S. aureus*	*K. pneumonia* *E. coli* Polymicrobial 6%	*K. pneumoniae* *P. aeruginosa*
Outcome	Not provided	Increased mortality Increased LOF	Increased LOF	Not provided	Not provided	Increased mortality Increased LOF	Increased LOF

[1] Expressed as episodes per 1,000 ventilator days. BW = Birth weight; ET = endotracheal; LOF = length of stay; CONS = coagulase-negative staphylococci.

Cernada /Brugada /Golombek /Vento Neonatology 2014;105

Newborn Immune Responses

LOWER IMMUNOGLOBULIN LEVELS
COMPLEMENT ACTIVITY DECEASED
GRANULOCYTE CHEMOTAXIS AND KILLING ACTIVITY REDUCED
SKIN AND MUCOUS MEMBRANES HAVE INCREASED PERMEABILITY



CDC Diagnostic Criteria below 1 year

Diagnostic criteria for VAP in infants younger than 1 year

Radiological signs	Patient with one or more (in patients with underlying diseases two or more) chest X-rays with one of the following findings: – new or progressive and persistent infiltrate – consolidation – cavitation – pneumatoceles
Clinical signs and symptoms	Worsening of gas exchange [e.g. oxygen desaturations (e.g. pulse oximetry <94%), increased oxygen requirements, or increased ventilation demand] and three of the following: – temperature instability with no other recognized cause – leukopenia (<4,000 WBC/mm^3) or leukocytosis (>15,000 WBC/mm^3) and left shift (>10% band forms) – new onset of purulent sputum, or change in the character of sputum, or increase in respiratory secretions, or increased suctioning requirements – apnea, tachypnea, nasal flaring with retraction of chest wall or grunting – wheezing, rales, or rhonchi – cough – bradycardia (<100 beats/min) or tachycardia (>170 beats/min)
Microbiolocical findings	At least one of the following: – positive growth in blood culture not related to another source of infection – positive growth pleural fluid culture – positive quantitative culture from a minimally contaminated LRT specimen [e.g. BAL (≥10^4 CFU/ml) or protected specimen brushing (≥10^3 CFU/ml)] – ≥5% BAL-obtained cells contain intracellular bacteria on direct microscopic examination (e.g. Gram stain) – histopathological exam shows at least one of the following criteria for pneumonia: abscess formation or foci of consolidation with intense PMN accumulation in bronchioles and alveoli, positive quantitative culture of lung parenchyma (≥10^4 CFU/g tissue), or evidence of lung parenchyma invasion by fungal hyphae or pseudohyphae

WBC = White blood cells; LRT = lower respiratory tract; CFU = colony-forming units.

Microbiological criteria

Bronchoscopic Bronchoalveolar Lavage

Non Bronchoscopic Bronchoalveolar Lavage

1) 25 polymorphonuclear leukocytes/ hpf;

2) More than 2% inflammatory cells;

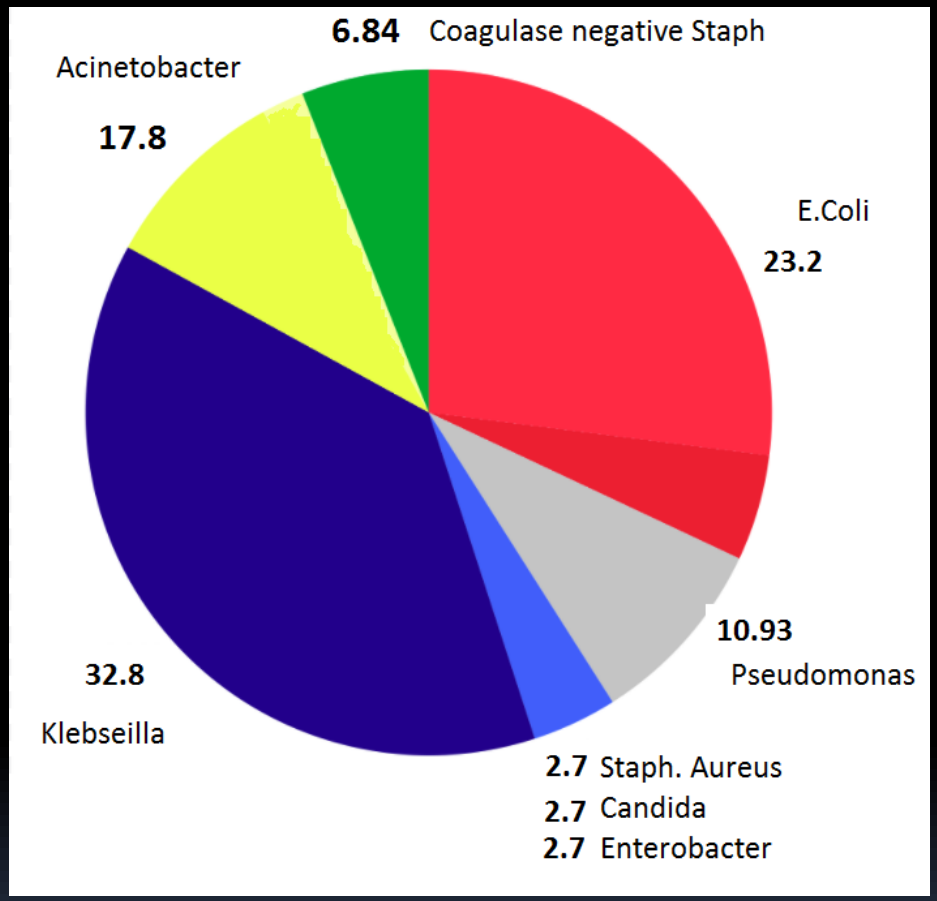
3) Presence of polymorphonuclear leukocyte cells with intracellular organisms (ICO) ranging from 2–10%

Cordero L, Sananes M, Dedhiya P, et al: Purulence and Gram-negative bacilli in tracheal aspirates of mechanically ventilated very low birth weight infants. J Perinatal 2001; 21:376.

VAP Diagnosis	Crit. Care Med 1999:27:2537-43	
Technique	Sensitivity (%) N=103	Specificity(%) N = 103
ET aspirate Culture	93	41
PSB Culture	69	95
BAL Culture	72	88
PSB & BAL Cultures, ICB	90	88

Utility of Gram staining:	J Perinatol 2010: 30:270-4	
	Gram Positive cocci (%)	Gran Negative rods (%)
Sensitivity	82	100
Specificity	100	82

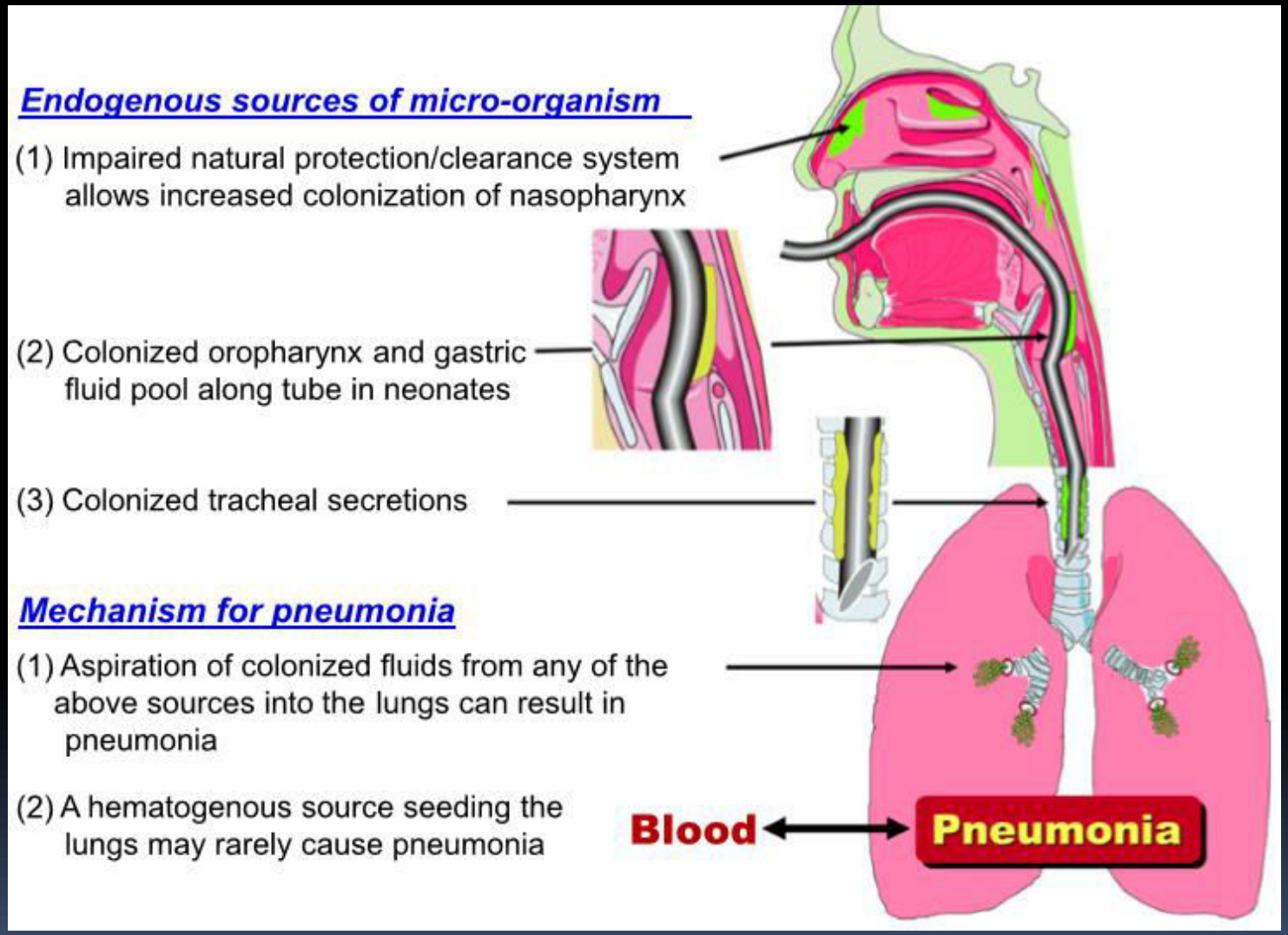
Organisms Isolated In VAP



Tripathi et al / Study of Ventilator Associated Pneumonia in Neonatal Intensive Care Unit Internet Journal of Medical Update 2010 January;5(1):12-19

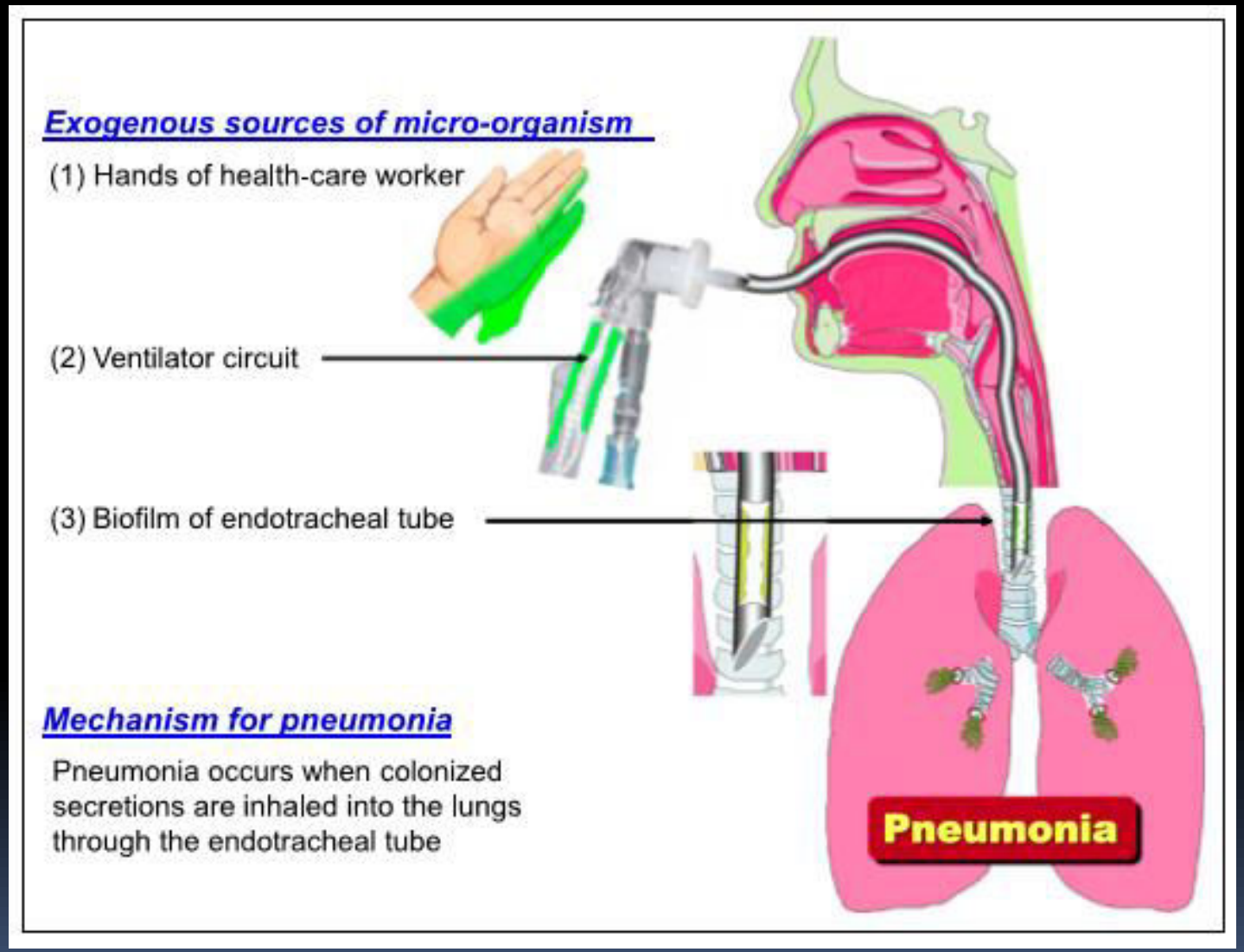
Internet Journal of Medical Update 2010 January;5(1):12-19

Pathogenesis of VAP



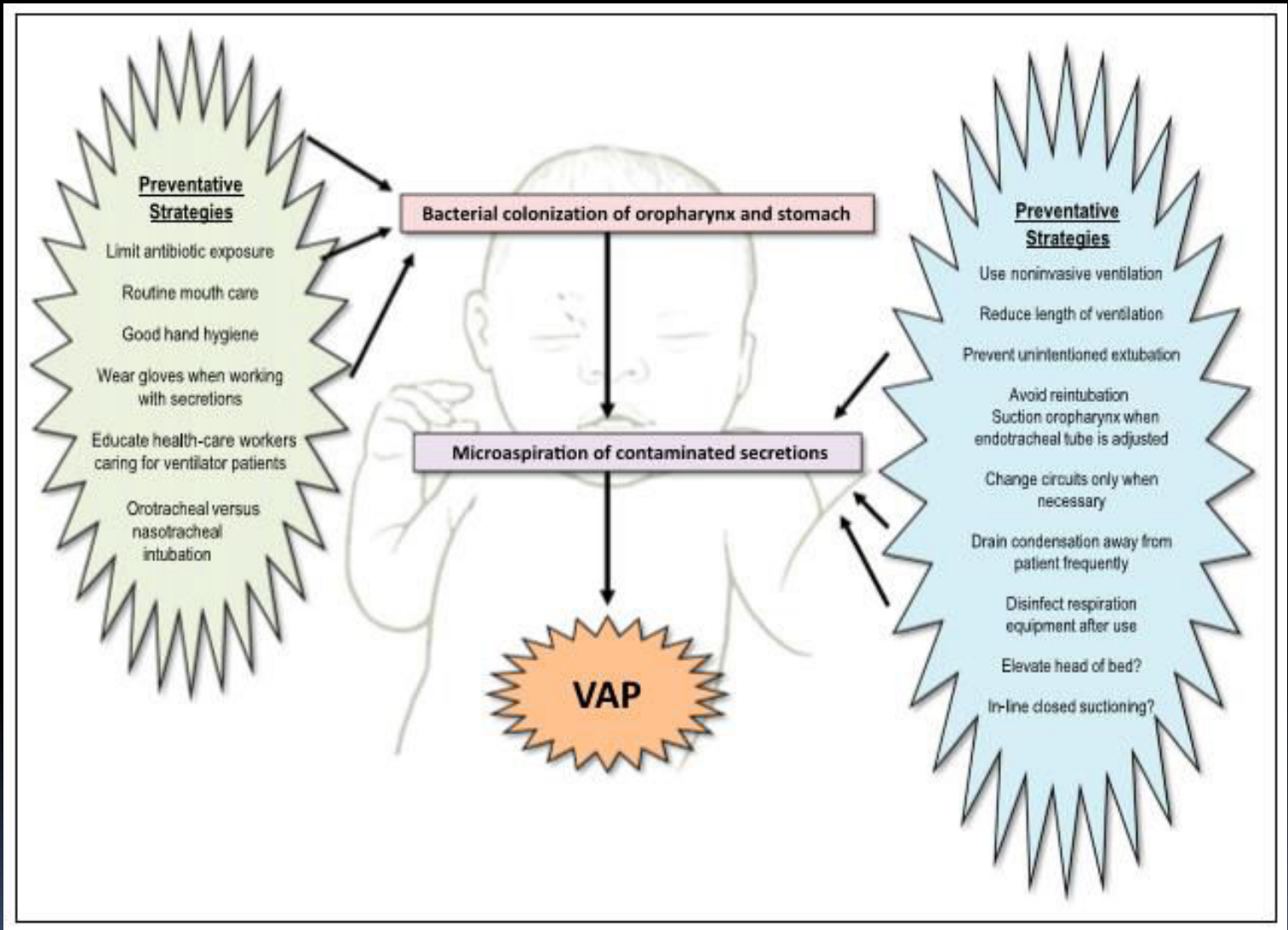
Endogenous sources of organisms responsible for ventilator-associated pneumonia (VAP). (Courtesy of Walt Earhart, Wheaton Franciscan Healthcare. From: NeoreviewsPlus August 2010.

Pathogenesis of VAP



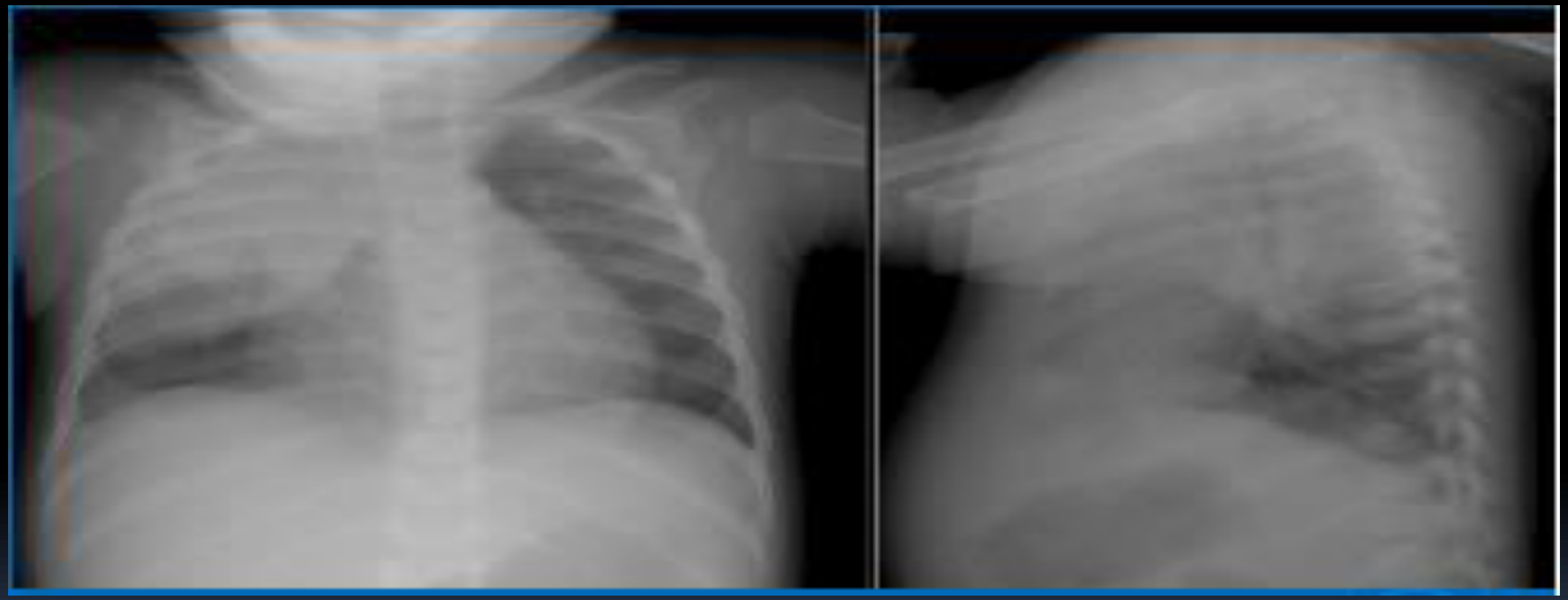
Exogenous sources of organisms responsible for ventilator-associated pneumonia (VAP). (Courtesy of Walt Earhart, Wheaton Franciscan Healthcare. From: NeoreviewsPlus August 2010.

Relationship between preventative measures and pathogenesis of ventilator-associated pneumonia (VAP).



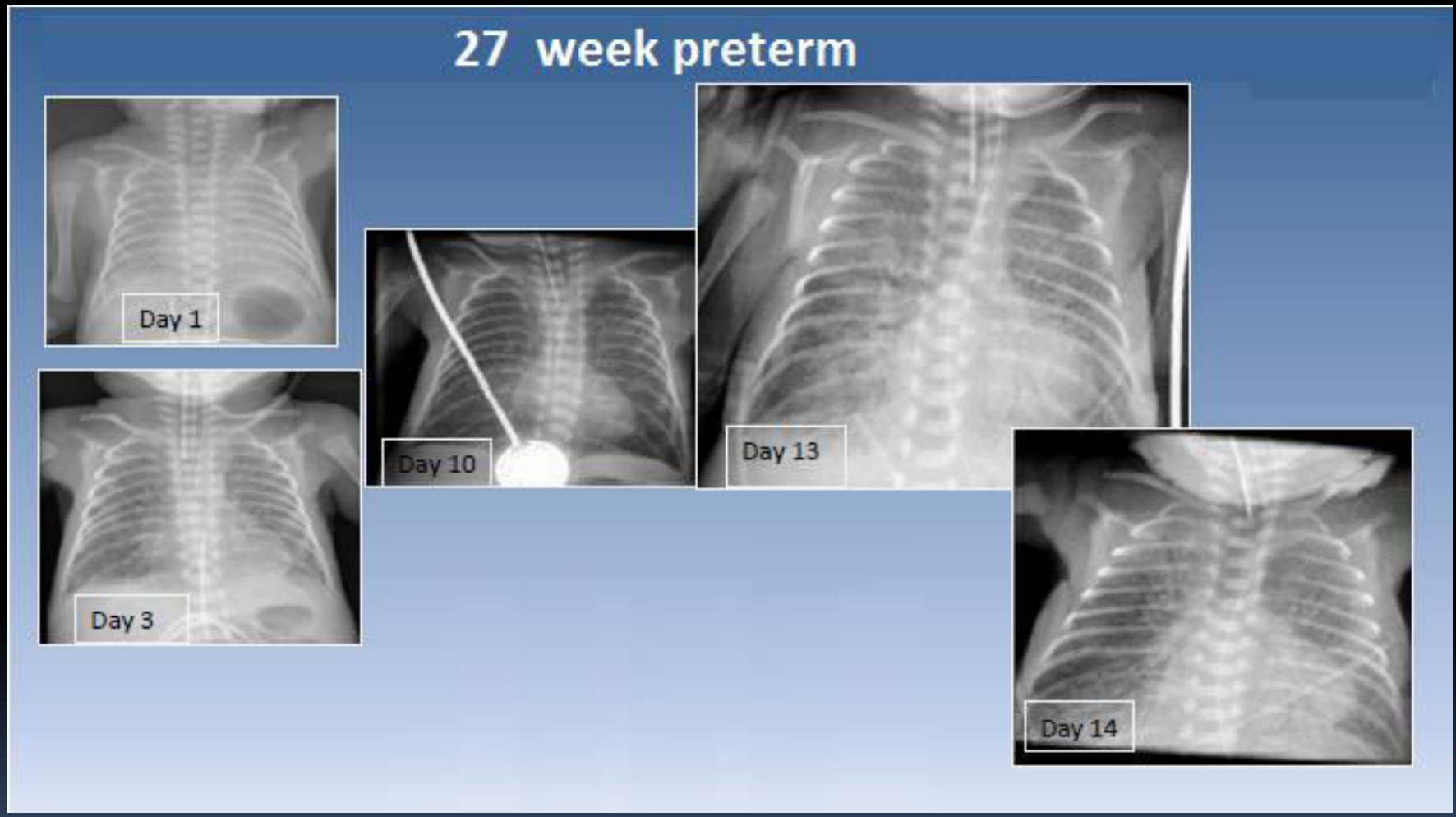
Adapted from Garland JS. Strategies to prevent ventilator-associated pneumonia in neonates. Clin Perinatol. 2010;37(3):638. Copyright 2010.

Radiological Features



New or progressive infiltrate : air bronchogram specificity
Consolidation
Cavitations or pneumoceles

Radiological Features



New or progressive infiltrate : air bronchogram specificity
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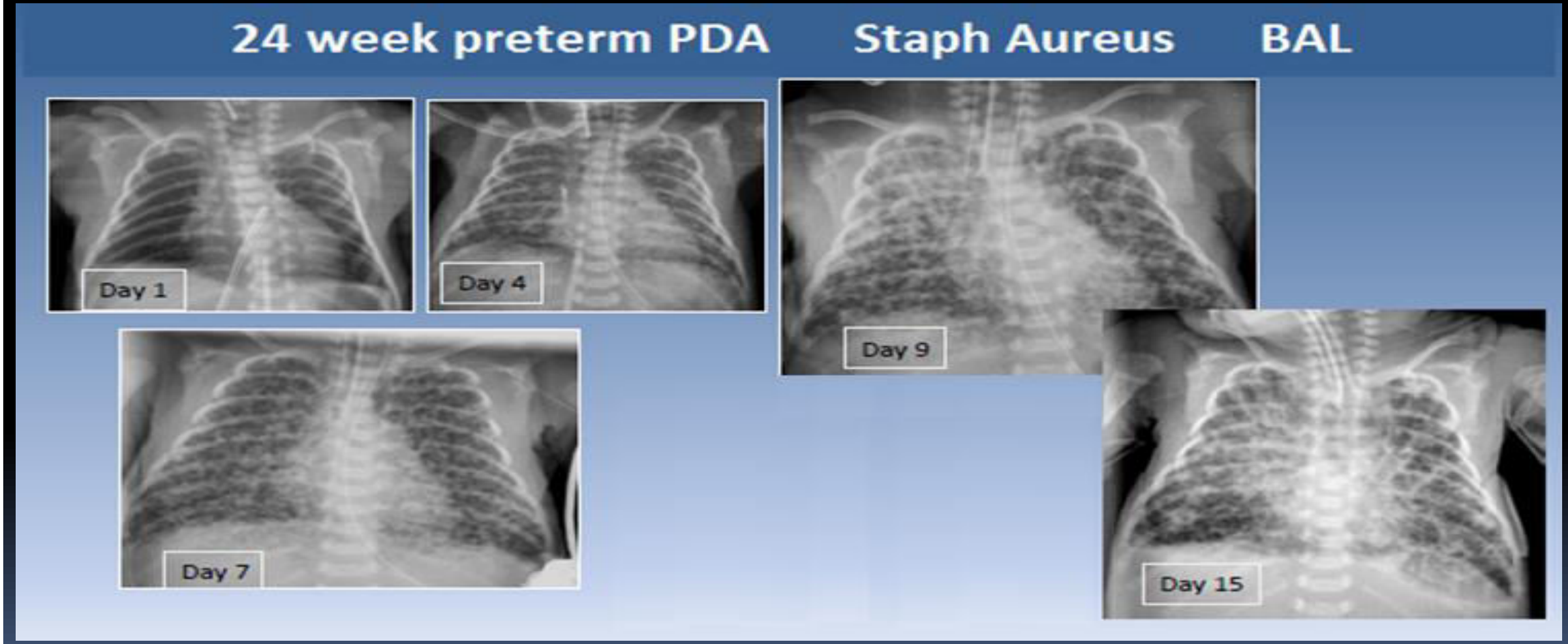


VAP care bundle approach

In December 2004, the Institute for Healthcare Improvement (IHI) challenged hospitals to save 100,000 lives by June 2006

The team approach using the IHI bundle has been shown to be successful in reducing VAP

ZAP VAP

Curley, M. A., et al 2006. Tailoring the Institute for Health Care Improvement 100,000 Lives Campaign to pediatric settings : The example of ventilator-associated pneumonia.

VAP care bundle

- Hand hygiene
- Oral hygiene
- Suction technique
- HOB elevated 30 degrees or hig position
- Stress Ulcer Prophylaxis
- Off sedation
- Daily Assessment of readiness to wean

Comprehensive evidence based clinical practice guidelines for ventilator associated pneumonia: CDC 2004

Neonatal Ventilator-Associated Pneumonia: An Under diagnosed Problem in the Neonatal Intensive Care Units 2017 Saudi Arabia

The quality-of-evidence of these interventions with good impact on VAP rates

- Hand hygiene – Wearing gloves when in contact with secretions
- Minimizing days of ventilation by daily evaluation for readiness to be extubated to nasal continuous airway pressure –
- Preventing unplanned extubation by creating a uniform procedure for securing endotracheal tubes and avoid reintubation –
- Suctioning orophaynx
- Preventing gastric distension –
- Changing ventilator circuit only when visibly soiled or malfunctioning – Removing condensate from ventilator circuit frequently

Al –Alaiyan et al J Pediatr Neonatal Care 2017, 7(3): 00288

Neonatal Ventilator-Associated Pneumonia: An Under diagnosed Problem in the Neonatal Intensive Care Units 2017 Saudi Arabia

The following recommended interventions do not have clear benefit

- Oral care with antiseptic or colostrum –
- Elevation of head of bed 30-45degrees –
- In-Line (closed) suctioning

Al –Alaiyan et al J Pediatr Neonatal Care 2017, 7(3): 00288

Infrastructure & Staff training

Establish (VAP) quality improvement team in intensive care units and develop a protocol for prevention of VAP.

Integrate VAP prevention program to staff orientation & refreshment program in ICU/ HDU / ventilator wards.

Provide adequate coaching & supervision to staff on intubation & care of ventilated patients until they are competent to work independently.

Crowding And Under Staffing

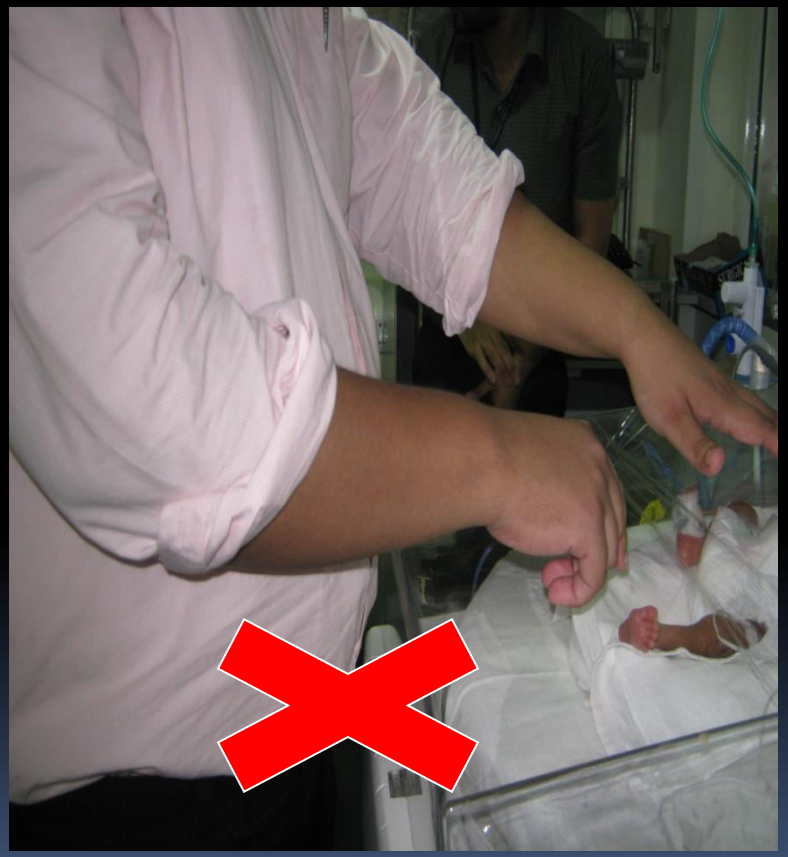
In a prospective study in 2011-2013 of Nosocomial infection, there was a significant drop in VAP Rate
When a move was made to a larger NICU with 50% more manpower and segregation of infected cases . The open bay concept was changed to laminar flow systems in the cubicle concept .

Air flow 0.5 micron or larger particle size
Less than 100,000 particles per cubic foot

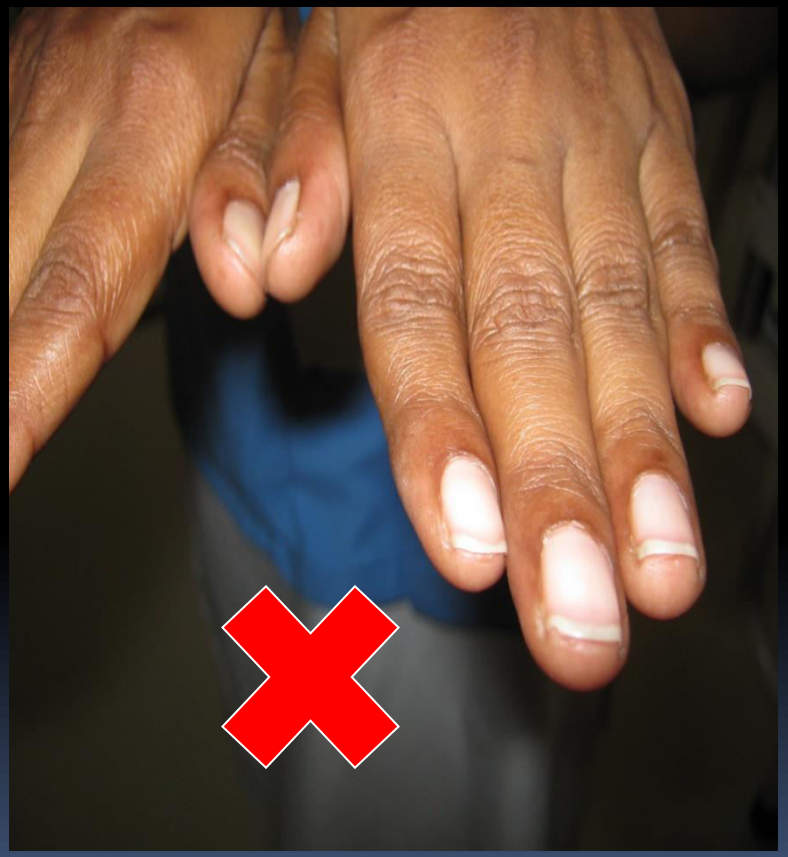
Nurse :baby Ratio 1:1 Ventilated ELBW
Nurse : Baby Ratio 1:2 Ventilated

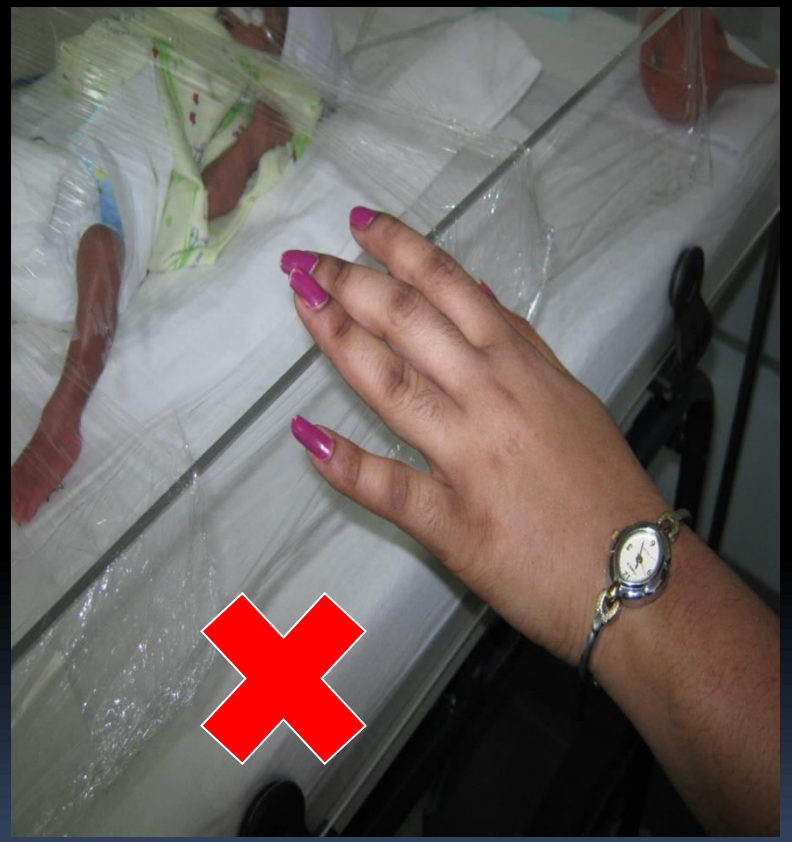
Zhou et al American Journal of Infection control 41 (2013) 1059-64

General care

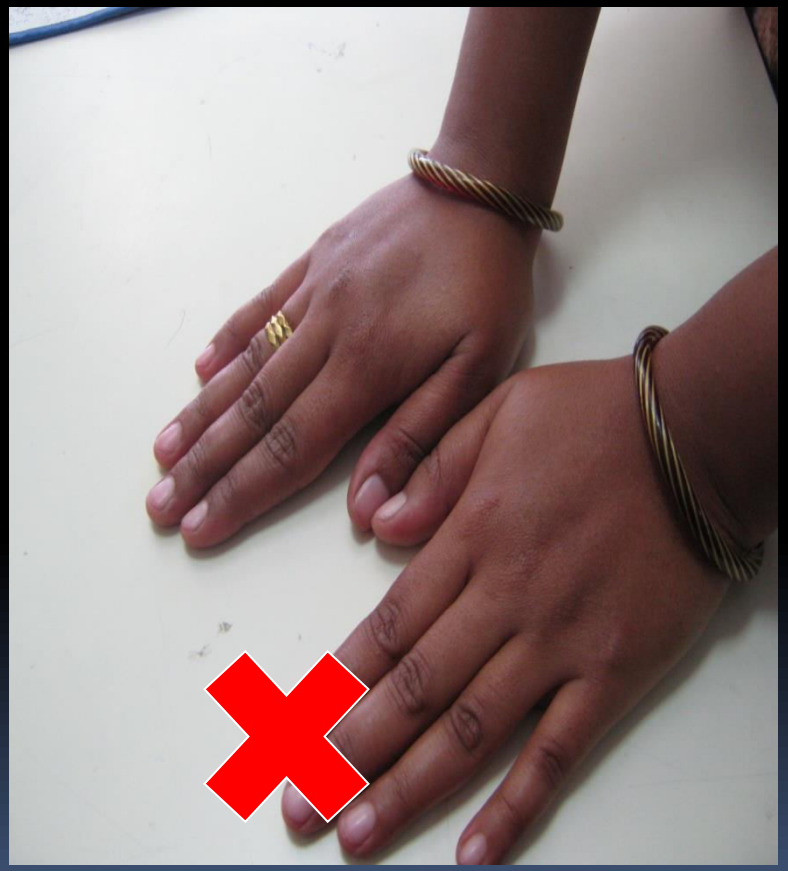


General care





General care

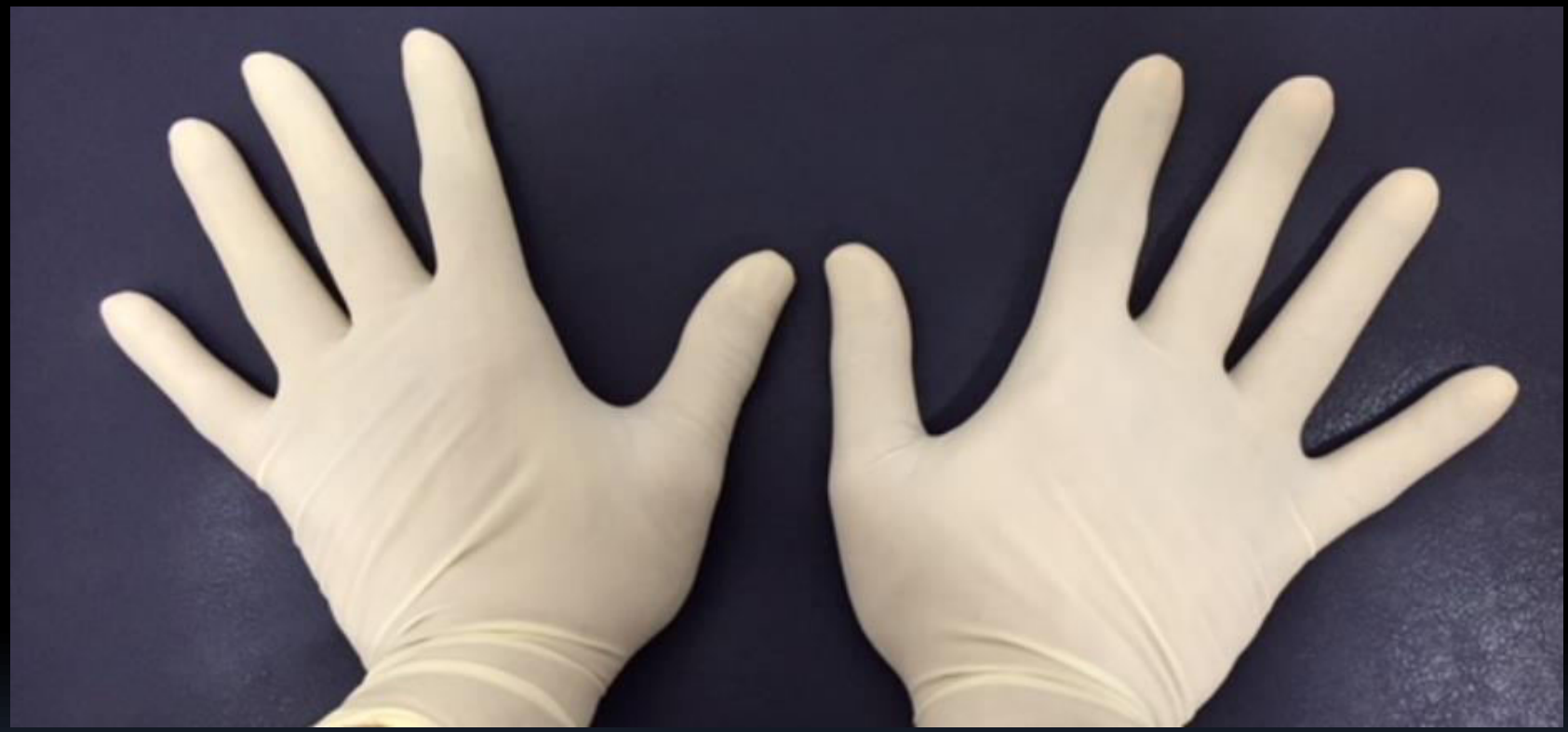


Non Sterile Gloves For General Care

Discard per baby per care

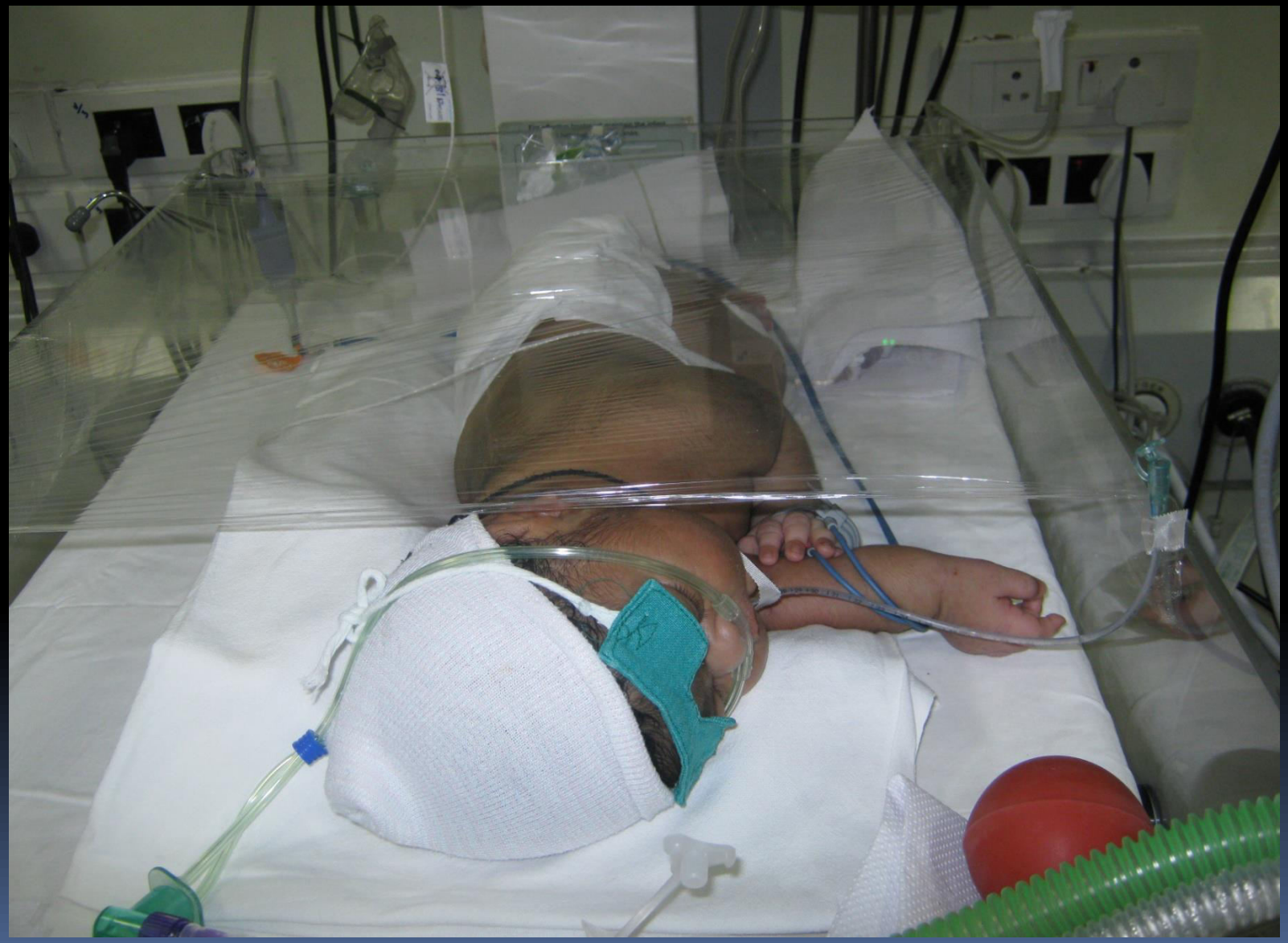
One intervention which could change the dynamics of HAI cycle

STERILE GLOVE FOR ALL VENTILATOR RELATED ACTIVITY

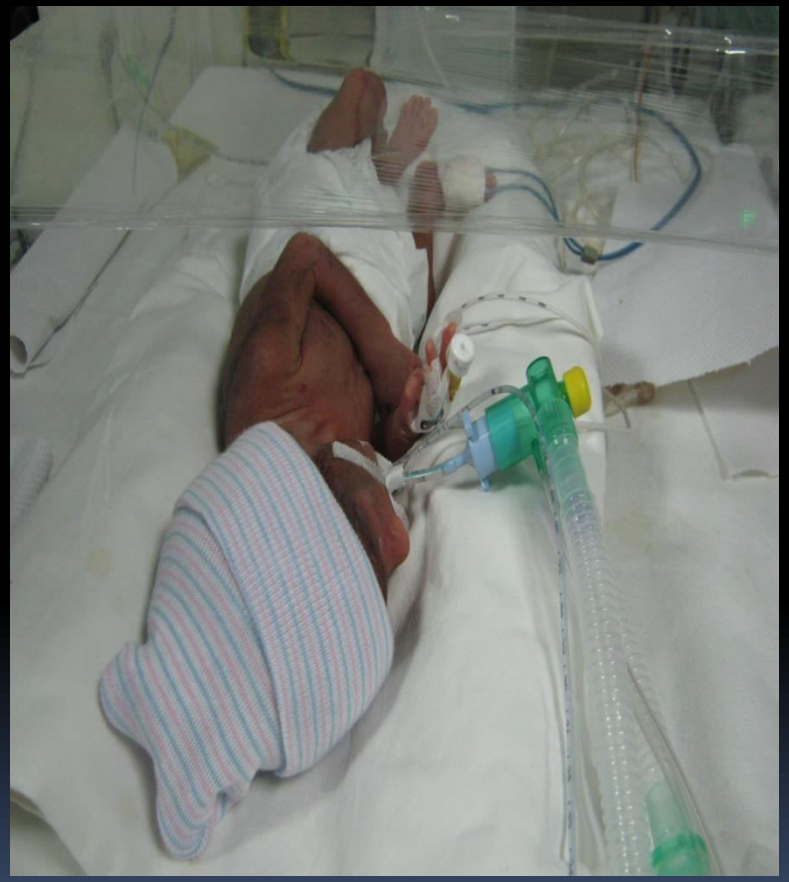


ET SUCTION , DRAINING CONDENSATE FROM VENTILATOR TUBING , POSITIONING BABY WITH ET TUBE

Position of infant



Position of infant



ORAL CARE

DOES APPLICATION OF ORAL CHLORHEXIDINE DECREASE THE INCIDENCE OF VENTILATOR ASSOCIATED PNEUMONIA IN NEONATES: A RANDOMIZED CONTROLLED TRIAL

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1Pediatrics, 2Microbiology, 3Radiodiagnosis, PGIMER, Chandigarh, India

Background and aim: Oral chlorhexidine (CHX) application decreases the incidence of ventilator associated pneumonia (VAP) in adults. This study aimed to determine the effectiveness of oral CHX application in decreasing the incidence of VAP in neonates.

Method: In this open-label controlled trial, neonates requiring endotracheal intubation for mechanical ventilation were randomly assigned to 'chlorhexidine' and 'no chlorhexidine' group. The CHX group received applications of CHX (0.2% w/v, Chlorhex Plus, Dr. Reddy's Laboratory, Hyderabad, India) every 8hrs from randomization until extubation, by a cotton applicator on the oral mucosa. The control group received standard care. The primary outcome was number of episodes of VAP per 1000 person-ventilation hours. VAP was defined using standard CDC criteria for infants < 1year of age.

Results: One hundred four neonates were enrolled (CHX =51, control=53). The mean gestation was 32.4±4 and 32.9±3.4weeks, while the median [IQR] age at intubation was 48.0 [26.0, 219.0] and 50.0 [13.0, 130.0] hours in CHX and control groups respectively. The incidence rate of VAP was 1.9 and 2.6 episodes per 1000 person-ventilation hours in CHX and control groups respectively [incidence rate difference = -0.7 (95% CI: - 2.5 to1.1, p = 0.4)]. No subject had local or systemic adverse reactions to CHX.

Conclusion: Oral application of CHX was well tolerated in neonates. However, it did not decrease the incidence of VAP significantly.

PROTOCOL RECOMMENDED WITH EVIDENCE

Neonatal VAP Prevention Protocol	
Neonatal VAP Prevention Component	**Supporting Evidence/Rationale**
Hand hygiene	
• Use meticulous hand hygiene before and after patient contact for oral care and handling respiratory equipment and supplies.	• Neonatal VAP rates have been reduced by approximately one-third with hand hygiene compliance. [34,35] • Contamination of the oral cavity by caregivers occurs during care practices such as tracheal suctioning and device manipulation.[2]
• Wear gloves when handling ventilator condensate and other respiratory/oral secretions.	• Evidence-supported strategies are for gloves to be worn when handling condensate from the ventilator and meticulous hand hygiene performed before and after handling respiratory equipment.[1,63]

Clinical Issues in Neonatal Care 2016 Applying Adult Ventilator-associated Pneumonia Bundle Evidence to the Ventilated Neonate
Carla D. Weber , MS, CCNS-Neonatal, RNC

Neonatal VAP Prevention Protocol

Neonatal VAP Prevention Component	Supporting Evidence/Rationale
ET intubation	
• Use a new sterile ET tube for each intubation attempt. • Ensure the tube does not touch the bed or other environmental objects before or during intubation attempts. • Use a sterilized laryngoscope.	• Cross-contamination risk can be reduced by using an aseptic technique and a sterile or disinfected equipment.[1,32,89]
• Use at least 2 NICU staff members for changing the ET tube tape or repositioning.	• To prevent accidental extubation, adequate staff levels must be maintained.[39,40]

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Neonatal VAP Prevention Protocol

Neonatal VAP Prevention Component	Supporting Evidence/Rationale
Suction practices	
• Clear secretions from the posterior oropharynx prior to: o ET tube manipulation (ie, retaping) or suctioning: o Repositioning patient o Extubation o Reintubation	• Secretions forming in the subglottic area are rapidly colonized with pathogenic bacteria.[11,36] • Hypopharyngeal suctioning before suctioning or repositioning the ET tube and/or the patient reduces risk of aspirating pooled oropharyngeal and nasopharyngeal secretions.[15,41,43]
• Use a closed ET tube suction system.	• Opening a closed-suction system may allow for dissemination of respiratory pathogens into the patient environment. NICU nurses report closed-suction systems to be easier, faster to use, and better tolerated by patients.[11,48,49]
• Suction an ET tube on an "as-needed" basis and avoid using normal saline.	• Normal saline does not thin or mobilize mucous, can adversely affect arterial and global tissue oxygenation, and can dislodge bacterial colonies.[50]

Clinical Issues in Neonatal Care 2016 Applying Adult Ventilator-associated Pneumonia Bundle Evidence to the Ventilated Neonate Carla D. Weber , MS, CCNS-Neonatal, RNC

Neonatal VAP Prevention Protocol

Neonatal VAP Prevention Component	Supporting Evidence/Rationale
Feeding	
• Prevent gastric distention: o Avoid bolus feedings o Check gastric residuals every 4 h and monitor abdominal girth. • Implement measures to prevent reflux (see the "Positioning" section)	• Intermittent or bolus feeds pose an increased risk of reflux because of intra-abdominal pressure and gastric overdistention.[1,58] • Avoid gastric distention and monitor residuals every 4 h in enterally fed patients to decrease the risk of aspirating gastric contents.[1,42]

Clinical Issues in Neonatal Care 2016 Applying Adult Ventilator-associated Pneumonia Bundle Evidence to the Ventilated Neonate Carla D. Weber , MS, CCNS-Neonatal, RNC

Neonatal VAP Prevention Protocol

Neonatal VAP Prevention Component	Supporting Evidence/Rationale
Positioning	
• Ensure patient is in the midline and lateral position while being mechanically ventilated as tolerated.[a]	• Neonatal tracheal colonization from oropharyngeal contamination has shown to be reduced from 87% in the supine position to 30% in the lateral position.[43,61]
• Keep HOB elevated as close as possible to 15°-30°.	• Maintaining at least 15° head elevation in neonates after ventilation correlates with less microaspiration of stomach contents.[54]
• For neonates with gastroesophageal reflux: o Elevate HOB as much as possible up to 30° o Ensure the left lateral position after feeding	• For neonates with reflux, keep HOB 30° and place in the left lateral position after feeding.[57,62]

Abbreviations: ET, endotracheal; HOB, head of bed;

Clinical Issues in Neonatal Care 2016 Applying Adult Ventilator-associated Pneumonia Bundle Evidence to the Ventilated Neonate Carla D. Weber , MS, CCNS-Neonatal, RNC

Neonatal VAP Prevention Protocol, Continued

Neonatal VAP Prevention Component	Supporting Evidence/Rationale
Oral care	
• Start oral care no later than 24 h after intubation.[a]	• Neonatal oral cavities are shown to be colonized within 24 h after birth.[18] • Intubated patients become colonized with oral pathogenic bacteria within 24 h of intubation.[11]
• Provide oral care with scheduled hands-on care: o Every 3-4 h o Prior to reintubation as time allows[a] o Prior to OG tube reinsertion[a]	• Evidence on adult and pediatric patients supports oral care performed every 2-4 h.[15,41,78,79] • Biofilm is identified on ET tubes on intubated neonates[72,75] and can be postulated to cover OG tubes. • Reintubation is a risk factor for VAP development.[8,36-38] • Biofilm load from the ET tube or OG surfaces could rub off onto the mouth/tongue during the removal process.
• Target known regions for bacterial proliferation such as the tongue, oral tissues, lips, ET tube, and OG tube using gentle scrubbing during the oral care procedure.[a]	• Biofilm forms on inert surfaces in the mouth, such as an ET or OG tube.[72,75] • Dry and cracked oral tissues, tongue, and lips provide regions for bacterial proliferation of species involved in VAP.[76]
• Conduct assessment of oral tissue, tongue, saliva, and ET/OG tube with oral care.[a]	• Oral assessment combined with oral hygiene has shown up to 50% decrease in VAP rates.[65,68]
• Use water-soluble moisturizer/sterile water to assist in the maintenance of healthy lips and gums.[a] o Avoid petroleum-based moisturizer if open wounds are present. o Avoid moisturizers containing alcohol and lemon-glycerin compounds.	• A water-soluble oral moisturizer allows tissue absorption and added hydration.[68,80] • Petroleum-based oral moisturizers may cause inflammation if open wounds are present, and they are not easily broken down for elimination if ingested or aspirated.[2,68] • Alcohol-containing oral moisturizers and lemon-glycerin compounds can cause excessive drying of oral tissues.[97]

Neonatal VAP Prevention Protocol

Oral Care Procedure for Ventilated Neonate

Key equipment

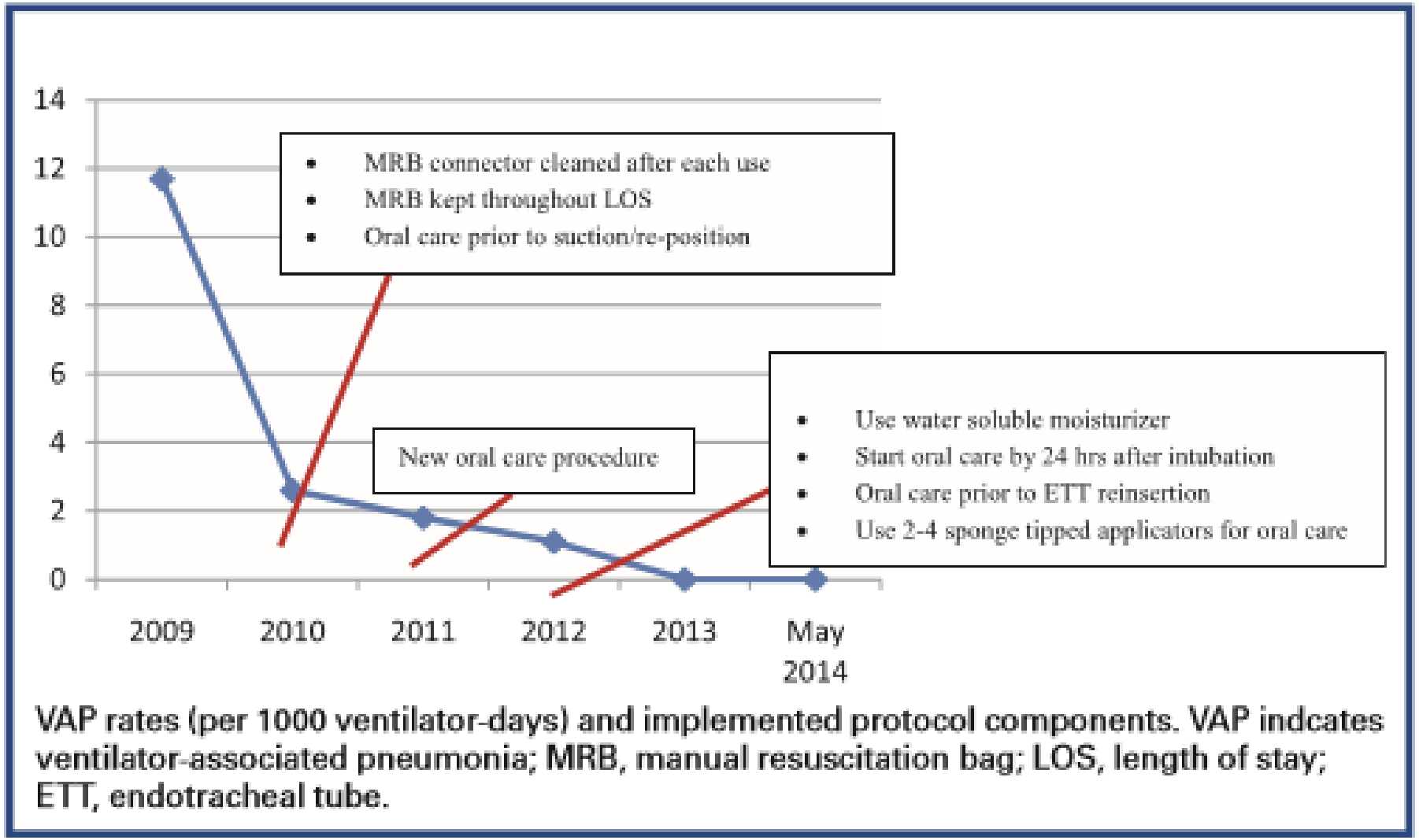
Oral suction catheter
4 Oral swab/sponge-tipped applicators
Sterile water
Sterile gauze
Gloves
Oral syringe for sterile water

Key steps

1. Perform hand hygiene and don clean gloves.
2. Ensure patient is in the side-lying/midline position.
3. Closely observe behavioral cues to determine oral swabbing time.
4. Dip sponge-tipped applicator/swab in sterile water.
5. Clean all 4 quadrants of gum surfaces and upper posterior part of the oropharynx (up to 30s gentle swabbing each quadrant). Rinse after each quadrant with up to 5 mL of sterile water dispensed via a syringe with continual aspiration with an oral suction device. Lightly scrub exterior surface of the ET tube/OG tube last with a new sponge-tipped applicator.
6. With a new sponge-tipped applicator dipped in sterile water, clean ventral and posterior surfaces of the tongue brushing with posterior to anterior movements up to 30 s.
7. With a new sponge-tipped applicator, lightly scrub exterior surface of the ET tube/OG tube last for up to 30 s working from posterior to anterior.
8. Use an applicator/swab to remove any mucous and rinse the swab in a sterile water bottle as needed.
9. Perform oropharyngeal suction again at the end of the procedure.
10. Clean exterior of the mouth with a sterile gauze and sterile water.
11. Reposition infant to the opposite side keeping the midline in the side-lying position after oral care is performed.
12. Repeat oral care every 3-4 hours with hands-on care.
13. Dispose of contaminated sterile water.
14. Change the suction catheter once every 24 h.

Abbreviations: ET, endotracheal; OG, orogastric.

VAP rates and implemented protocol components



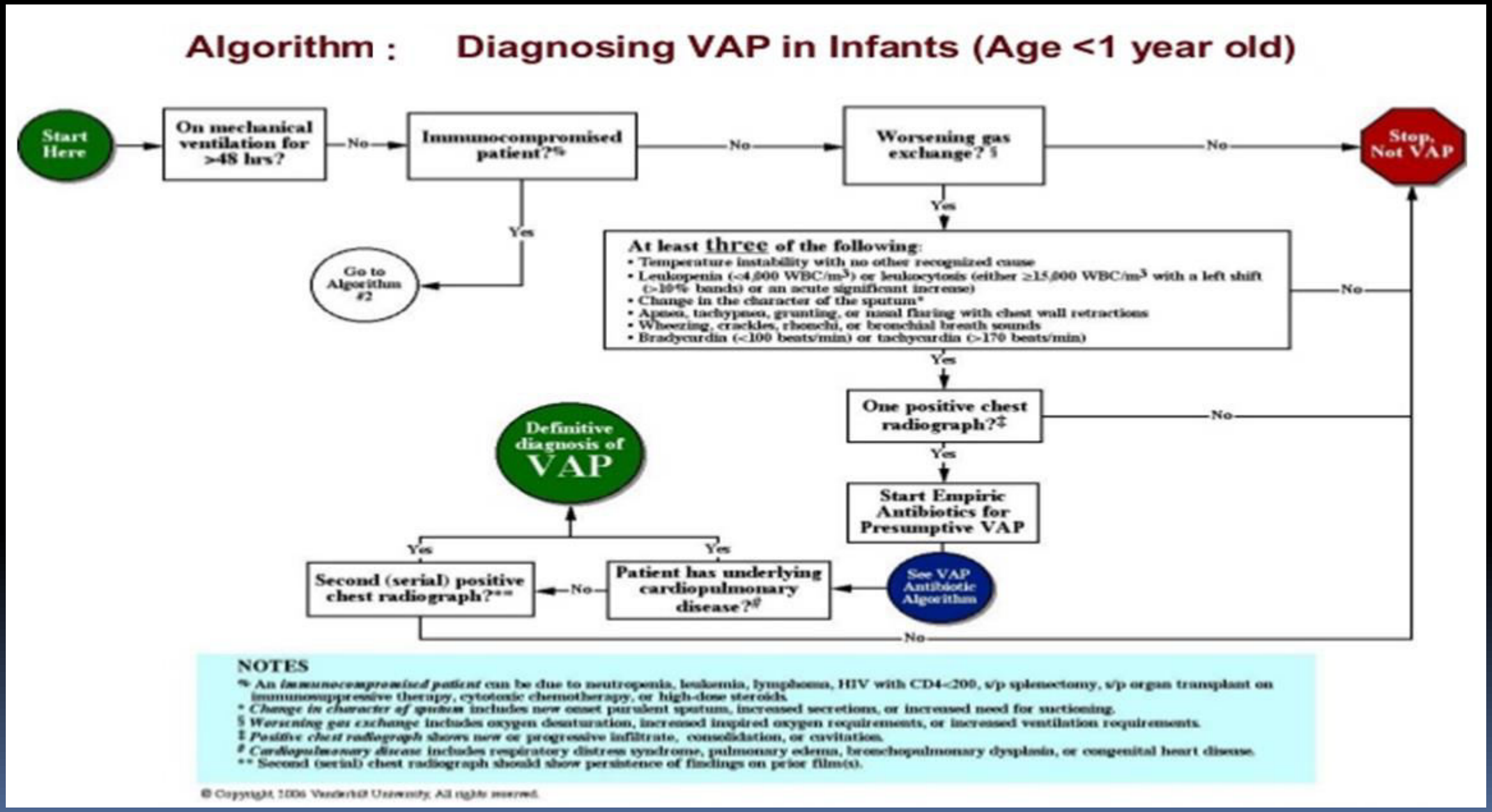
VAP rates (per 1000 ventilator-days) and implemented protocol components. VAP indcates ventilator-associated pneumonia; MRB, manual resuscitation bag; LOS, length of stay; ETT, endotracheal tube.

Advances in Neonatal Care • Vol. 16, No. 3

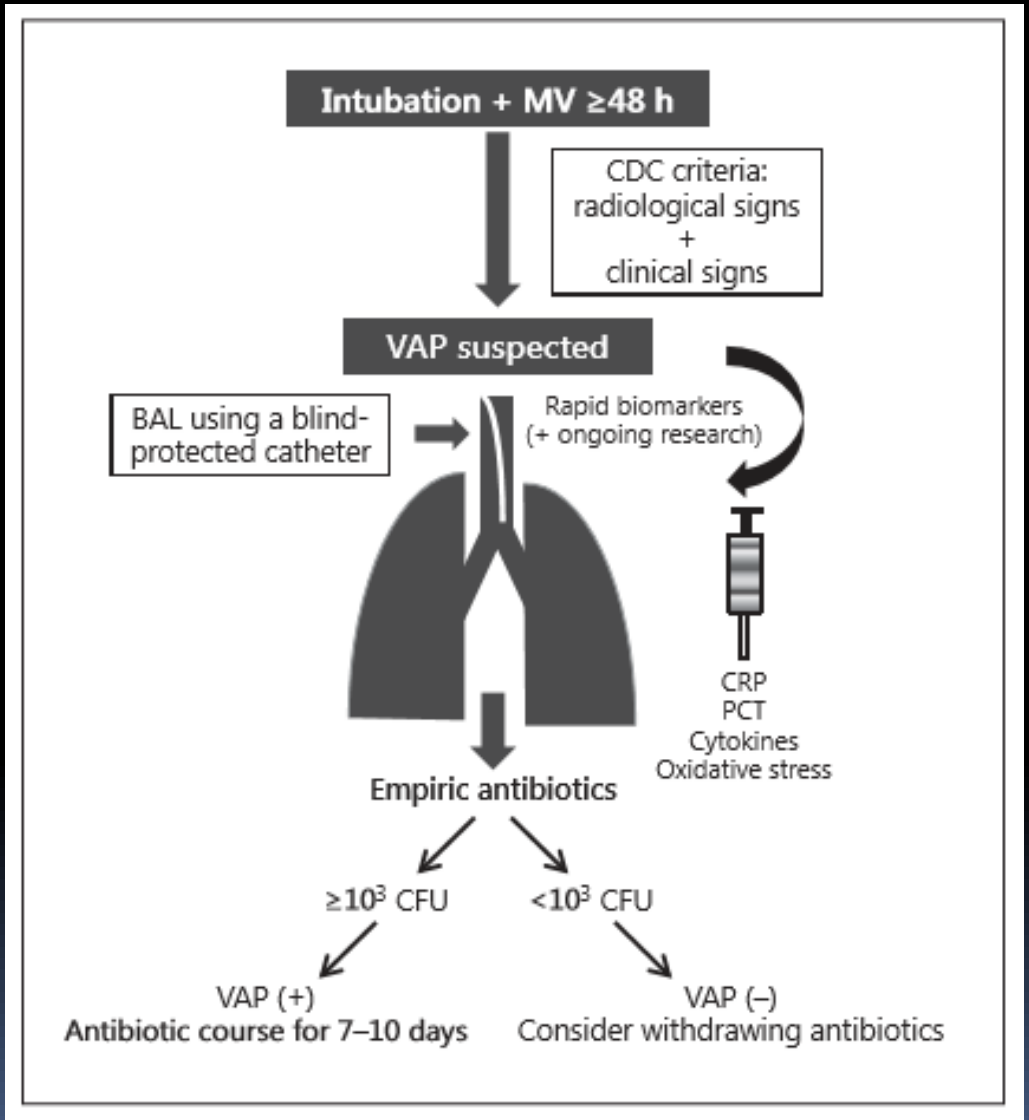
Treatment of VAP

Use of early, appropriate, and broad-spectrum antibiotics

CDC GUIDELINES FOR DIAGNOSING VAP



Diagnostic Algorithm For Neonatal VAP .



Cernada et al Neonatology 2014;105:98–107

Duration Of Antibiotic Therapy

Antibiotic therapy **Broad spectrum covering the prevelant multi drug resistant bacteria** should continue for a minimum of 7–14 days. Longer treatment may be warranted in cases of severe, persistent illness, or if there is concurrent infection beyond the lungs.

An adult study comparing 8- day and 15-day treatment of VAP found no significant difference in mortality or relapse rates.*

Cautionto be exercised in the subset of patients with VAP caused by Gram-negative, non-fermenting bacilli **(rods)** who received the 8-day course had higher relapse rates

A 10-day course of therapy is a reasonable starting point for uncomplicated pneumonia, which may be modified as circumstances require.

* Chastre J, Wolff M, Fagon J-Y, Chevret S, Thomas F, Wermert D, et al. Comparison of 8 vs 15 days of antibiotic therapy for ventilator-associated pneumonia in adults: a randomized trial. Jama 2003 Nov;290(19):2588–98.

TREATMENT OF VAP

The use of colistin in VAP caused by carbapenem resistant *Acinetobacter* species

Use of aerosolized antibiotics colistin

De-escalation of antibiotics based on patients' culture results and clinical improvement

Shorter duration of antibiotics for patients with uncomplicated VAP upto 8 days to prevent multidrug resistance

Antibiotic therapy for VAP

Initial empiric therapy for ventilator-associated pneumonia in patients with significant risk factors for multidrug-resistant pathogens

Potential pathogens	Combination antibiotic therapy
Multidrug-resistant pathogens *Pseudomonas aeruginosa* *Klebsiella* spp. *Acinetobacter* spp.	Anti-pseudomonal cephalosporin (cefepime, ceftazidime) or Anti-pseudomonal carbapenem (imipenem or meropenem) or β-Lactam/β-lactamase inhibitor (piperacillin–tazobactam) plus Anti-pseudomonal fluoroquinolone (ciprofloxacin or levofloxacin) or Aminoglycoside (amikacin, gentamicin, or tobramycin) plus
Methicillin-resistant *Staphylococcus aureus*	Linezolid or vancomycin

American Thoracic Society. Infectious Diseases Society of America. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. Am J Respir Crit Care Med 2005;171: 388–416.

Efficacy of an infection control program in reducing ventilator-associated pneumonia in a Chinese neonatal intensive care unit 2013 Zhou et al

Results: Of 491 patients receiving mechanical ventilation, 92 (18.7%) developed VAP corresponding to 27.33 per 1,000 ventilator-days. The rate decreased from 48.84 per 1,000 ventilator-days in phase 1 to 25.73 per 1,000 ventilator-days in phase 2 and further diminished to 18.50 per 1,000 ventilator-days in phase 3 ($P < .001$). Overall mortality rate of admitted neonates significantly decreased from 14.0% in phase 1 to 2.9% in phase 2 and 2.7% in phase 3 ($P = .000$). Gram-negative bacteria (95.5%) were the predominant organisms in VAP and *Acinetobacter baumannii* (65.2%) was the most frequently isolated microorganism.

Conclusions: Implementing a multifaceted infection control program resulted in a significant reduction in VAP rate with long-term effects. Such interventions could be extended to other low-income countries.

Zhou et al. / American Journal of Infection Control 41 (2013) 1059-6

Efficacy of an infection control program in reducing ventilator-associated pneumonia in a Chinese neonatal intensive care unit 2013 Zhou et al

The NICU environment

Reinforcement of hand hygiene practices

Periodic educational activities on VAP prevention

Rational waste disposal

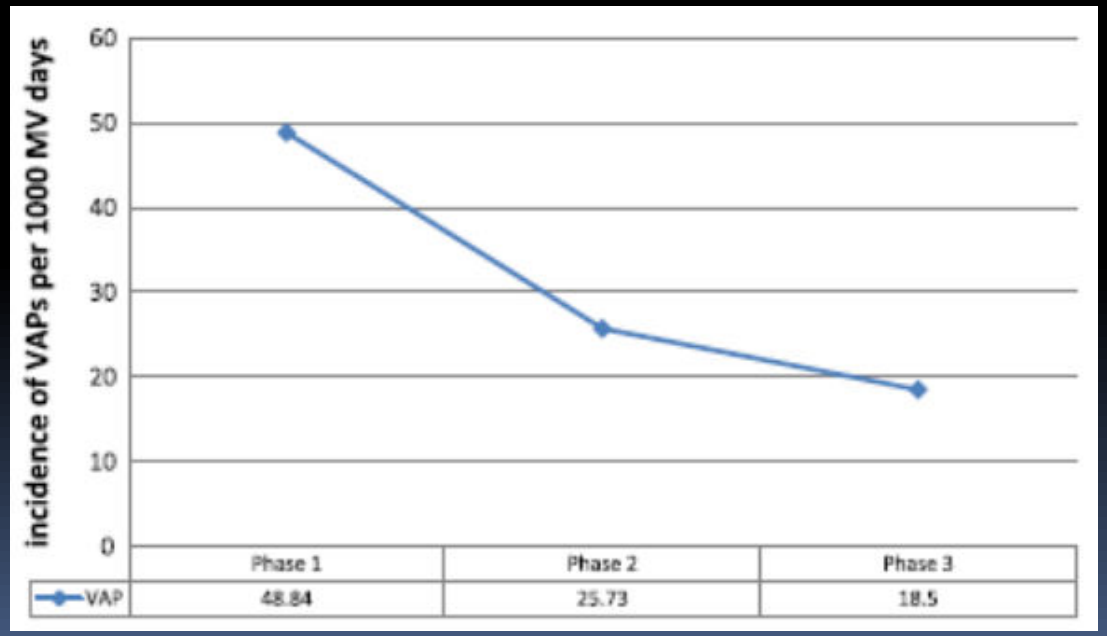
Enhancement of patient isolation and ventilator disinfection

Shorten duration of mechanical ventilation

Enhance the respiratory management of patients

Ventilator care was provided by specialized nursing team, and the closed endotracheal suctioning system was changed every 72 hours or as clinically indicated.18 The ventilator circuit was changed between patients or if it was soiled or damaged. Other measures included keeping the ventilator circuits lower than the endotracheal tube and frequently draining water from condensation in the ventilator circuit.

Rational use of antibiotics



Zhou et al. / American Journal of Infection Control 41 (2013) 1059-6

CHENNAI EXPERIENCE

Of the 265 mechanically ventilated neonates enrolled in the study, 135 neonates entered the study cohort. The incidence of VAP was 22.22 cases per 100 mechanically ventilated neonates. Klebsiella (66.67%) was the predominant organism isolated from the lower respiratory tract specimen (LRT) collected through the endotracheal tube. Home delivery, respiratory dis- tress at admission, unstable cardiopulmonary assessment at admission defined as atleast one of the following: unstable airway/abnormal breathing abnormal circulation/altered mental status, repeated intubations (more than 1), prolonged ventilation, prolonged duration of hospitalization and level III stay were found to significant risk factors for VAP by univariate analysis. Factors that retained significance in multivariate logistic regres- sion model were unstable initial cardio pulmonary assessment (p value = 0.010, adjusted OR: 0.2, 95% CI: 0.0,0.6) and repeat- ed intubations (p value, 0.001, adjusted OR: 34.3, 95 % CI: 8.3,142.4). The mortality rates for the neonates with **VAP was 50% and for those without VAP was 69.5 % (p value = 0.030).**

VAP is a serious nosocomial infection. Preventable risk factors should be addressed in all neonatal units. Further research is necessary to formulate the guidelines for diagnosis of VAP in neonates.

Indian J Pediatr (January 2015) 82(1):96 N. Vijayakanthi et al

LUCKNOW EXPERIENCE

The study group comprised of 98 neonates out of which, 30 neonates developed VAP (30.6%). VAP rates were 37.2 per 1000 days of mechanical ventilation. Most common bacterial isolated from endotracheal aspirate of VAP patients was *Klebsiella spp* (32.8%), *E.coli* (23.2%) and *Acinetobacter* (17.8%) being the other two common organisms. Very low birth weight (<1500 grams), prematurity (gestational age < 37 week), duration of mechanical ventilation, number of reintubations and length of NICU stay were significantly associated with VAP in bivariate analysis. Multiple regression analysis revealed that duration of mechanical ventilation (OR 1.10, 95% CI 1.02, 1.21; P = 0.021) and very low birth weight (OR 3.88, 95% CI 1.05, 14.34; P = 0.042) were two single independent and statistically significant risk factors for predicting VAP. VAP developed in nearly one third of intubated neonates having gram negative organisms as predominant etiological agent.

Semi quantitative assessment of ET aspirates > 10^5 CFU

Tripathi et al / Study of Ventilator Associated Pneumonia in Neonatal Intensive Care Unit
Internet Journal of Medical Update 2010 January;5(1):12-19

LUCKNOW EXPERIENCE

Variables	Pneumonia (n=30)	No Pneumonia (n=68)	P value
Postnatal age (Early vs late neonatal period)	27/3	63/5	NS
Sex (M:F)	4:1	3:8	NS
Very low birth weight (birth weight < 1.5 kg)	10/20	6/92	0.002
Prematurity (EGA < 37weeks)	17/13	20/48	0.01
Small for gestational age (SGA)	2/28	4/64	NS
Length of NICU stay in days (mean ± SD)	32.7± 34.7	19.7 ± 23.9	0.0028
Number of reintubation (%)	18/30 (60%)	6/68 (8.8%)	<0.001
Duration of MV (hours) (mean ± SD)	300.2±174.6	138.04±93.1	<0.001

Tripathi et al / Study of Ventilator Associated Pneumonia in Neonatal Intensive Care Unit Internet Journal of Medical Update 2010 January;5(1):12-19

LUCKNOW EXPERIENCE Outcome

The mean length of NICU stay

This was significantly longer in patients with VAP as compared to those with out VAP i.e. 232.7days Vs 19.7 days (p = 0.028).

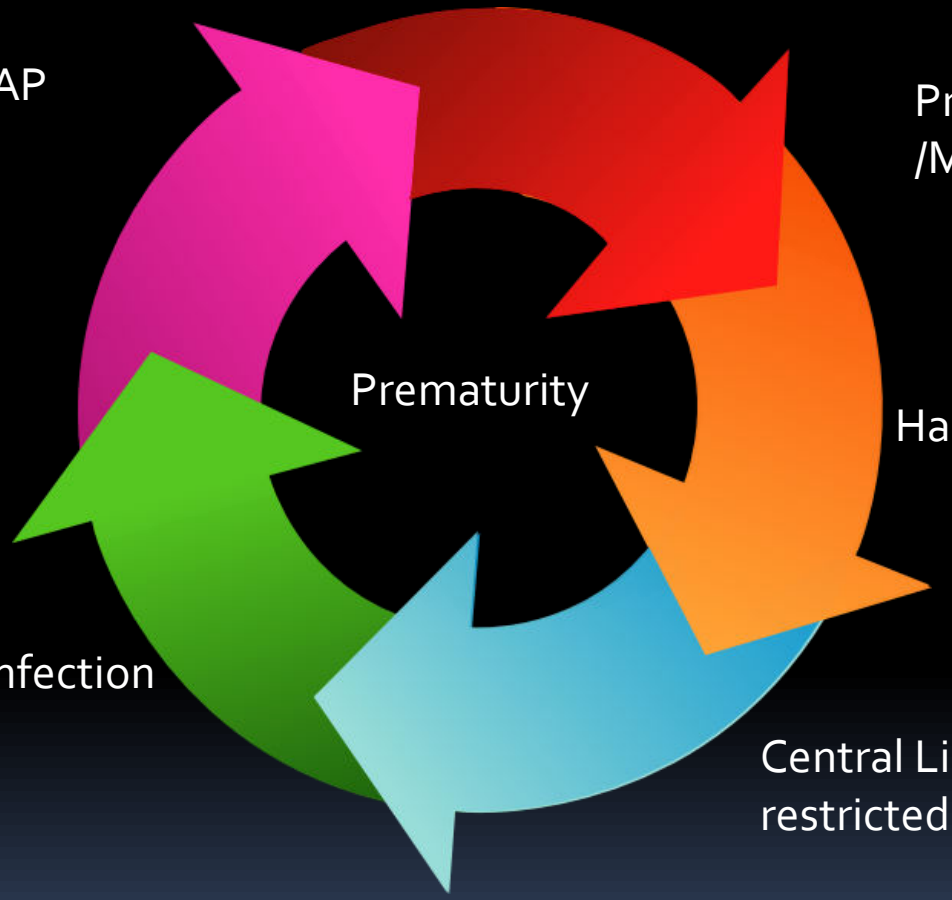
Mortality rates

This were higher in patients with VAP (40%) and

lower in non-VAP cases (22.06%) (p=0.058).

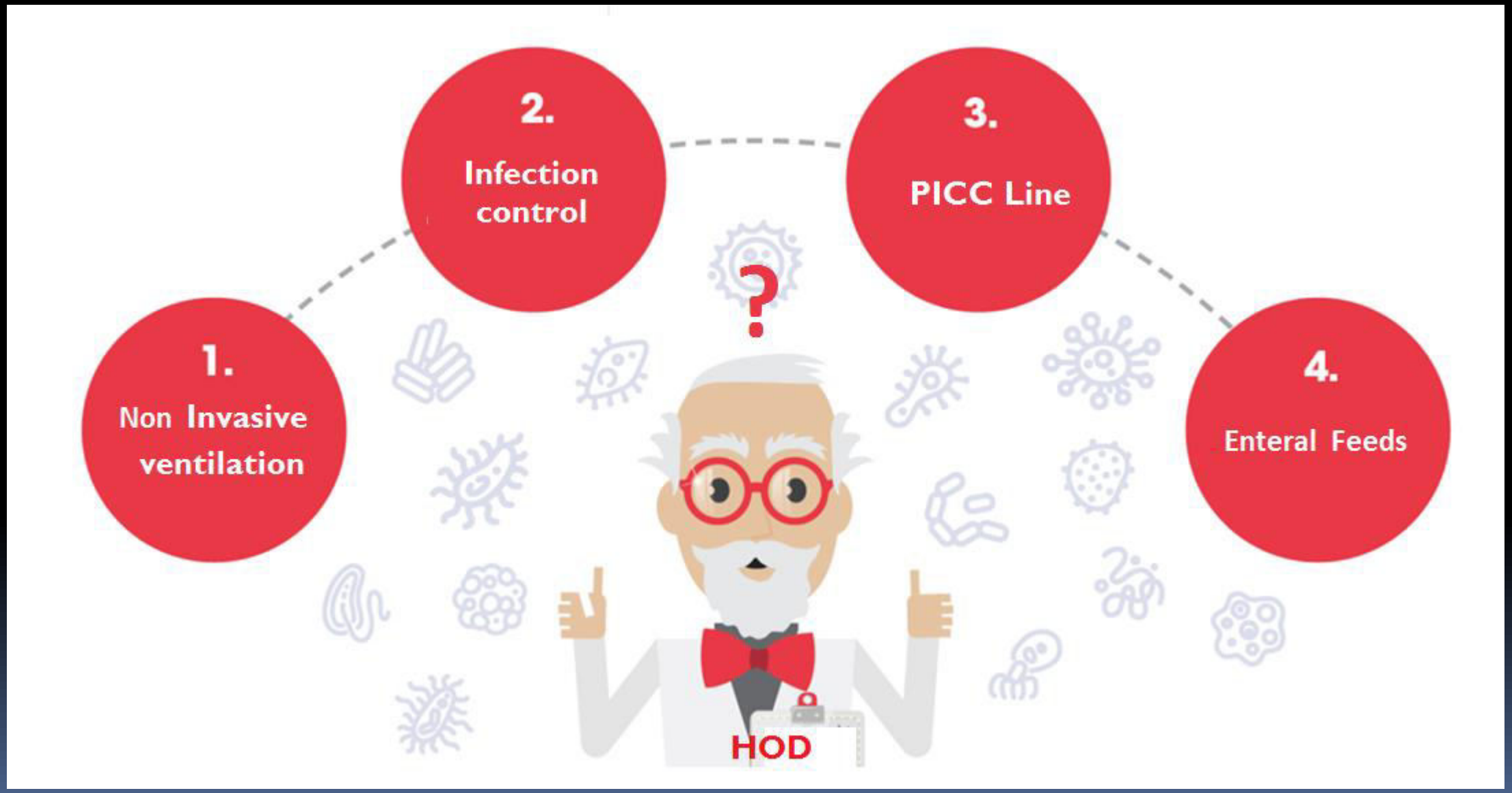
Tripathi et al / Study of Ventilator Associated Pneumonia in Neonatal Intensive Care Unit
Internet Journal of Medical Update 2010 January;5(1):12-19

CONCEPTUAL MODEL



Dr. Rajiv P.K 2017 NNF

STRATEGY SINCE 1992



COMPLIANCE OF VENTILATOR CARE PROTOCOL

Hand washing Station Logo

1991 -2017

Three decades of NICU care

Childs Trust Hospital	1991
PVS Memorial Hospital kochin	1992 -1999
Mallya Hospital Bangalore	1999 - 2002
Amrita institute of medical sciences	2002 -2010
NMC speciality Hospital Dubai	2002 -2017

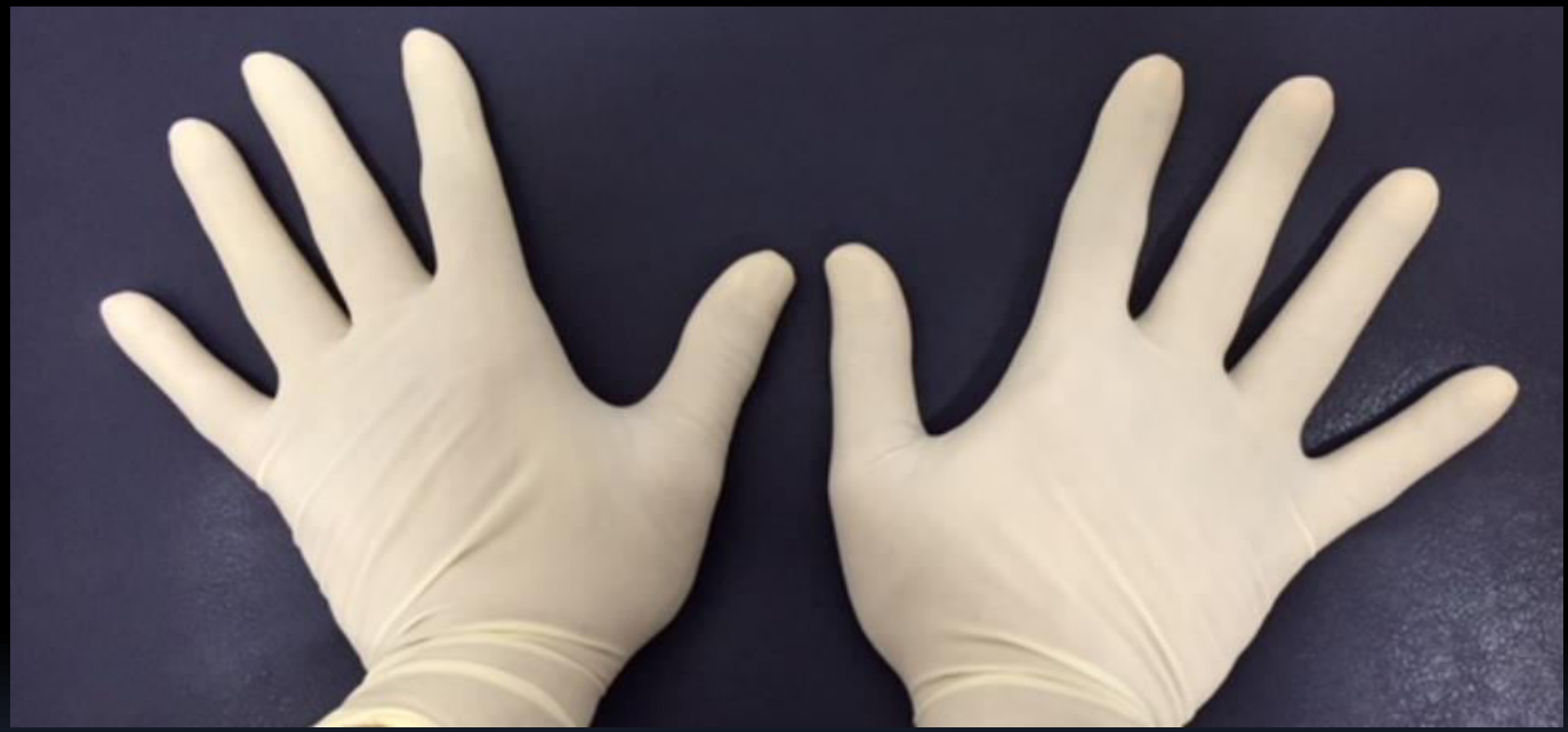
Survival 92.3% above 25 weeks gestation

Non Sterile Gloves For Routine Care

One intervention which could change the dynamics of HAI cycle

Discard per care

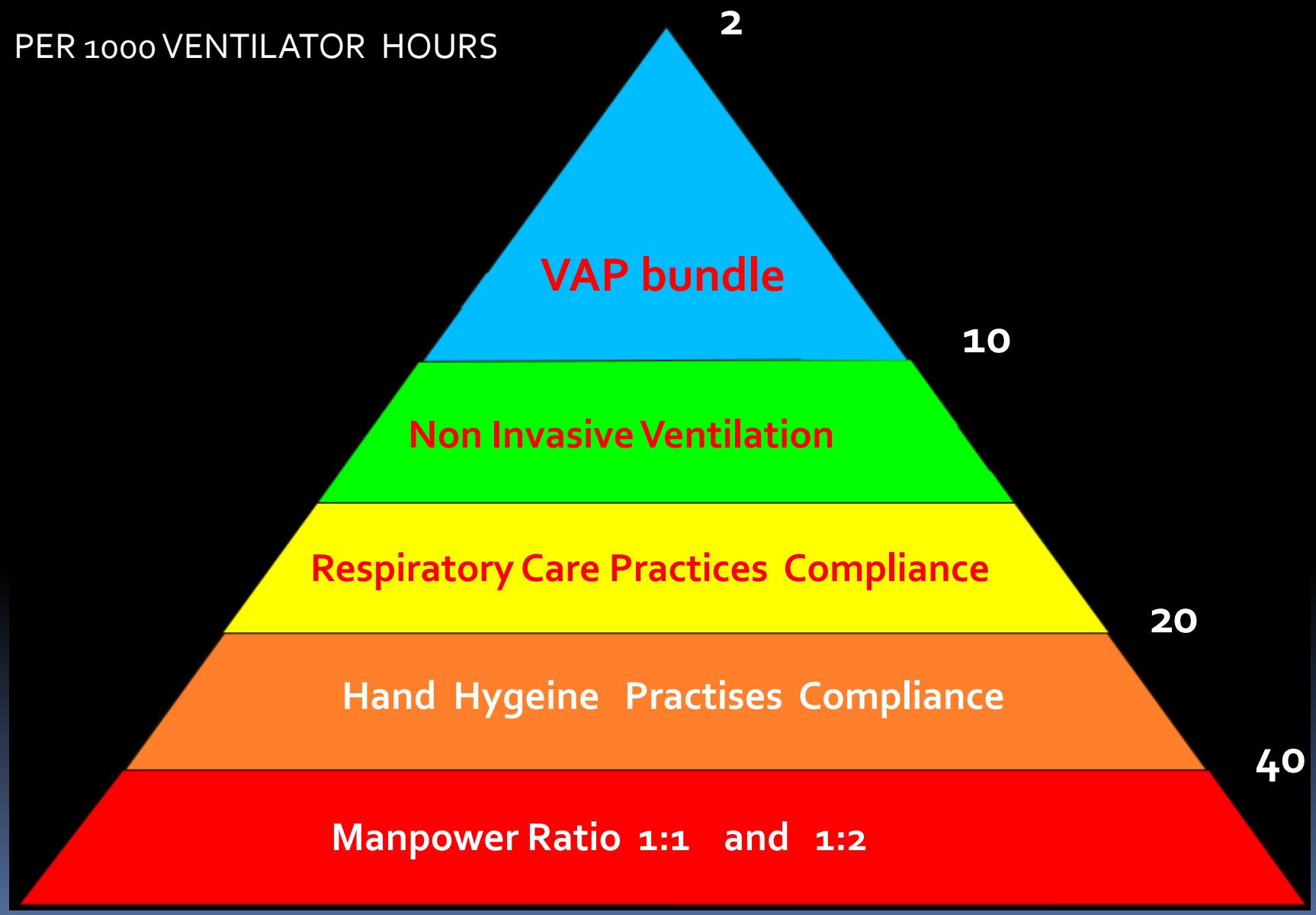
STERILE GLOVE FOR ALL VENTILATOR RELATED ACTIVITY



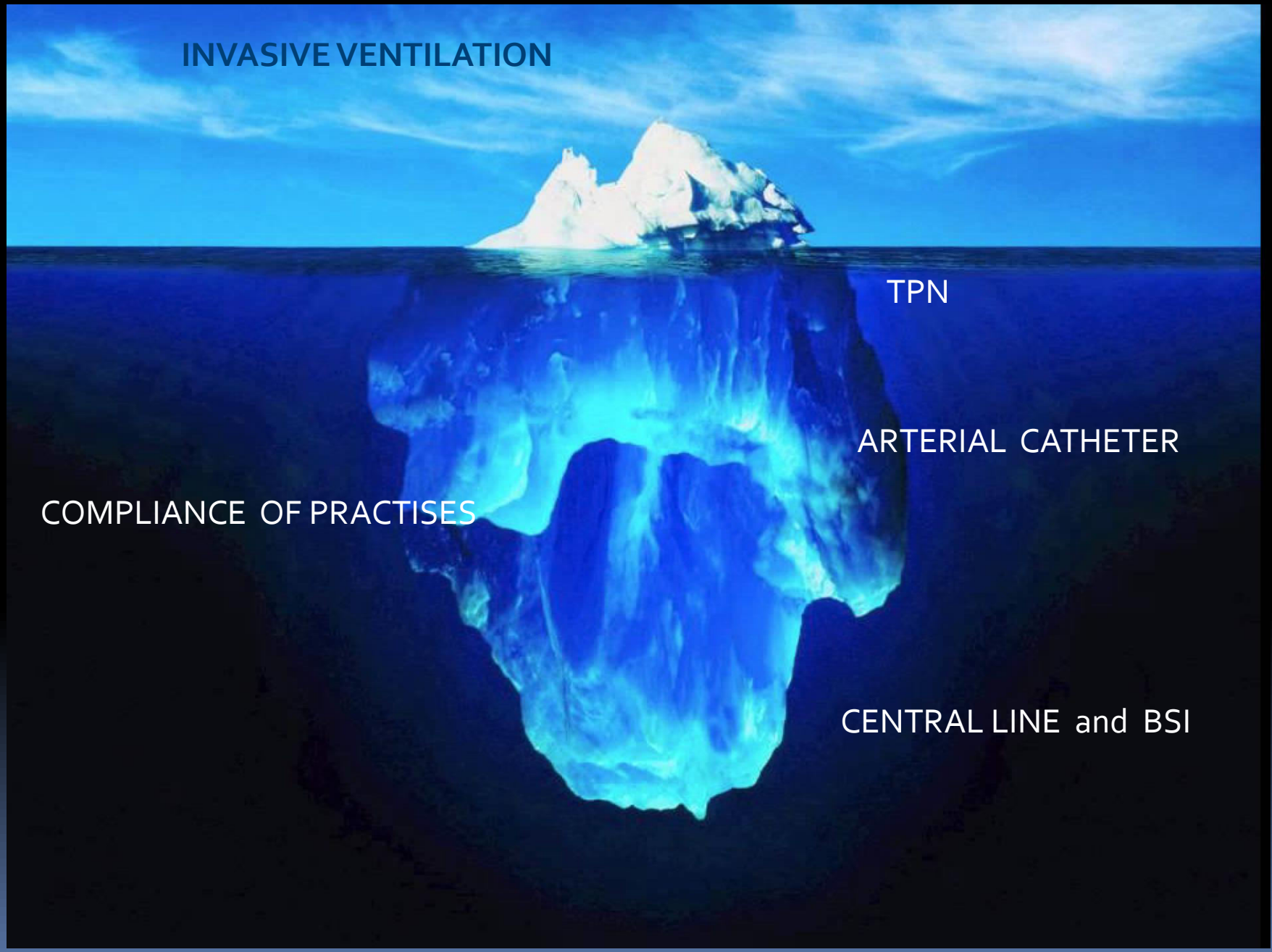
ET SUCTION , DRAINING CONDENSATE FROM VENTILATOR TUBING , POSITIONING BABY WITH ET TUBE

LOGISTICS OF VAP CONTROL

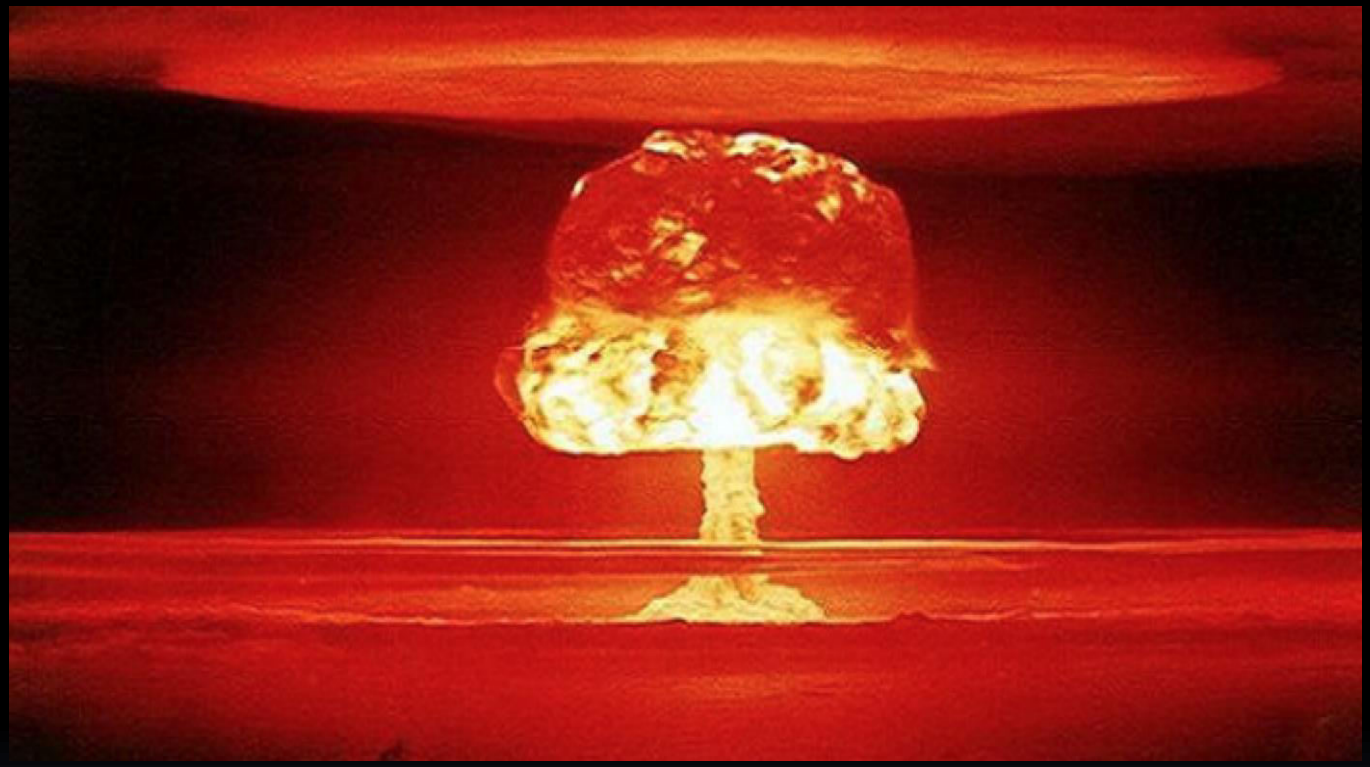
VAP RATE PER 1000 VENTILATOR HOURS



RESTRICTED USE OF KEY ELEMENTS IN VAP



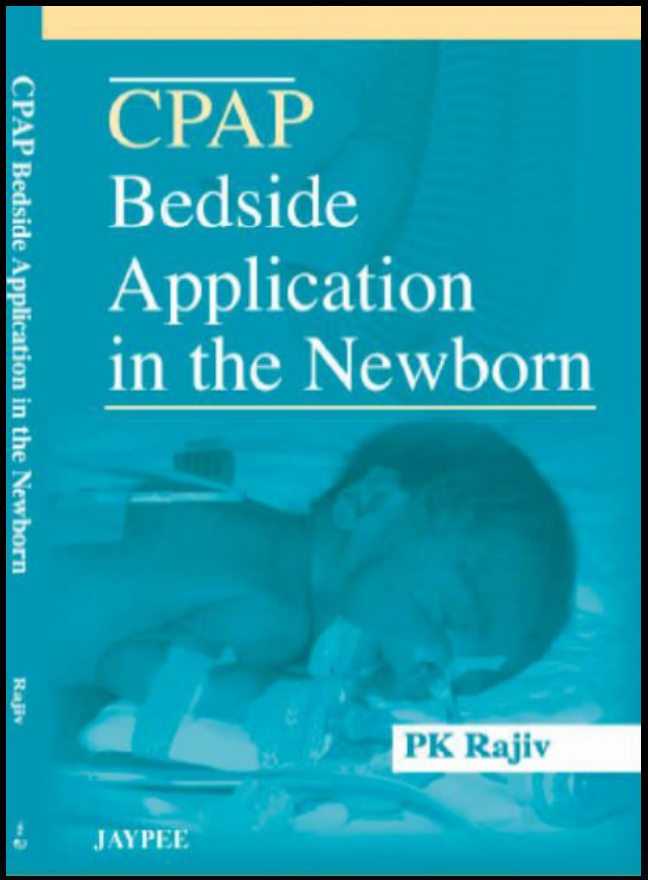
Central Line Blessing or Bane



Restricted use above 28 weeks gestation is recommended . In our unit in 7 years we had no blood stream infection, catheter related infection ,or ventilator associated pneumonia above 28 weeks gestation and no mortality treating 2700 babies… Blood stream infection as a precursor to VAP leads to higher mortality. Do we need central line vacation. Vicious cycle of Blood stream infection and length of stay , exacerbated by VAP

NON INVASIVE VENTILATION

If you do not ventilate a baby you do not get BPD
Richard Polin

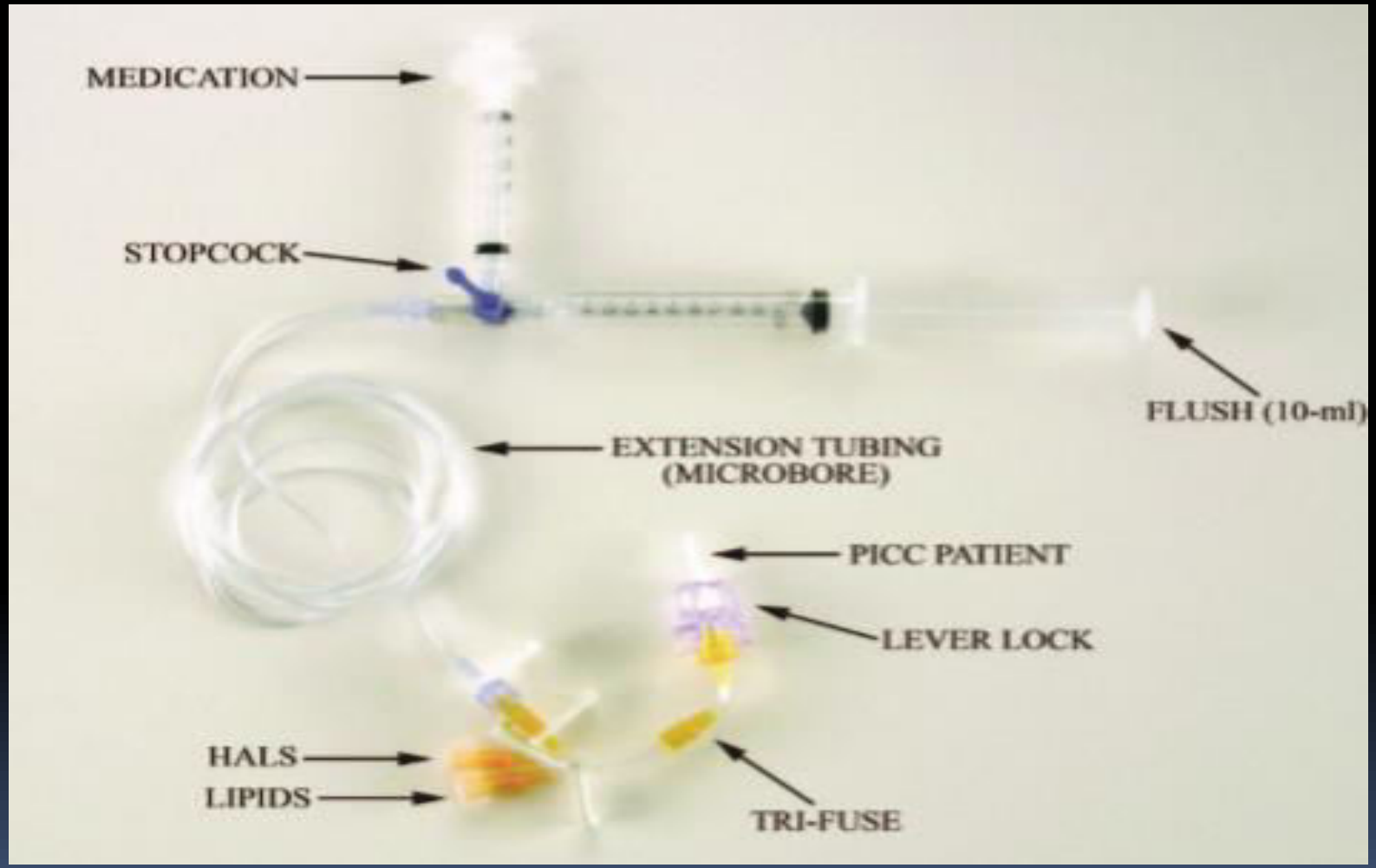


SYNCHRONISED NASAL INTERMITTENT POSITIVE PRESSURE VENTILATION

PROPOSED VAP BUNDLE FOR INDIA CONSIDERATIONS

- HAND HYGEINE practices
- After hand disinfection
- Non sterile disposable gloves per care /care
- Sterile gloves and gown for ventilator related care
- **Closed hand care** for routine care and ventilator related care
- **Closed suction system** for ET suction
- **Closed system for central line** Hany Aly Et al 2003

Is Bloodstream Infection Preventable Among Premature Infants? Pediatrics 2005;115: 1513–1518;

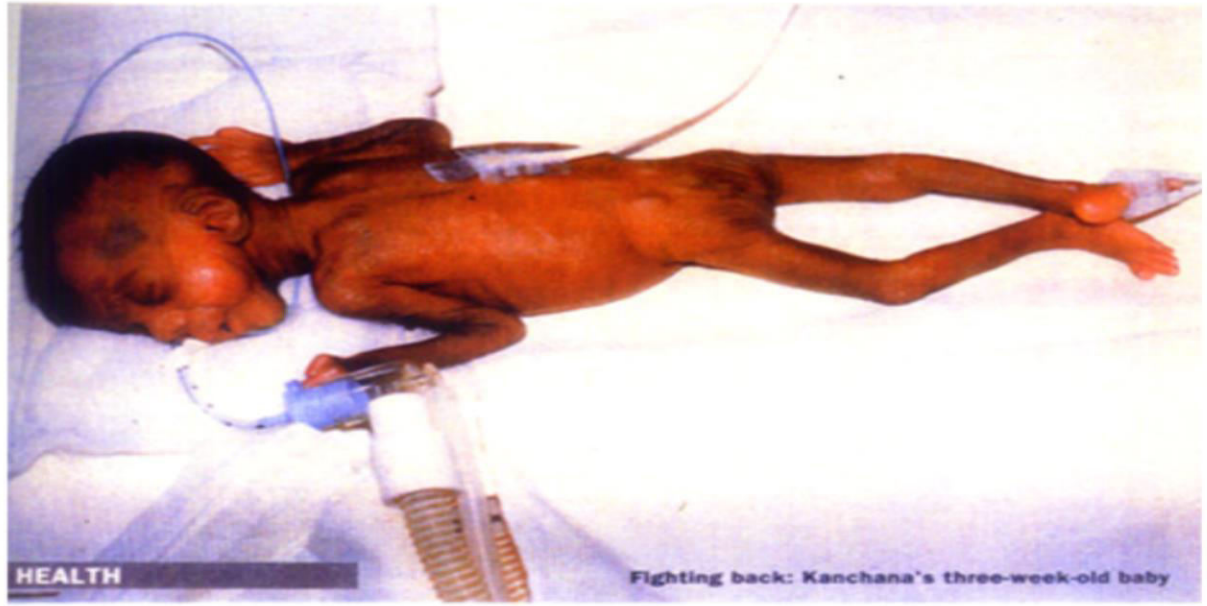


System used for administration of medications through a central line. PICC indicates peripherally inserted central catheter;
HALS, hyperalimentation;
LIPIDS, intralipids
Applying the closed medication system was associated with reduced BSI rates in our unit from **46.7% and 5.6%**

Hany Aly, MD*; Victor Herson, MD‡; Anne Duncan, RN*; Jill Herr, MSN‡; Jean Bender, APRN‡; Kantilal Patel, PhD§; and Ayman A. E. El-Mohandes, MD, MPH

500 GRAM BABY FIRST TIME IN INDIA

1997



Fighting back: Kanchana's three-week-old baby

AGAINST ALL ODDS

A premature baby weighing half a kg survives—and lives a normal life

KANCHANA Suresh developed labour pains when she was six months pregnant. Wife of a carpenter, she had been through three abortions earlier and couldn't bear the thought of losing this child, too. Fortunately, she was rushed to hospital, where she bore a girl-child. However, the baby weighed a mere 510 gm.

A normal baby weighs above 2.5 kg and the doctors do not give any 'thing' below a kilo a good chance of survival. Even in the US only 60 per cent to them survive, usually handicapped. But the team of doctors and nurses—led by Dr P.K. Rajiv of the Abhishek Paediatric Foundation—looking after Kanchana at P.V.S. Memorial Hospital in Kochi, Kerala, was determined to make her baby lead a normal life.

The baby developed pneumonia barely 12 hours after birth. More a lump of flesh than life, the child also had breathing difficulties. A premature baby can become 'blue' if sufficient oxygen does not reach her. It could prove fatal, paralyse her, turn her deaf or damage her brain forever. So the doctors put the baby on artificial ventilation, which requires precise monitoring because forced pressure can damage the delicate lungs and cause oxygen toxicity. High concentration of oxygen in the blood can impair her vision or even blind her. The doctors scanned her head every four days: the ultrasounds were positive—she wanted to live.

It was only by the tenth day that Kanchana could hold her baby close to her bosom and breast-feed her, though only in dribbles. When the baby put on weight—700 gm—and the doctors tried to take her off ventilation she developed bronchopulmonary dysplasia—breathing trouble. She wasn't ready to face the world on her own yet and stayed on ventilation for a month and a half before leaving for home last April.

The baby is perhaps the first reported case in India of a premature baby weighing so little at birth and born so early to have survived with favourable neurological outcomes: no brain damage, no paralysis or vision problems.

What made her survive? Technology—not many hospitals in India have infant ventilators with alarms that tell you that the baby is having trouble breathing. Apnea monitors that tell you that the baby's respiratory movements have failed; blood-gas analysers and pulse oximeters that continually display the saturation of arterial oxygen or warn you about the carbon dioxide

PROPOSED VAP BUNDLE FOR INDIA CONSIDERATIONS

Restricted use of central lines above 28 weeks gestation / days UAC 4/UVC 7 (CDC 14)/ PICC 14

(CDC no time frame)

Enteral feed advance.

Restricted use if central lines below 28 weeks

days Uac 4 / Uvc 7 (14 CDC) / Picc 21

(CDC no time frame)

Enteral feed advance

PROPOSED VAP BUNDLE FOR INDIA CONSIDERATIONS

Aggressive weaning to NIV CPAP /SNIPPV (hospital days and duration of ventilation)

Surveillance of multidrug resistance

Head of department / associates practice in same hospital (compliance)

Training every 3 months with audit of progress (psychology of compliance)

PROPOSED VAP BUNDLE FOR INDIA CONSIDERATIONS

RESPIRATORY CARE

Drain condensate away from baby by keeping reservoir below baby level

Separate suction catheters and system for oral and ET

Do not open closed system to drain condensate 2-4 hourly

Closed suction system changed weekly / visibly soiled

ET suction only when clinically indicated.

Oroparyngeal suction before position change and 4 hourly

Avoid emergency intubation and extubation

Lateral position of baby than supine

Head end up position 15- 30 degree

Adequate humidification of gas

ESSENTIALS OF NEONATAL VENTILATION RAJIV VIDYASAGAR SATYAN 2018 ELSEVIER

This is the third textbook in the world dedicated to neonatal ventilation
and the only book in the world giving bedside ventilation navigation
guidance in the world .(900 pages) This book took 8 years of my life
to conceptualize, implement and coordinate and 3 years with elsevier
rigid quality standards.. This will be the first neonatal ventilation book
from elsevier from developing countries. This book will have 45 of the
worlds best stalwarts from USA ,UK, Australia , Germany ,UAE and
India to write the specific chapters, in which i was co author is some
key chapters. This was my life ambition and is the first
book ,addressing this standardization of ventilator care, so far not attempted in the world in 40 years.This is targetted as a expert counsel book for all nicus in the world . www.drpkrajiv.net

Thank you