STRATEGIES TO REDUCE Infections in the New Born: Immediately After Birth & in SNCU

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Problem?

- Second most Important cause of Death
- Emerging Antimicrobial Resistance
- Emerging Fungal Sepsis
- Prolongs duration of hospitalisation
- Increases treatment Costs, duration of hospital stay
- Difficult to diagnose: Lack of facility for culture
- Overuse of antibiotics

Contributing Factors for Healthcare Associated Infections

- High patient-to-nurse ratio
- Bed space less than 1 meter (3 feet) apart
- Low compliance with hand hygiene practices
- Limited resources for isolation or cohorting
- Increasing use of complex medical, surgical procedures
- Increasing use of invasive medical devices (e.g., mechanical ventilators, central intravenous lines)
- Inadvertent contamination of prepared supplies/pharmaceuticals (e.g. IV fluid, infant formula, medications)
- Suboptimal cleaning, disinfection, and sterilization practices
- Antibiotic resistance due to overuse of broad-spectrum antibiotics

Ref: Allegranzi et al. 2011

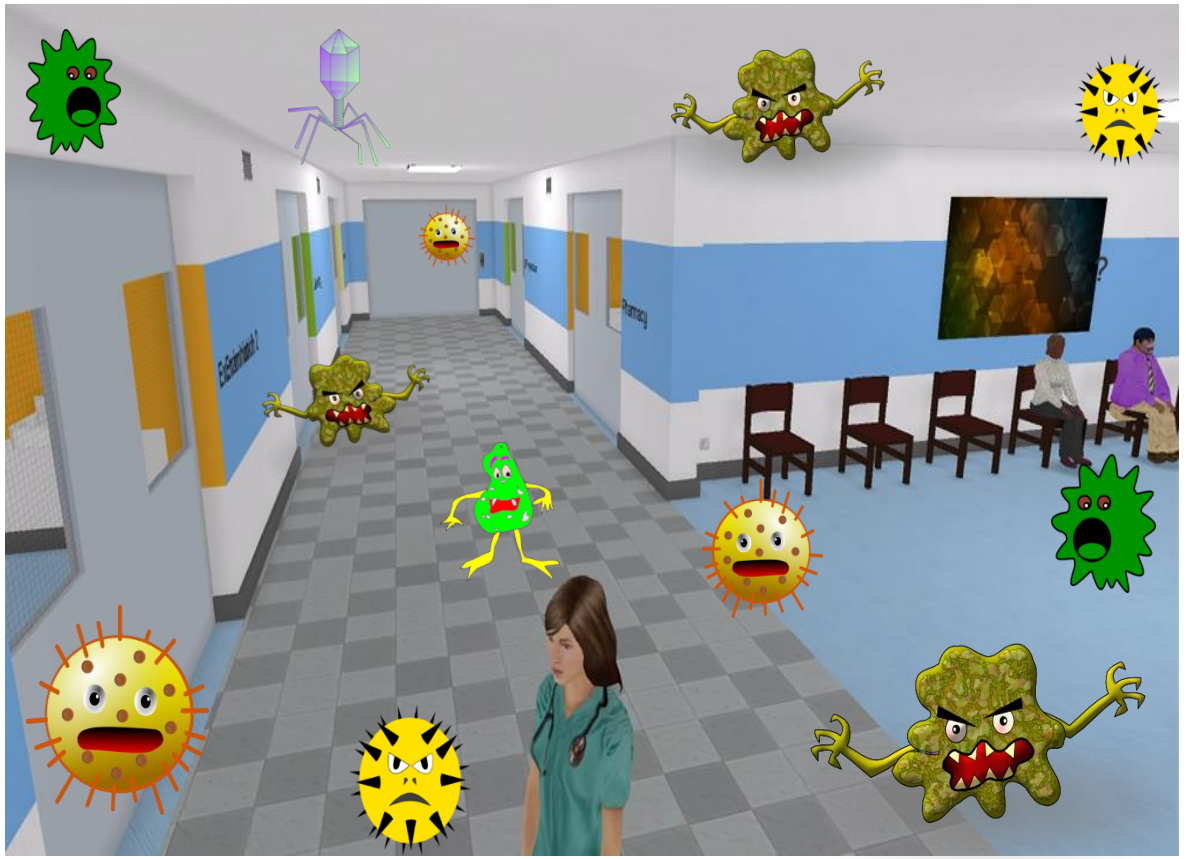
In NICU, we handle the tiniest of babies, who are sickest of all…….

A clean, hygienic environment is the fundamental need for their intact survival.

We achieve this through some strict policies, and good practices…

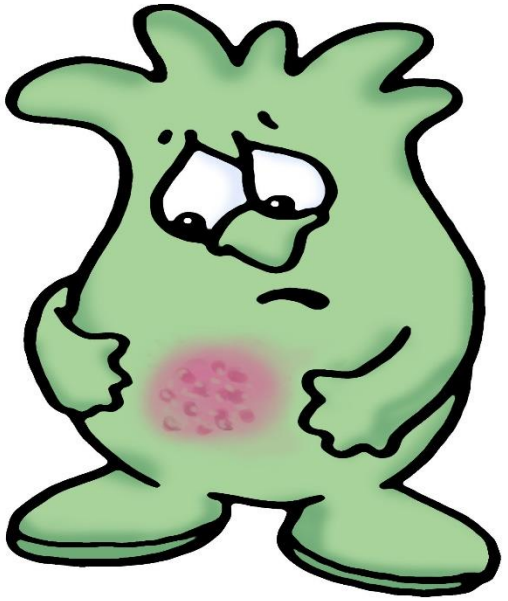
HCAI / Nosocomial Infections

- Infections acquired during the process of receiving inpatient health care.



What are HCAIs in NICU

- CLABSI (Central line associated blood stream infections
- VAP (Ventilator Associated Pneumonia
- CAUTI: Catheter associated UTI
- SSI: Surgical Site Infections



CLABSI

CLABSI is defined as a LCBI (Laboratory confirmed blood stream infection)

1. Primary infection in patient with central catheter.
2. Central line for more than two calendar days on the date of the event, with day of device placement being day one, and the line was also in place on the date of the event or the day before.
3. Bloodstream infection (BSI) cannot be attributable to an infection at another site

Ref: CDC/NHSN

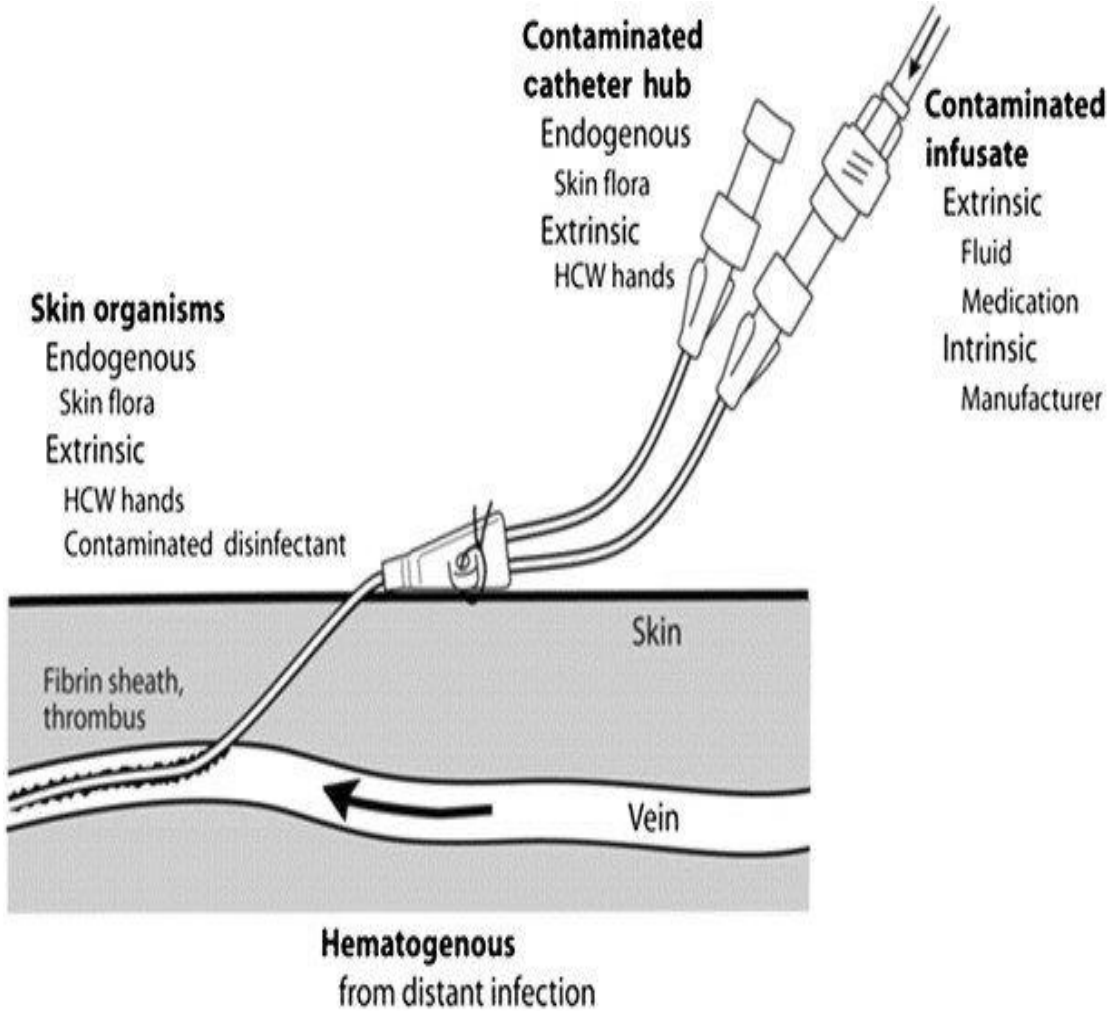
CLABSI

- Most common HCAI
- Incidence 3.2 to 21.8 per 1000 central venous catheter days.
- Mortality rate due to CLABSI between 4 to 20%
- More in developing world

- Hightower HB et al. Reduction of central line–associated bloodstream infections in a tertiary neonatal intensive care unit through simulation education. Pediatr Qual Saf. 2022;7(6):e610.

Pathogenesis of CLABSI

- Multiple entry points : through skin :
  - Endogenous skin flora
  - Extrinsic organisms from environment. through hands
  - At Initial catheter insertion
  - Colonization and infected from poor hub care
  - Contamination of IV fluids or drugs.
  - Hematogenous dissemination of bacteria from a distal site.



Risk Factors

- Low Birth weight.
- Prematurity
  - Impaired innate immune responses & neutrophil functions
  - Relative deficiencies in complements, immunoglobulin.
  - Lack of maternally derived opsonic antibodies
- Independent risk factors: need for TPN, Use of millilumen catheters.
- Number of central catheter days (odds increases 20 fold with more than 21 days)
- Length of stay more than 12 days
- Blood transfusion
- Postnatal growth failure
- GI conditions: Abdominal surgery, bowel obstructions, dysmotility, ischemic reperfusion injuries.

Microbiology:

Coagulase-negative staphylococci is the most common.

MSSA, methicillin-resistant Saureus, enterococci: gram-positive, polysaccharide encapsulated organisms produces adhesins, biofilm, and slime that promote adherence to catheter surfaces.

Fungal : Broad-spectrum antibiotic exposures, prolonged NPO , and use of histamine2-blocking medications: increases Candida albicans and Candida parapsilosis), Also exploit poor host immune defenses and biofilm production to cause CLABSIs.

-Gram-negative organisms (Escherichia coli and Klebsiella species predominate.

VAP : Ventilator Associated Pneumonia

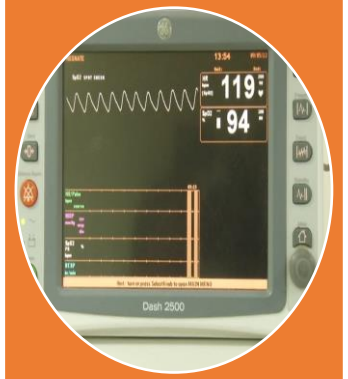
- 2nd commonest HCAI in neonates
- the incidence ranges from 0 to 37 per 1,000 ventilator days

Developed (UMIC): 2.7 – 10.9 / 1000 VD

Developing (LMIC) : up to 37 /1000 VD

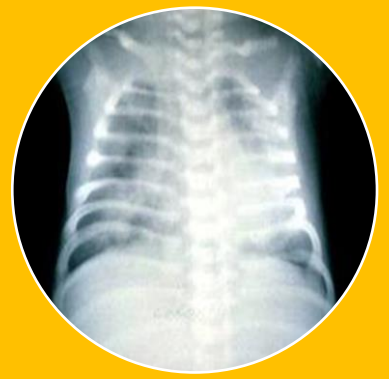
- VAP : HCAI in mechanically ventilated neonates
- that develops more than 48 hrs after initiation of MV

Definite VAP

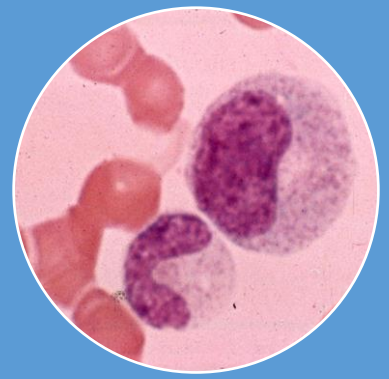


Ventilation >48hr

Clinical Deterioration



Radiological Changes



Microbiological evidence

Pathogenesis of Ventilator Associated Pneumonia

Endogenous Sources of Micro-organism

1) Impaired natural protection/clearance system allow increase colonization of nasopharynx

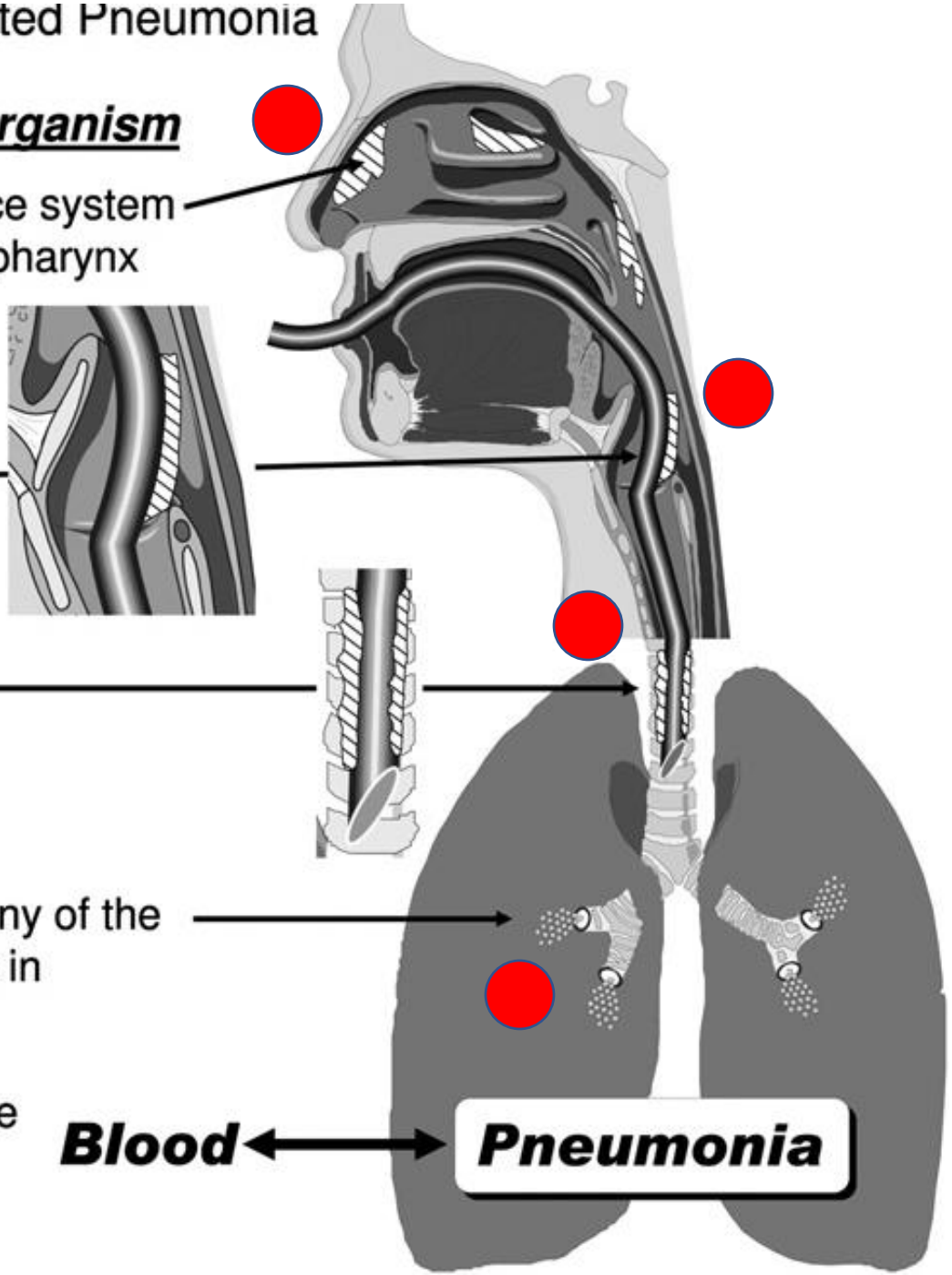
2) Colonized oropharynx & gastric fluid pool along tube in neonates

3) Colonized tracheal secretions

Mechanism for pneumonia

1) Aspiration of colonized fluids from any of the above sources into lungs can result in pneumonia

2) A hematogenous source seeding the lungs may rarely cause pneumonia



IPC during delivery & after birth

- Strict asepsis & Hand hygiene in the labour room
- Delivery over mothers abdomen
- Initiate early breast feeding within 1 hour
- Encourage exclusive breastfeeding.
- Apply relevant IPC precautions (Transmission-Based Precautions and prophylaxis) to those who are exposed or infected during or before birth (e.g., congenital syphilis, rubella, HIV, HBV, and other infectious diseases).
- Encourage exclusive breast feeding.
- Eye care : with sterile swab : single use for each eye
- Cord Care: Keep it dry and open
- Don’t apply anything
- Administer Vit K and Birth immunization using safe injection practices.

Hand Hygiene

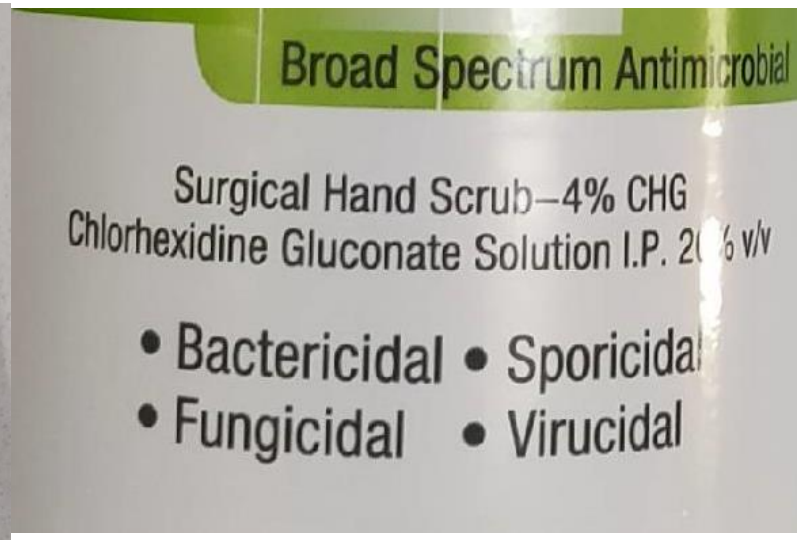
- Most Effective, Low cost
- Hand washing: (remove jewellery, e.g. rings). All jewellery and ornaments like bangles, watches, and rings must be removed
- At the time of entry
- Whenever hands are soiled

Infection Control Practices

HAND HYGIENE : LOW COST, MOST EFFECTIVE METHOD TO PREVENT INFECTIONS.

Remember SUIMAN

WHO recommended 6 steps of Hand hygiene: SUIMAN



Use this solution:

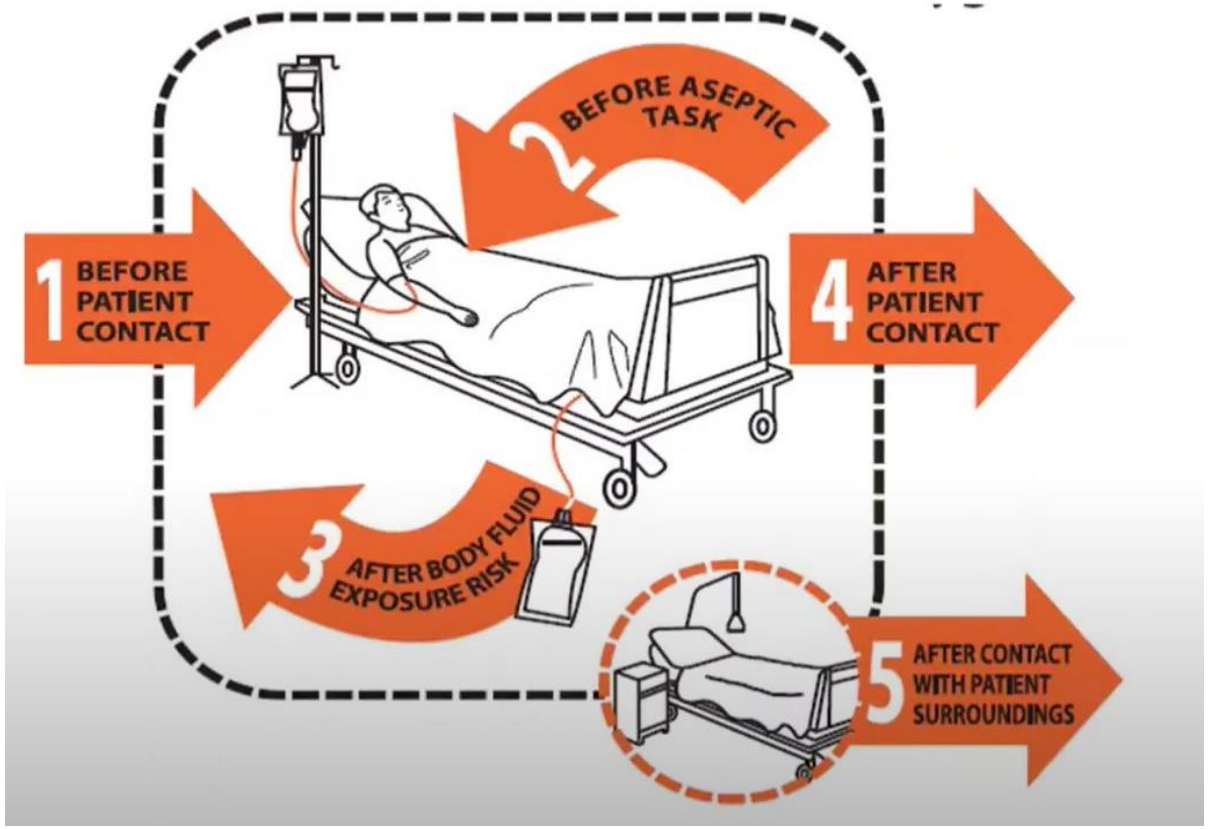
In Wards

ICU

Nursing homes

Aseptic Hand wash

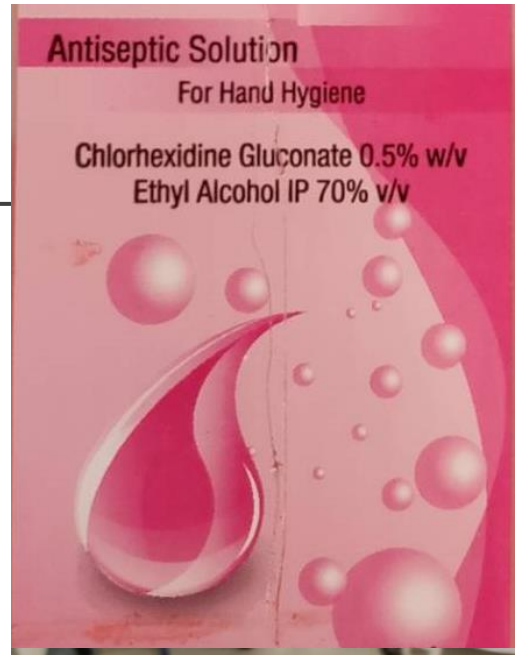
5 Moments of Hand Hygiene



Hand Rub – provided hands are visibly clean

1. Whenever touching any patient esp. in inpatient units and critical care ar eas
2. Also, preferred in between infectious OPD patients.
3. After handling any potentially infectious object
4. In high dependency areas and after attending patients in isolation or with known transmissible condition

Dispense the required amount of solution onto the hands.
Ensure solution covers all hand surfaces.
Rub vigorously, using hand washing technique, until dry.



How to use Hand rub

Hand Hygiene	Recommended time
Hand rub (Alcohol-Based Formulation)	**20-30 sec**
Hand wash (soap and water)	**40-60 sec**
Surgical scrub	**2-6 minutes**

Use an alcohol-based hand rub

0.5% chlorhexidine + 70% w/v ethanol

Chlorhexidine and alcohol is ideal as they cover Gram-positive and Gram-negative organisms, viruses, mycobacteria and fungi.

Chlorhexidine also has residual activity

“Easily Available & Accessible

Hand Rub

Hand Hygiene & Glove use

- Use of gloves does not replace hand washing
- Wear gloves after proper hand hygiene
- Wear gloves only when Indicated
- Other aspects of hand hygiene - Avoid jewellery, wrist watches
- No artificial finger nails, nail polish
- Keep natural nails short
- Cover cuts/abrasions with waterproof dressing
- Hand Hygiene promotion programs
- Address behaviour and attitude of health workers
- Monitor hand hygiene and provide performance feedback

Hand hygiene – by all staff and attendants

Hand Hygiene

You must perform hand hygiene to:

1. Protect the patient against harmful germs carried on your hands or present on his/her own skin
2. Protect yourself and the health-care environment from harmful germs

Education Training and motivation

- Monitor healthcare workers adherence with recommended hand hygiene practices and give feedback
- Implement behavioural approaches to identify barriers and facilitators to improve handwashing rates.
- Implement a multidisciplinary program to improve adherence to recommended practices
- Provide training to new or transferred in staff on hand hygiene and IPC protocols
- Encourage patients and their families to remind health care workers to practice hand hygiene

Good practices – leading to clean environment & asepsis

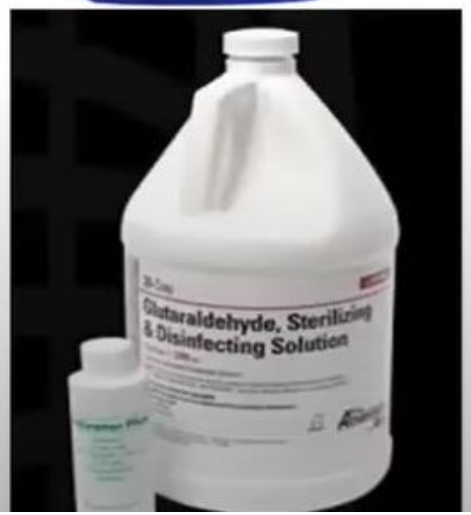
Equipment and Environment

Intensification of house keeping & disinfection routines

- Floors: 5% Phenyl, wet mopping; each shift
- Walls: 2% Bacillocid; each shift
- Window AC: surface & filter washed once a wk
- Refrigerator: defrost & clean with soap once a wk
- Bucket & sink: soap/ detergent daily
- Mop head: washed in soap & water, disinfect with hypochlorite (1%) for 30m, dry in sunlight; daily
- Baby's linen, blanket: autoclave
- Feeding utensils/ paladi: wash, boil 10m/ hot oven before each use
- Swab container, injection/medicine tray, set for procedures, cheattle forceps, steel drums= autoclave

Strengthening of Disinfection & Sterilization of equipment

- Cidex/ Plasma Sterilization: Resuscitation bag, reservoir, O2 mask, vent tubing, bottle and tubing of suction machine
- 2%Bacillocid: Weighing machine, warmer, incubator
- Spirit/ 70% alcohol: Laryngoscope blade, thermometer, probe, BP cuff, measuring tape, steth
- Syringe pump: soap&water, cidex if blood stained
- O2 hood: soap & water



Adherence to Aseptic Protocols

- Preparation of cot
- Weight recording/ Temp/ spo2 recording
- Feeding, suctioning
- Changing wet nappies
- Preparing & administering injection
- Heel prick, blood sampling, putting IV line, LP
- Maintaining asepsis at IV lines
- Any other invasive procedures
- Visitors, attendants and vendors protocols
- **Bundle care**

Daily Mopping Of Walls

Daily Cleaning Of Patient's Bed

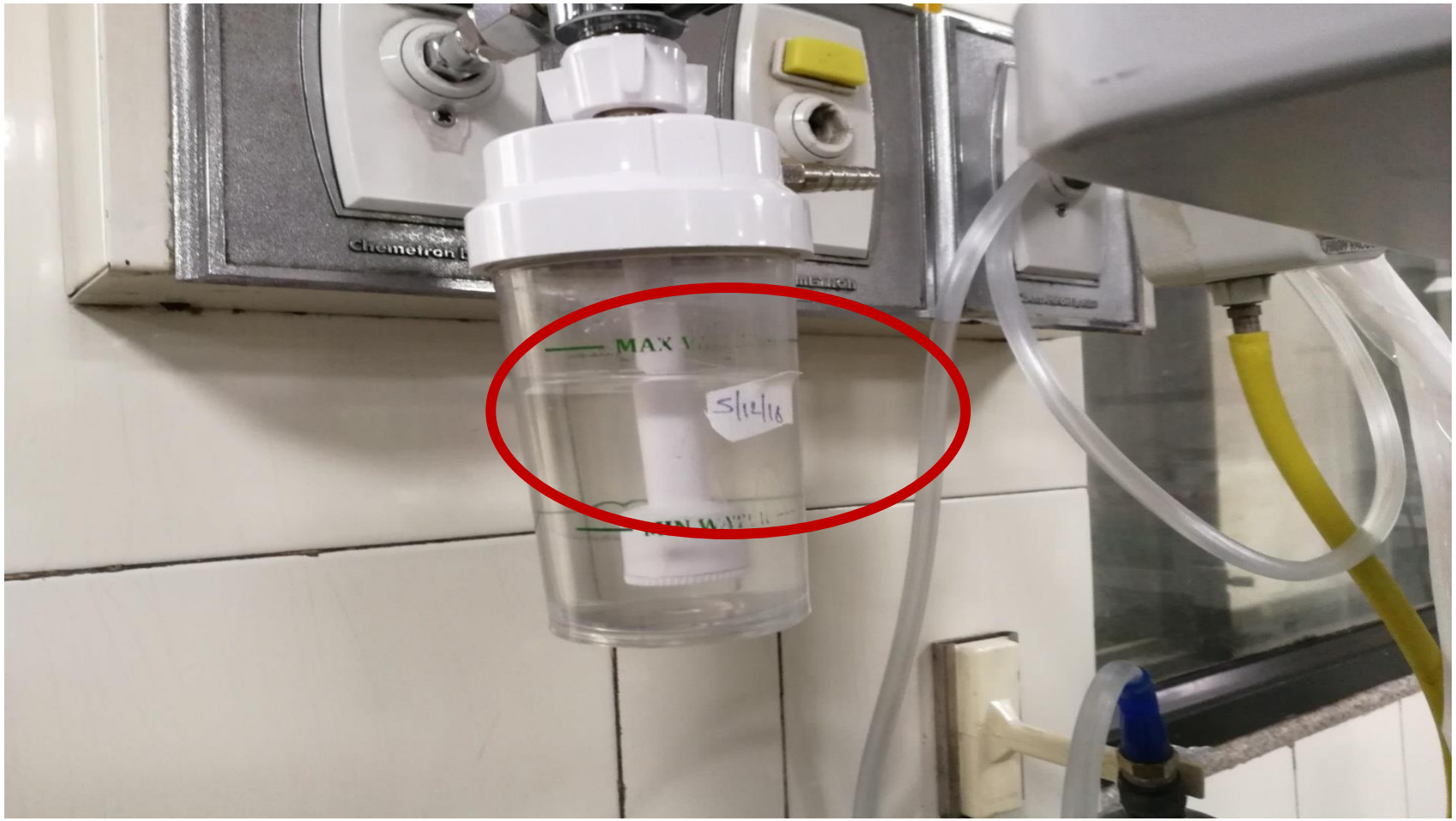
Floor Cleaning

Equipment Cleaning

Clean Bedding & Nesting

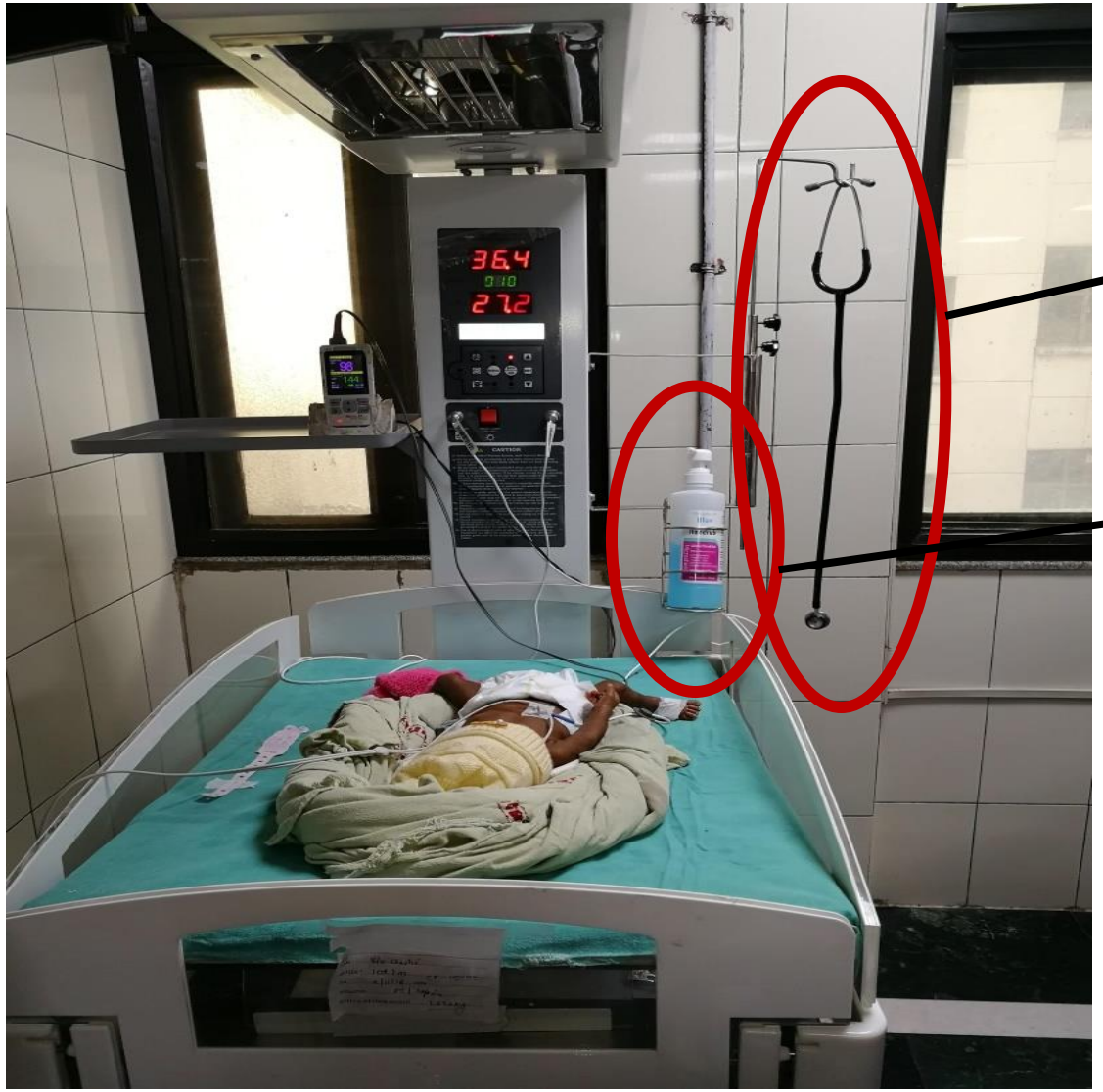
Sterile Equipment For Emergency Use

Daily Change Of Water In Humidifiers (With Date)

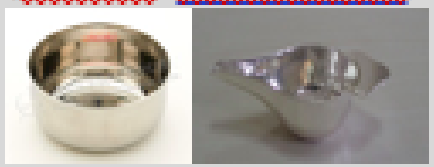


Clean Patient Bed

Clean Patient Surroundings



Clean Dressing Trolley & IV Line Tray

	Name	Disinfection	Frequency & other considerations	To be done by
1	Baby linen, blanket cover 	Wash and autoclave	Use autoclaved linen each time.	Nurse
2	Cotton gauze	Autoclave	As required.	Nurse
3	Feeding utensils (paladai, katori,spoon) 	Wash with soap water and boil for 10 min	Before each use.	Nurse/ mother
4	Swab container, injection tray and medicine tray 	Wash with soap water and autoclave	Daily morning shift, Use separate container for each baby.	Nurse
5	Sets for procedures 	Autoclave	After each use, Every 72 hours if not used.	Nurse

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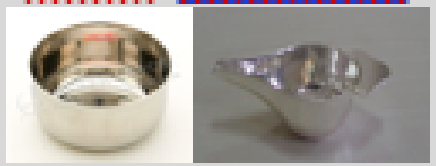
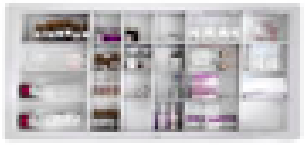
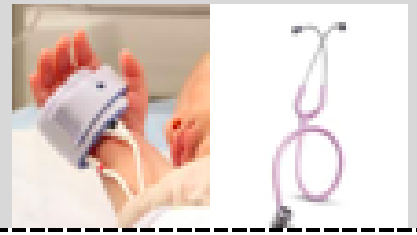
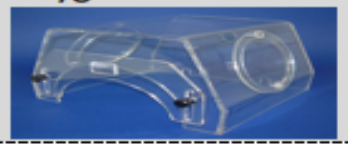
3	Feeding utensils (paladai, katori,spoon) 	Wash with soap water and boil for 10 min	Before each use.	Nurse/ mother
4	Swab container, injection tray and medicine tray 	Wash with soap water and autoclave	Daily morning shift, Use separate container for each baby.	Nurse
5	Sets for procedures 	Autoclave	After each use, Every 72 hours if not used.	Nurse

6	Cheattle forceps 	Autoclave	Daily. Put in sterile autoclaved bottle containing dry sterile cotton.	Nurse
7	Stethoscope, tape, pulse oximeter probe, radiant warmer probe, thermometer 	Clean with spirit cotton. Clean with 0.5% bacillocid at terminal cleaning	Daily before use.	Nurse
8	Laryngoscope 	Clean with spirit swabs daily and after each use for the same baby, Wrap in autoclaved cloth and write date and time on it	Wash with soap water, Put the blade in 2% glutaraldehyde after removing bulb and wash thoroughly after removing from it. Time of contact (Use in between babies): For sterilization: 4-6 hours For disinfection: 15-20 mins	Nurse

10	Resuscitation bag, reservoirs, oxygen tubing, suction jar and tubing 	Clean with soap water after dismantling. Immerse in cidex for 4-6 hours. Rinse in distilled water. Dry and wrap in autoclaved linen. Write date over it Add 5-10 ml of Ashaquart after cleaning into the suction bottle	Weekly for resuscitation bag and reservoir. Weekly autoclaving for suction jars Daily for others (night shift).	
11	Weighing machine 	Wipe with surface disinfectant (bacillocid(0.5%)/ spirit before each use	Daily in morning shift and when required.	Nurse
12	Infusion pumps and Monitors 	Clean with bacillocid. If blood stained clean with soap and water	Daily in morning shift. If possible in each shift	Aide
13	Oxygen hood 	Wash with soap and water, dry with clean linen	Daily in night shift.	Aide
14	Radiant warmer and incubator 	Clean with 0.5% bacillocid daily if occupied. If not occupied clean with 2% bacillocid. If culture positive sepsis, clean with 10% bacillocid	Daily in morning shift.	Nurse

Changing Of Tubings

- Oxygen humidifier container Q 24 hrs
- Suction bottle cleaned Q 24 hrs
- Suction tubing changed Q 24 hrs
- IV sets/ Dorsifix Q24-48 hrs
- Syringes for use in infusion pump Q 24-48 hrs
- Blood set single use
- IV cannulas single use
- Needles and syringes single use

Terminal Cleaning Checklist

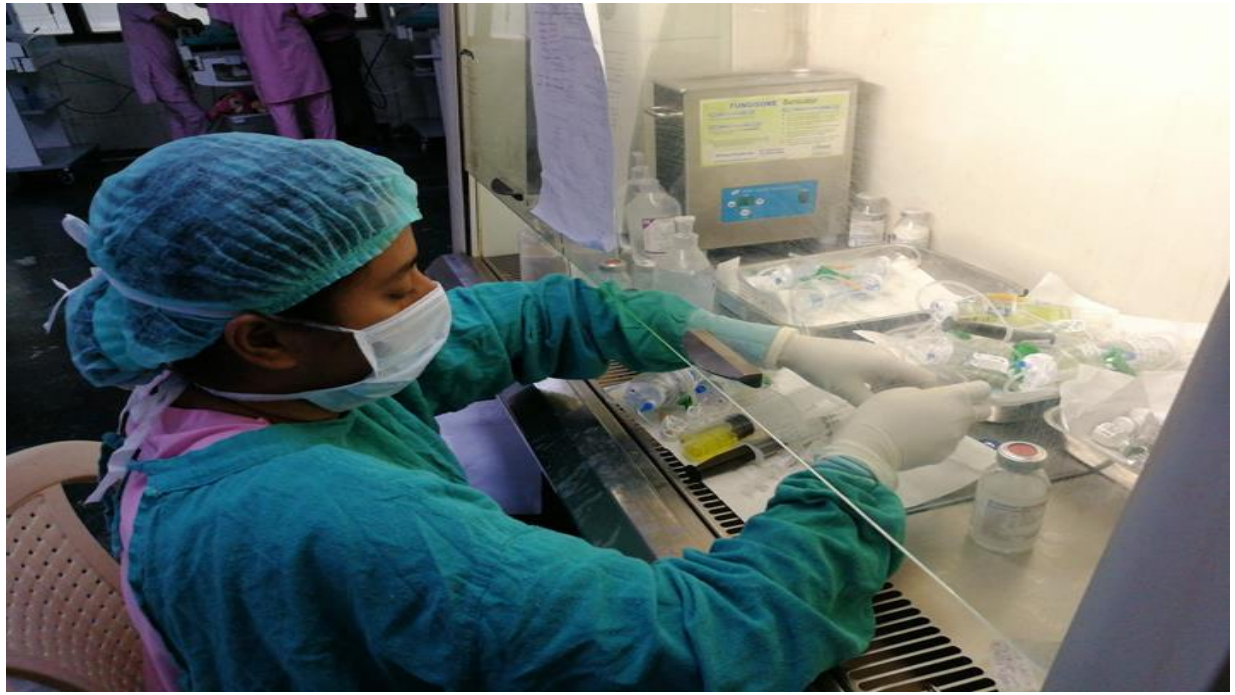
TERMINAL CLEANING CHECKLIST BED NO

SNO	ITEMS	EQUIPMENT	CLEANED Y/N	NAME OF THE STAFF
1	RADIANT WARMER/INCUBATOR			
	PROBE			
	BASE			
	DRAW			
	HUMIDIFIER			
2	INFUSION PUMP			
	1			
	2			
	3			
3	SYRINGE PUMP			
	1			
	2			
	3			
	4			
4	CARDIACMONITOR			
	SPO2 PROBE			
	NBP CABLE			
	ECG CABLE			
	RECTAL PROBE			
5	PULSEOXY			
	MASIMO/NELCOR			
6	AMBUBAG			

Preparation & giving medication

- *Ensure one needle, one syringe, one medication, one patient*
- DO NOT change the needle in order to reuse the syringe;
- DO NOT use the same mixing syringe to reconstitute several vials;
- DO NOT combine left over medications for later use.
- Whenever possible, use a single-dose vial for each patient
- DO NOT touch the diaphragm after disinfection with the 60–70% alcohol (isopropyl alcohol or ethanol).
- DO NOT enter several multi-dose vials with the same needle and syringe.
- Replace fluid bottle/ multidose vial/ infusion set after 24 hr of use

Preparation Of IV Medication Under Strict Asepsis In Laminar Flow

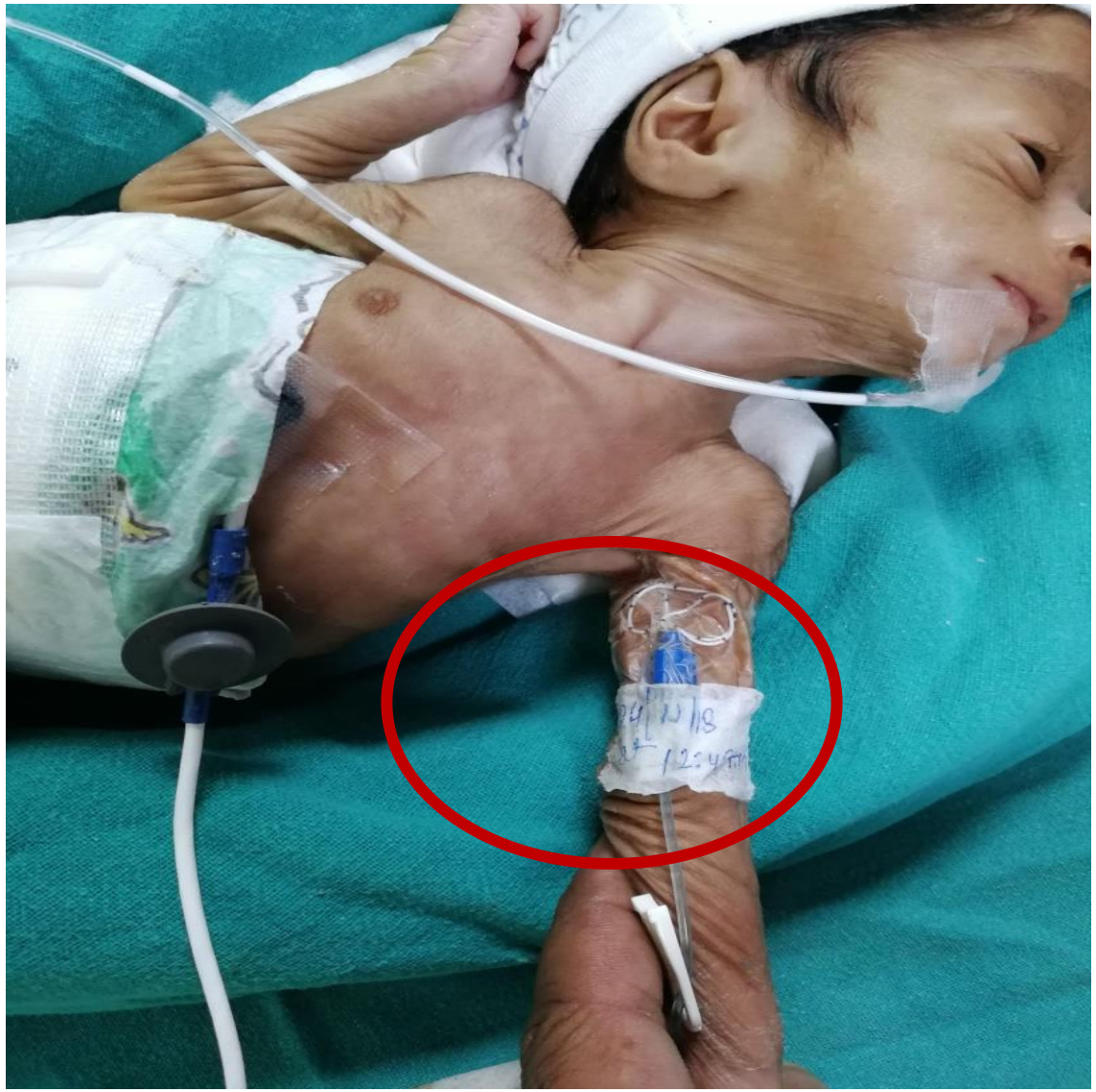


Administration of Medications with Strict Asepsis

Closed IV System

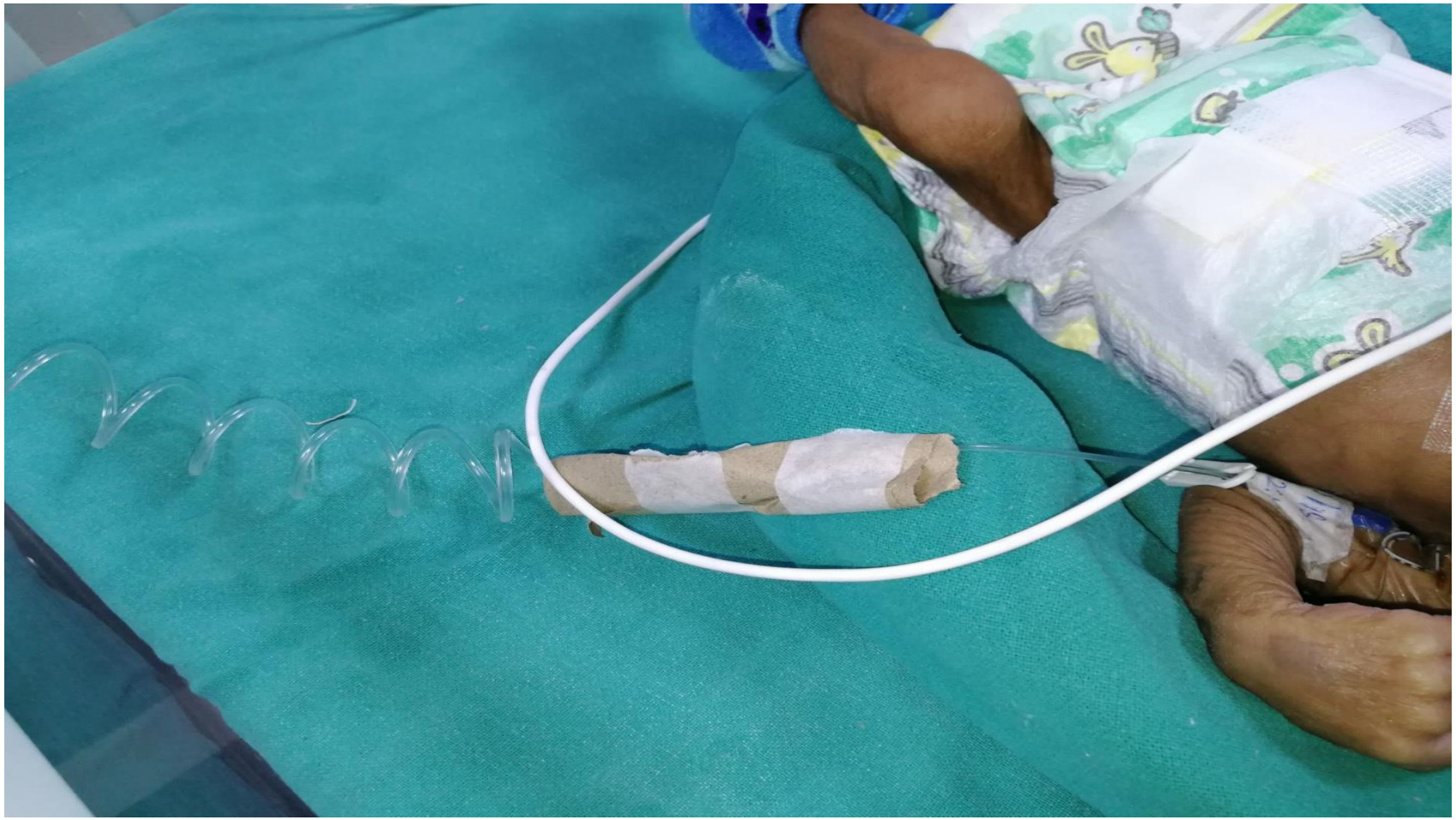
Minimal handling = minimal infection

Clean fixation of IV line (with date and time)



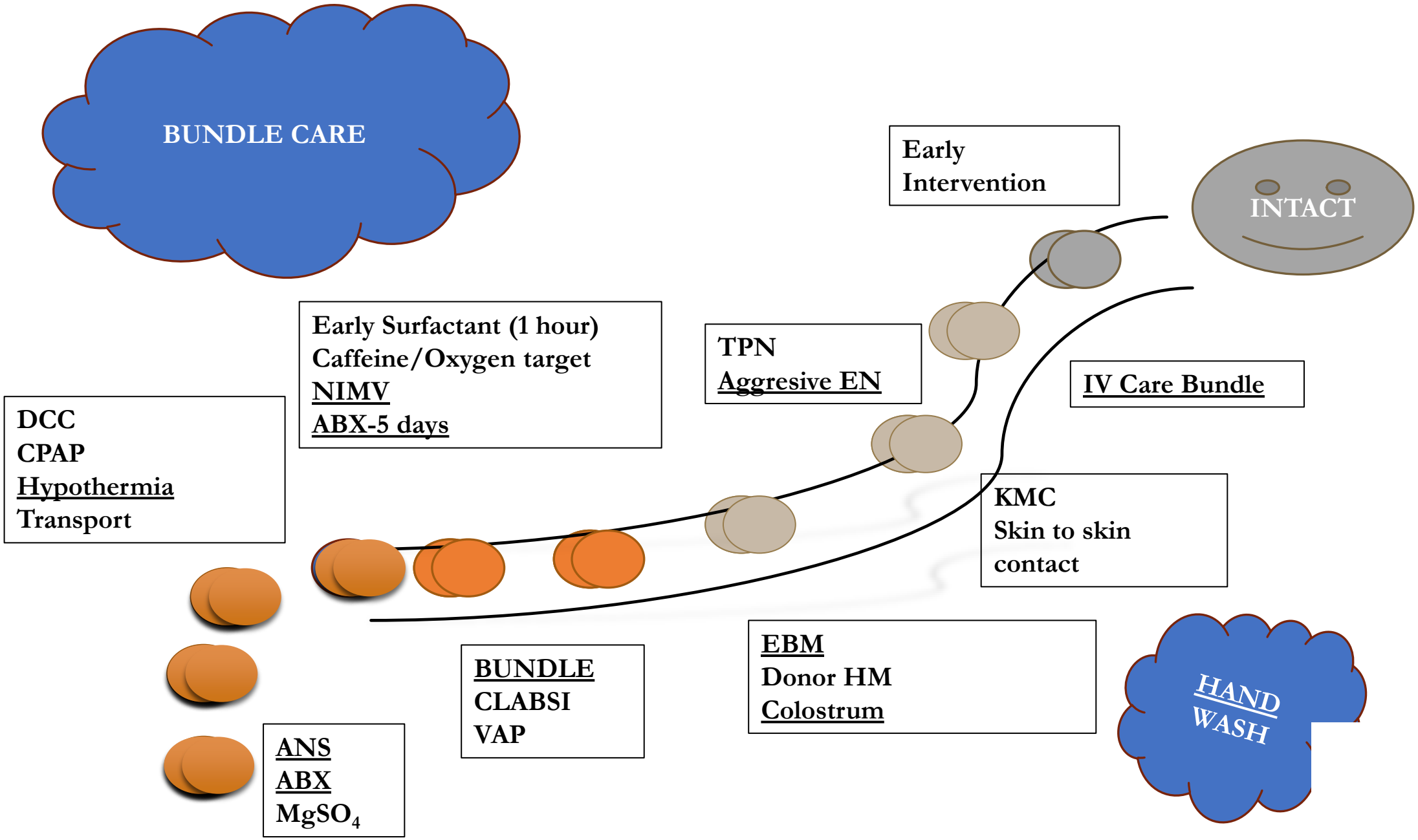
Clean Fixation Of IV Cannula With Splint And Transparent Dressing

Clean IV line Intersections



Clean Fixation Of OG Tube

STRICT ASEPSIS DURING ENDOTRACHEAL SUCTIONNING


BUNDLE CARE
Early
Intervention
INTACT
Early Surfactant (1 hour)
Caffeine/Oxygen target
NIMV
ABX-5 days
TPN
Aggresive EN
IV Care Bundle
DCC
CPAP
Hypothermia
Transport
KMC
Skin to skin
contact
BUNDLE
CLABSI
VAP
EBM
Donor HM
Colostrum
HAND
WASH
ANS
ABX
MgSO4

VAP Bundle

1. Active surveillance for VAP
2. Adherence to hand hygiene guidelines
3. Performance of daily assessments of readiness to wean.
4. Use of weaning protocols
5. Performance of regular oral care with an antiseptic solution
6. Use of NIV whenever possible and minimization of the duration of MV
7. Preferable use of OT instead of NT intubation
8. Removal of the condensate from circuits and keeping the circuit closed during removal
9. Change of circuit only when visibly soiled or malfunctioning
10. Avoidance of gastric overdistention
11. Avoidance of H2RB agents & PPI
12. Use of sterile water to rinse reusable respiratory equipment

Prevention of CLABSI In NICU

- No single intervention

- Bundles : are several EB practices individually proven, When applied together may result in greater improvement in desired outcome.

Bundle Interventions for CLABSI

Insertion Bundle

Establish a central catheter kit or cart with all the items required.

Perform hand hygiene with an alcohol-based product or disinfectant containing soap before and after palpating insertion sites and before and after inserting the central catheter

Use maximal barrier precautions sterile gown, sterile gloves, surgical mask, hat, and large sterile drape)

(Disinfect the skin with a proper antiseptic (e.g., 2% chlorhexidine, 70% alcohol) before catheter insertion

Dressings: Use sterile transparent/semipermeable dressing to be change when visibly soiled.

Bundle Interventions for CLABSI

Maintenance Bundle

Perform hand hygiene with an alcohol-based product or disinfectant containing soap before or after accessing the catheter, or before or after changing the dressing.

Daily check: catheter insertion sites to identify signs of infection and dressing integrity

If the dressing is damp, soiled or loosened, change the dressing aseptically and disinfect the skin around the insertion site (e.g., 2% chlorhexidine, 70% alcohol)

Use the fewest number of ports or lumens.

Maintain aseptic technique and scrub the hub using appropriate disinfectant at least for 15 seconds before and after.

Replace tubing used to administer blood, blood products, or fat emulsions within 24 hours of beginning the infusion

Daily review to remove catheter ASAP.

Avoid:

- Inline filters: in-line filters are not recommended for use only to prevent CLABSI. No difference in infections.
- Catheter dressing regimen: transparent dressings /Gauze dressing.
- Chlorhexidine-impregnated dressings: Not recommended
- Systemic prophylactic antimicrobials: Not effective.
- Antimicrobial locks: only in neonates with long term catheters with history of multiple CRBSI despite maximum aseptic precautions.
- Chlorhexidine bathing: Lack of evidence
- Avoid use of topical antibiotics or creams.

Prevention of Infection

- Personelle
- Infection Control Practices
- Early interventions and less invasive approach
- Design of NICU
- Education and surveillance
- Antimicrobial Stewardship

HOW'S BIO-MED WASTE DISPOSED

YELLOW

Anatomical waste and discarded medicines must be disposed using incineration, plasma pyrolysis or deep-burial

RED

All contaminated waste should be disposed using autoclaving or microwaving method or using chemical disinfection

WHITE

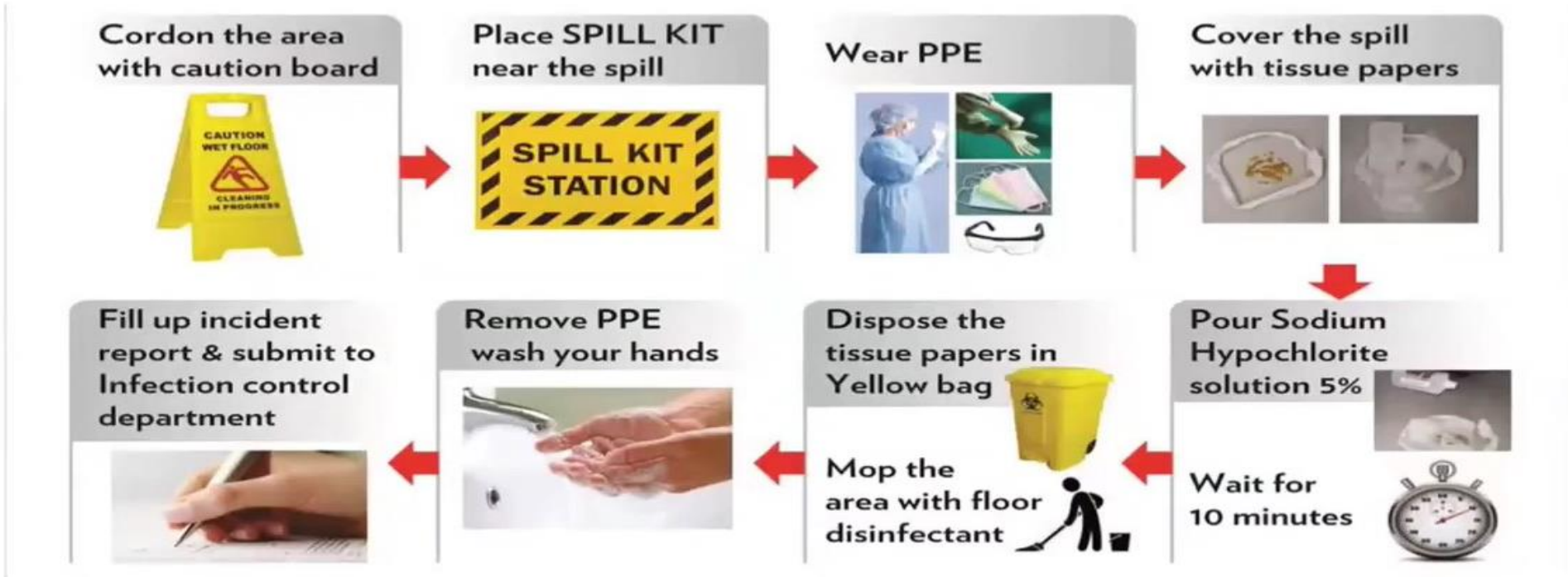
Waste sharps including metals should be disposed with sterilization & shredding, disinfection, burial or recycling

BLUE

Glassware & metallic body implants should be first disinfected using scientific methods before being sent to recycling

Bio-medical waste management

Spill management



Linen and Laundry management

Early Aggressive Enteral nutrition

- Remember: Breast milk reduces risk of sepsis and necrotizing enterocolitis in preterm infants
- Immunologic properties of breast milk secretory IgA
- Specific macrophages and lymphocytes
- Secretory molecules with antibacterial properties

BM has prebiotics, and probiotics and has been shown to decrease the incidence of gastrointestinal and respiratory infections in infancy.

Start Enteral nutrition ASAP: specially mothers milk

Precautions During Handling Breast Milk

- Contaminated breast milk pumps and refrigerated storage practices also a source of infection.
- Mothers- ensure hand hygiene and expression of milk into sterile containers.
- Clean the containers with hot, soapy water after each use, before they are sterilized.
- Breast pump : separate consumables for expression for each mother
- Wash all pump components that are in contact with milk with hot, soapy water after each use, dry thoroughly, and store in a clean place.
- Sterilize or high-level disinfect pump components daily.

Breast Milk Handling And Storage

- Store milk in sterile containers covered securely
- Label with infant's name, medical record number, date of birth and date of pumping and time
- On room temperature can be kept for 1 hour
- In refrigerator for 24 hours
- When stored in a refrigerator or freezer with milk for other infants, place all the feeds for each infant into a larger, labelled, cleanable bin or zip-lock bag, one for each infant.
- Use oldest milk first
- Follow the facility's written policy to identify and follow up (create a policy if none exists).

Family Centred Care

- Mother should be involved in the care of the baby mainly for hygienic care

Kangaroo mother care: Because a mother's touch is a miracle that never ceases to be miraculous.

Education


कंगारू माता देखभाल
(कंगारू मदर केयर : के.एम.सी.)
कंगारू माता देखभाल (के.एम.सी.) क्या होती है?
इस विधि में माँ अपने कम वजन के शिशु को अपनी नग्न छाती से चिपका कर रखती है
के.एम.सी. से बच्चे को गर्मी मिलती है। यह सनपान को बेहतर व साँस ठीक से लेने में सहायता करती है।
के.एम.सी. कैसे दी जाती है?
माँ बैठी हुई अथवा आधी लेटी हुई अवस्था में होनी चाहिए।
जितना समय तक संभव हो, के.एम.सी. दें।
किन शिशुओं को के.एम.सी. की जरूरत होती है?
2.5 कि.ग्रा. से कम वजन वाले सभी शिशुओं को के.एम.सी. की आवश्यकता होती है।
सभी कम वजन वाले शिशुओं को के.एम.सी. से लाभ होता है।
के.एम.सी. कहाँ पर दी जा सकती है?
नर्सरी अथवा प्रसवोत्तर वार्ड में
कब तक के.एम.सी. देते रहना चाहिए?
घर पर भी जारी रखनी चाहिए
माँ के अलावा और कौन के.एम.सी. दे सकता है?
परिवार का कोई भी सदस्य जैसे दादी, नानी, दादा, पिता के.एम.सी. दे सकते हैं।
के.एम.सी. की घटक क्या हैं?
माँ का अपनी छाती के साथ शिशु को चिपकाए रखना
स्तन-पान
के.एम.सी. देने के लिए आवश्यकताएं
माँ की मदद करना और अस्पताल से छुट्टी के बाद उपचार प्रदान करना
लाभ :
शिशु उचित तर्क लगा है।
स्तन-पान को बढ़ावा मिलता है।
शिशु के मानसिक व शारीरिक विकास में सुधार होता है।
अस्पताल से जल्दी छुट्टी होती है।
शिशु में होने वाले रोगों की संभावना कम होती है।
शिशु-माँ के आपसी बंधन को बढ़ावा मिलता है।
कंगारू माता देखभाल शिशु का अधिकार माँ का प्यार
आप किस लिए इन्तजार कर रहे हैं?
के.एम.सी. एक आसान, कम-खर्च तथा अति प्रभावी उपचार है जो कम वजन वाले शिशुओं को फायदा पहुँचाती है।
शिशुओं तथा उनकी माताओं को के.एम.सी. अच्छी लगती है।
आप भी अपनी कुटिया में के.एम.सी. को बढ़ावा दे सकते हैं चाहे सो आज से ही शुरू कर सकते हैं।
सभी कम जन्म-भार वाले शिशुओं के लिए के.एम.सी. सुनिश्चित कीजिए।
AIIMS, New Delhi
JIPMER, Chennai
KEM, Mumbai
KGMU, Lucknow
PGI, Chandigarh
KMC India Network
Save the Children USA
कृपया और अधिक जानकारी के लिए हमारी वेबसाईट www.kmcindia.org पर लॉग ऑन करें।
www.newbornwhocc.org


Strict hand washing by mothers


Mothers Education

Transmission Based Precautions

Precautions		Equipment
Standard	soiling	gowns
	Contact	gloves
	Splashing	mask , eye protection
Contact	MDR bacteria	gloves, gowns
Droplet	influenza, pertussis	gown, gloves, regular surgical mask
Airborn	Varicella, measles, TB	N-95, negative pressure environment

Spacing for Facilities with Newborn

Type of design	Newborn nursery	Special care unit NICU
Multi-patient rooms	• 2.2 square meters per infant • 1 meter (3 feet) between bassinets	• 11.2 square meters per infant • 2.4 meters (8 feet) between incubator /warmer/bassinet/ crib • Aisles > 1.2 meters (4 feet) wide
Single patient rooms	2.2 square meters, at least 1 meter (3 feet) in all directions between cribs	• > 14 square meters > 14 square meters •2.4 meter (8 feet) wide aisles •Space should be added for sinks, desks, cabinets, computers, and corridors

Spacing for Facilities with Newborn

Type of design	Newborn nursery	Special care unit NICU
Handwashing sinks	1 sink for every 6–8 patient s •A sink in the resuscitation area •1 sink per 3–4 patients in a dmission, observation, and continuing care areas	1 sink for every 3–4 patients
Air supply		• Positive pressure to adjacent areas • 90% efficiency filtration • 6 air exchanges/hour
Airborne infection i solation room (AIIR)	Access to at least one AIIR, which may be located on another ward	

Isolation & Cohorting

- Aim: Preventing the horizontal spread of infection from one patient to another. (Gastmeier P. 2004)
- When: Outbreaks
- If infections spread via direct or indirect contact
- If neonates are known or suspected to be colonized or infected with a different pathogen based on clinical diagnosis, microbiologic confirmation or epidemiology
- If neonates are particularly at risk of acquiring a HAI (protective isolation).
- Segregation of Inborn and outborn neonates admitted with infections

Surveillance of Infection

- Collection of data
- Sharing it with Staff
- Feed back
- Education and training

Developmental Supportive Care

Some more ….

- Appropriate vaccination of health care workers (eg, influenza vaccine and tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis, adsorbed)
- Visitation guidelines to identify ill/ infected visitors
- Cluster care
- Developmentally supportive care

Antibiotic Use And Misuse

Judicious use of Antibiotics: Avoid Prophylactic antibiotics

Over reliance of Sepsis screen

- De-escalate therapy once culture reports available
- discontinuing empirical treatment when a bacterial infection has not been identified.
- Use narrowest spectrum on the basis of susceptibility testing.
- Treat for the appropriate duration.
- Curtail the use of third-generation cephalosporins : as produces ESBL producing organisms.
- use other antibiotic agents, such as aminoglycosides for empirical therapy, has been associated with less antibiotic resistance.

How To Prevent AMR

1. Accurate Diagnosis

- Use Cultures properly, take blood culture before starting antibiotics.
- Facility for automated blood cultures at all centers
- Develop and validate point-of-care diagnostic method(s) for rapid and accurate diagnosis of sepsis
- Interpret Biomarkers wisely

2. Appropriate treatment

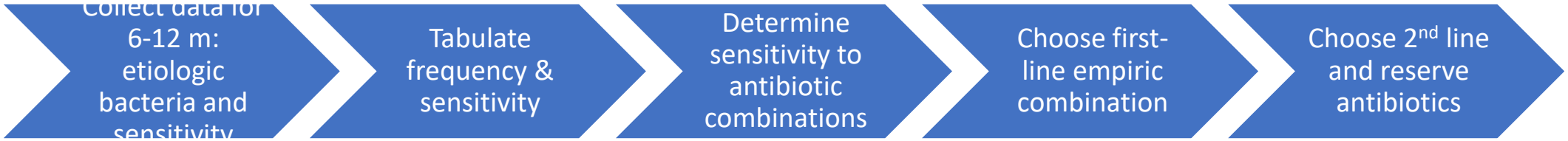
- Antimicrobial Stewardship:
- A written antibiotic policy
- Basic principles to use antibiotics
- What to start
- When to escalate/ de escalate
- When to stop

Antibiotic Stewardship

- Restrict the uses of antibiotics
- Avoid Broad spectrum
- Surveillance & auditing of culture
- Protocol of antibiotic prescription
- Infection control practices

Antibiotics: Choice of Empirical Antibiotics

- Choice of empirical antibiotics must be based upon local data of etiologic organisms and their antibiograms
- General principles:
  - Avoid third-generation cephalosporins, unless meningitis
  - Try to combine antibiotics with known synergism



- For units without access to local antibiotic data:
  - Where few strains are likely resistant to common antibiotics
    - Septicemia & pneumonia: Ampicillin/cloxacillin + gentamicin/amikacin
    - Meningitis: Ampicillin + cefotaxime
  - Where most strains are likely to be resistant
    - Ciprofloxacin/Piperacillin-Tazobactam + amikacin
    - 2nd line: Meropenem (add Vancomycin if MRSA suspected)

Courtesy: Dr M Jeevasankar

Antibiotics

Choice of antibiotics after culture sensitivity report

- If report shows resistance to empirical antibiotics:
    - Neonate not showing satisfactory clinical improvement or worsening of laboratory parameters
        - Upgrade to the simplest and narrowest spectrum sensitive antibiotic
    - If neonate shows clear cut clinical improvement
        - May cautiously continue with empirical antibiotics assuming in vivo sensitivity
        - Avoid resistant antibiotics if CNS or other deep-seated infection
- If the report shows sensitivity to simpler antibiotics
    - De-escalate to narrowest spectrum sensitive antibiotic, even if patient was improving on empiric antibiotics
    - Include duration of sensitive empiric antibiotic therapy while calculating total duration of antibiotics
    - Advantages of de-escalation:
        - Less antimicrobial resistance
        - Lower cost

Antibiotics : Duration

Diagnosis	Duration of antibiotics
Suspected sepsis, subsequent clinical course and biomarkers not suggestive of sepsis	Stop as soon as blood culture reported sterile
Culture-negative probable sepsis	5-7 days
Culture-positive sepsis with no meningitis	14 days
Meningitis	21 days
Ventriculitis	4-6 weeks
Bone and joint infections	4-6 weeks
Deep-seated abscesses	4-6 weeks

Most of the above durations of antibiotics are not based on strong evidence, and have come into clinical practice by convention

Restrict Uses of Broad Spectrum

- Cephalosporin- Never 1st line
- Stop broad spectrum once culture available
- Downgrade once culture available
- Rotation of antibiotics (Gentamicin)

Protocol of ABX Prescription

- Unit protocol
- Maximum of 4-5 antibiotics
- Document change of antibiotics
- Blood culture before change

Protocol of ABX Prescription

Minimize Duration of antibiotics

- 7-10 days in culture positive
- 5-7 days in pneumonia/screen positive
- 3 days or less in suspect sepsis

Protocol on upgarading of antibiotics

Microbiologist/Pharmacist/Form – Mero/Colistin
Unit protocol

Document change of antibiotics

Blood culture before change

Key Messages

- The incidence of neonatal sepsis in South Asia is 4 to 10 times higher than that in developed countries
- Simple, evidence based interventions can help, such as better asepsis, hand hygiene, and exclusive breastfeeding and establishing antimicrobial stewardship programmes
- Implementation research—quality improvement initiatives—to scale up the coverage of known interventions
- Identify the source of infection and transmission pathways of common pathogens
- Evaluate the impact of introducing antimicrobial stewardship programmes at different levels of health facilities

Alone we can
do so little;
together we can
do so much.

Battling super bugs in SNCU/NICU: Antimicrobial resistance burden & consequences

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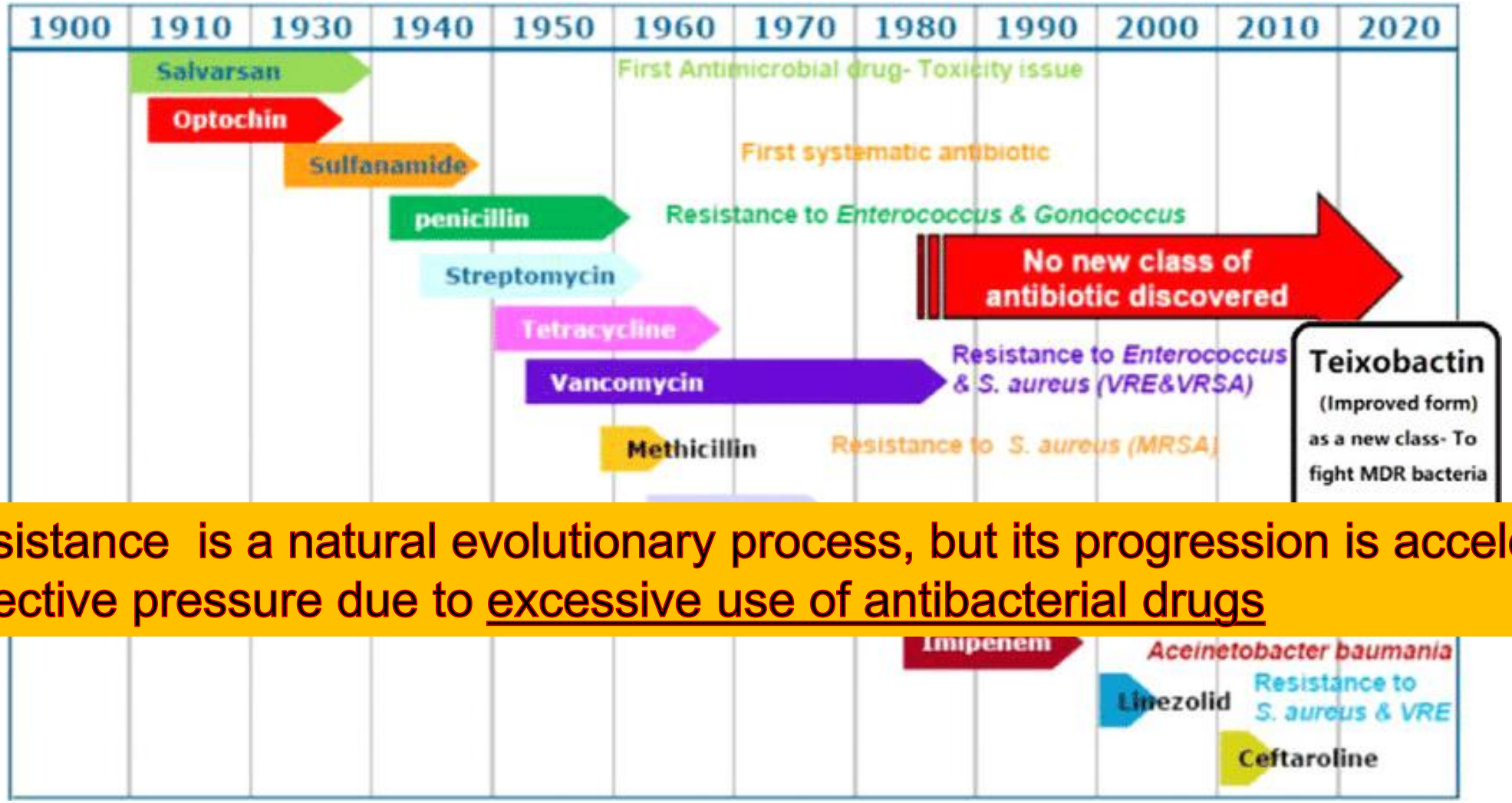
Antimicrobial agents- Use or Misuse!

- Antimicrobials - Essential life-saving drugs, often prescribed due to
  - ✓Fear of missing sepsis
  - ✓Sub-optimal point-of-care diagnostic markers
- However, considered as Ganga Jal- often misused!
- Charting antimicrobials gives pseudo-sense of being secured
- Common misuse
  - Incorrect prescription
  - Overconsumption
  - Prolonged use

Three most common abused drugs in our SNCU/NICU:

- Oxygen, **antibiotics** & intravenous fluids

Journey: Drug discovery & resistance development



Resistance is a natural evolutionary process, but its progression is accelerated by selective pressure due to excessive use of antibacterial drugs

Ruddaraju LK et al; Asian J Pharm Sci. 2020

Antibiotics Misuse- A Global Problem

- One of few health issues discussed in WHO Assembly

- Issue discussed in Modi-Obama meeting in 2015

District Hospital Study: Sepsis burden & multi-drug resistance in SNCUs

- SNCUs- 5 sites across India
- Total infants enrolled: 6612
- Nahta hospital, Balotra
- Culture +ve sepsis: 3.3%
- Culture –ve sepsis: 31.4%

	Culture-positive sepsis	Culture-negative sepsis	Total sepsis
Incidence/ prevalence*			
Overall (n=6612)	215 (3·3; 2·8-3·7)	2074 (31·4; 30·2-32·5)	2289 (34·6; 33·5-35·8)
Site 1 (n=1742)	10 (0·6; 0·3-1·0)	454 (26·1; 24·0-28·2)	464 (26·6; 24·6-28·8)
Site 2 (n=1358)	136 (10·0; 8·5-11·7)	608 (44·8; 42·1-47·5)	744 (54·8; 52·1-57·5)
Site 3 (n=1020)	22 (2·2; 1·4-3·2)	407 (39·9; 36·9-43·0)	429 (42·1; 39·0-45·2)
Site 4 (n=1100)	34 (3·1; 2·2-4·3)	311 (28·3; 25·6-31·0)	345 (31·4; 28·6-34·2)
Site 5 (n=1392)	13 (0·9; 0·5-1·6)	294 (21·1; 19·0-23·4)	307 (22·1; 19·9-24·3)

Common organisms
- Klebsiella spp.
- E.Coli
- Enterobacter
- CONS
- Staph. Aureus
- Acinetobacter spp.

	Died (n=681)	Survived (n=5931)	Relative risk (95% CI)	Adjusted relative risk* (95% CI)
No sepsis (n=4323)	185 (4·3)	4138 (95·7)	-	-
Culture-negative sepsis (n=2074)	410 (19·8)	1664 (80·2)	4·6 (3·9-5·4)	3·3 (2·8-4·0)
Culture-positive sepsis (n=215)	86 (40·0)	129 (60·0)	9.3 (7·5-11·6)	5·1 (3·9-6·6)

Data are n (%).

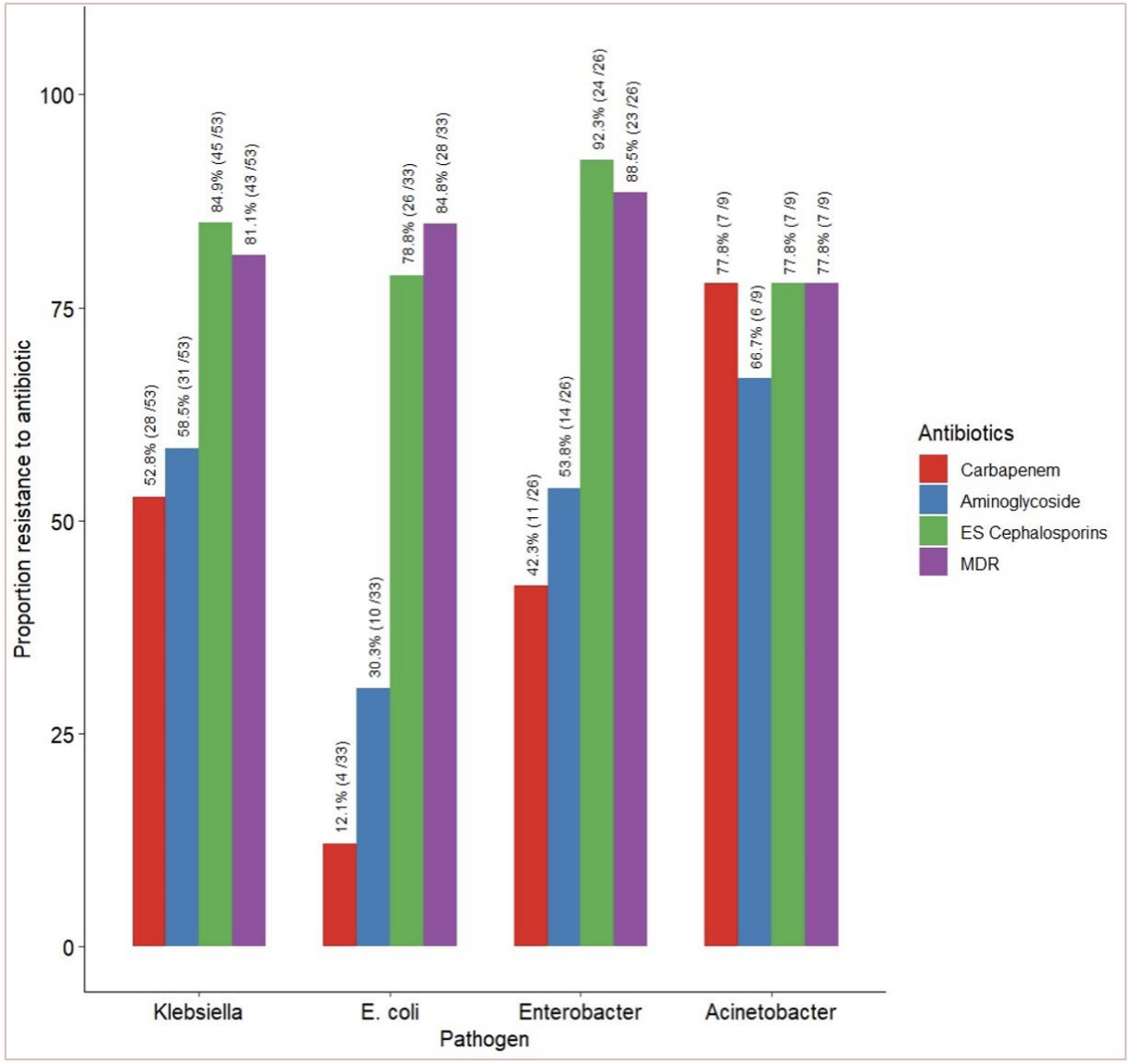
**Adjusted for birth weight, gestation, major malformations, and whether cried at birth or not.*

Under publication

Antimicrobial resistance (AMR) pattern

Multi-drug resistance (MDR):
Gram-negative isolates non-susceptible to ≥1 agent in ≥3 antimicrobial categories

Multi-drug resistance: 77-89%



Delhi Neonatal Infection Study (DeNIS)

- Level III NICU: 4 sites in Delhi from 2011-2014
- Total infants enrolled: 13530 out of 88636
- Incidence
  - ✓ Culture +ve & -ve sepsis: 14.3 (13,8-14.9)
  - ✓ Culture +ve sepsis: 6.2% (5.8-6.6)
- Multi-drug resistance: 40-80%
- Methicillin resistance: 40-80%

	Number of resistant isolates	CFR in culture-positive sepsis due to resistant pathogens	CFR in culture-positive sepsis due to sensitive pathogens
Gram negative			
Acinetobacter spp (n=222)			
ES cephalosporins	85/222 (38%)	59/85 (69%)	71/137 (52%)
Carbapenems	174/222 (78%)	106/174 (61%)	24/48 (50%)
MDR	181/222 (82%)	112/181 (62%)	18/41 (44%)
Klebsiella spp (n=169)			
ES cephalosporins	105/169 (62%)	57/104 (55%)	38/65 (58%)
Carbapenems	59/169 (35%)	36/59 (61%)	59/110 (54%)
MDR	91/169 (54%)	52/91 (57%)	43/78 (55%)
Escherichia coli (n=137)			
ES cephalosporins	65/137 (47%)	40/64 (63%)	43/73 (59%)
Carbapenems	21/137 (15%)	12/21 (57%)	71/116 (61%)
MDR	52/137 (38%)	30/52 (58%)	53/85 (62%)
Pseudomonas spp (n=68)			
ES cephalosporins	32/68 (47%)	29/32 (91%)	24/36 (67%)
Carbapenems	21/68 (31%)	19/21 (90%)	34/47 (72%)
MDR	13/68 (19%)	11/13 (85%)	42/55 (76%)
Enterobacter spp (n=44)			
ES cephalosporins	20/44 (45%)	6/20 (30%)	10/24 (42%)
Carbapenems	9/ 44 (20%)	4/9 (44%)	12/35 (34%)
MDR	22/44 (50%)	8/22 (36%)	8/22 (36%)
Gram positive			
Coagulase-negative staphylococci (n=150)			
Meticillin	85/140 (61%)	23/85 (27%)	14/55 (25%)
Vancomycin	0/138	..	36/138 (26%)
Staphylococcus aureus (n=122)			
Meticillin	43/114 (38%)	16/43(37%)	22/71 (31%)
Vancomycin	0/114	..	38/114 (33%)
Enterococcus spp (n=56)			
Meticillin	11/14 (79%)	10/11 (91%)	2/3 (67%)
Vancomycin	13/48 (27%)	9/13 (69%)	20/35 (57%)

Lancet Glob Health 2016

Burden of antimicrobial resistance in South-East Asia

Table 2 | Pathogen specific antimicrobial resistance in isolates from babies with neonatal sepsis in South Asia

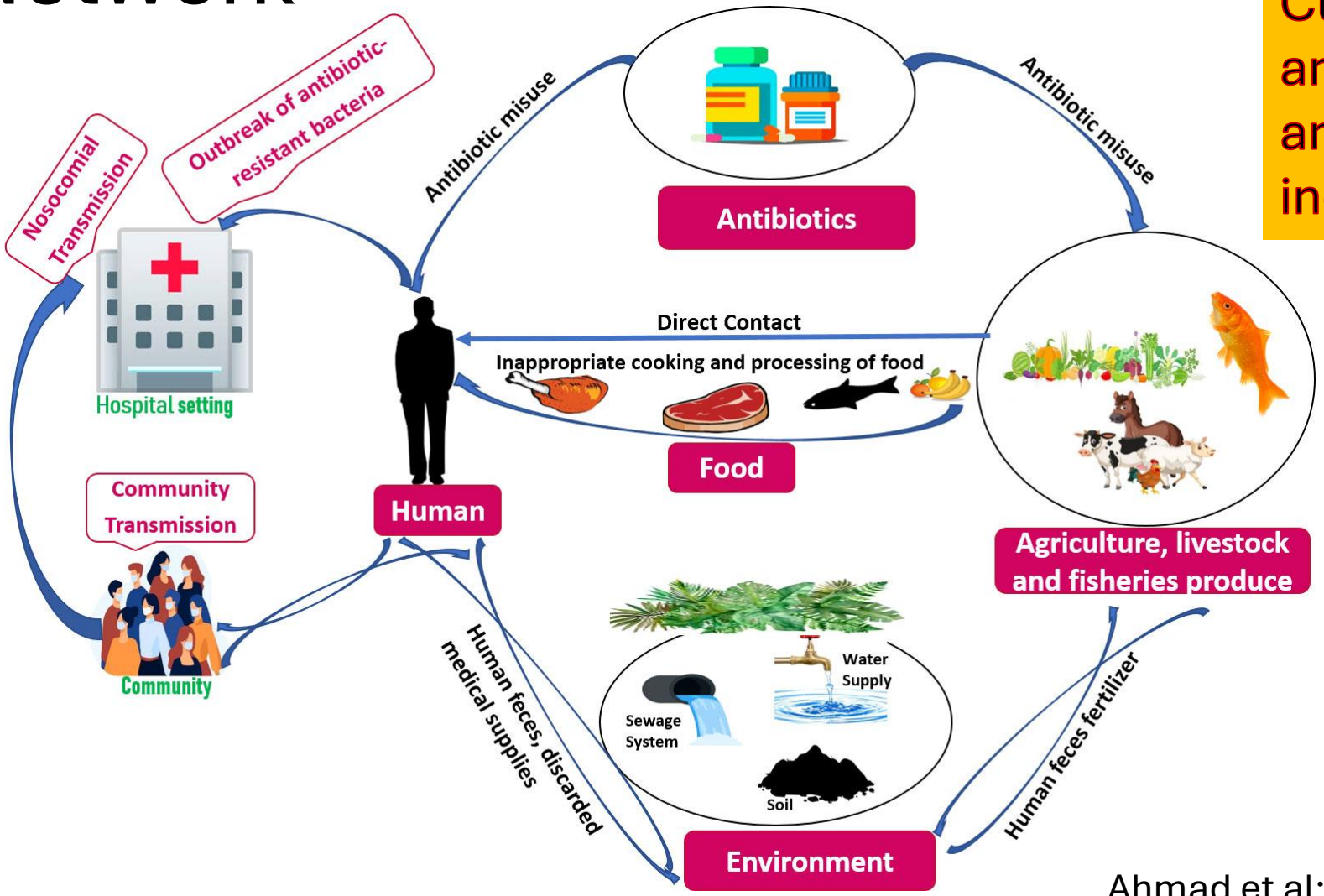
Pathogen (total No of isolates)	% of isolates resistant (95% CI); No of isolates					
	Ampicillin	Gentamicin	Cefotaxime	Ceftazidime	Meropenem/ meticillin	Multidrug
Hospital settings						
Klebsiella spp (n=4312)	86.8 (85.8 to 87.3); 2806	75.3 (74 to 76.7); 2954	72.5 (71.3 to 73.7); 4126	74.5 (73 to 75.9); 2455	10.4 (9.4 to 11.5); 254	70.7 (66.1 to 75.3)
E coli (n=2798)	88.2 (87 to 89.5); 2196	67.9 (66 to 69.8); 2254	66.9 (65.3 to 68.6); 2745	69.4 (67.4 to 71.4); 1773	8.1 (6.8 to 9.4); 1551	54.0 (48.1 to 59.9)
Acinetobacter spp (n=1347)	86.2 (83.8 to 88.5); 633	68.1 (65.1 to 71); 792	80.3 (78.2 to 82.4); 1121	73.6 (70.8 to 76.3); 718	64.8 (62.2 to 67.4); 828	78.7 (73.9 to 83.4)
S aureus (n=2437)	69 (67.3 to 70.6); 2266	54.5 (52.4 to 56.6); 1773	51.2 (49 to 53.3);1753	NA	46.5 (41.9 to 51.1); 310	NA
Community settings						
Klebsiella spp (n=116)	87.9 (82.3 to 93.5)	22.8 (15 to 30.1)	25.7 (18 to 33.5)	28.5 (19.8 to 37.1)	0 (0 to 2)	—
E coli (n=37)	72.4 (58 to 86)	18.7 (6 to 31)	50.3 (35 to 65.7)	37 (13.3 to 60.6)	0 (0 to 2)	—
S aureus (n=77)	74.6 (66.6 to 82.6)	3 (0-9)	9 (2 to 16)	NA	10 (0 to 20.5)	—

Data represent pooled proportion (95% CI); n=number of isolates tested, unless stated otherwise.
NA=not applicable.

a. 50-88% of common isolates are resistant to first line antibiotics—ampicillin and gentamicin
b. 50-80% are multi-drug resistant

Chaurasia et al, BMJ 2019

Antimicrobial resistance within One-Health Network



Curb use of antimicrobials agents in animal and agriculture industry!

Ahmad et al; Front Cell Infect Microbiol. 2023

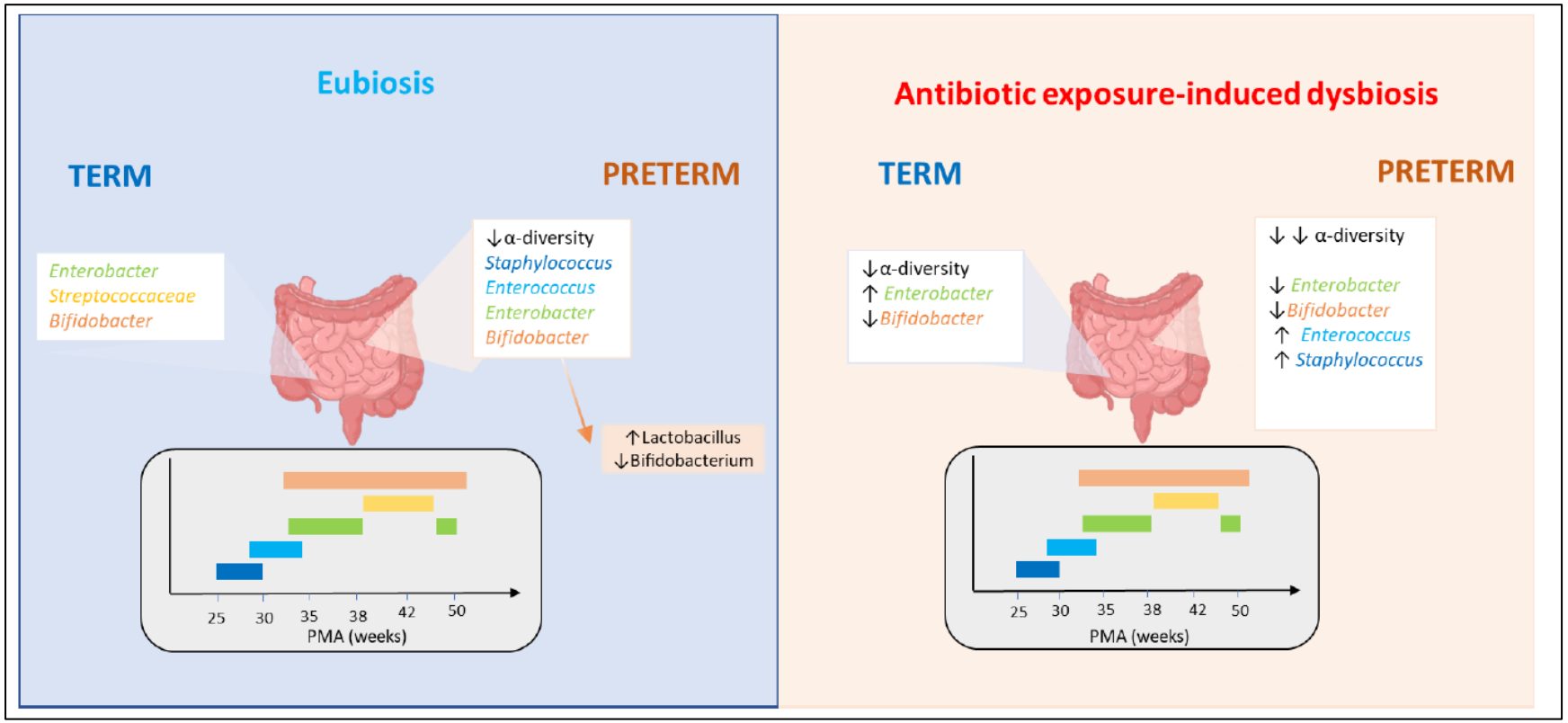
What has antibiotic misuse led to?

- Antimicrobial resistance
- Increase
  - Duration of hospitalization
  - Healthcare cost
  - Complications due to adverse effects of drugs & IV cannulation
  - Increased risk of infections

How newborns are different?

- Microbiota is getting established
- Microbiota-host cross talk involved in biological process:
  - Immune maturation
  - Metabolic processes
  - Neurocognitive & neuro-behavioural process (Microbiome-gut-brain-axis)
- Gets affected with antibiotic exposure (perinatal and postnatal)

Perinatal antibiotic exposure & neonatal gut microbiota



Morreale et al; Antibiotics (Basel). 2023

Impact of antibiotic on gut microbiota and resistance development…

(a) Antibiotic exposure - compared with no antibiotic exposure (9 studies; 2509 neonates)

Study	Infection and/or colonization rates (Lower / Unchanged / Higher)	Risk estimates	Specific outcomes	Colonization or infection
Calil, 2001	Higher	OR 2.5, 95% CI 1.08-5.77†	MDR *E. cloacae*	Colonization
Crivaro, 2007	Higher	Not available	ESBL-producing *S. marcescens* & *K. pneumoniae*	Colonization
Duman, 2005	Higher	RR 14.05; 95% CI 1.19-164.62	ESBL-producing Enterobacteriaceae	Colonization
Giuffre, 2016	Higher	Not available	MDR Gram-negative bacteria	Colonization
	Unchanged		ESBL-producing Gram-negative bacteria	Colonization
Kumar, 2014	Higher	OR 26.04, 95% CI 3.51-35.45†	Carbapenem-resistant *A. baumannii*	Infection
Millar, 2008	Unchanged	Not available	MDR Enterobacteriaceae	Colonization
Pessoa-Silva, 2003	Unchanged	OR 3.23, 95% CI 0.99-10.49	ESBL-producing *K. pneumoniae*	Infection
Rettedal, 2013	Higher	OR 5.5; 95% CI 5.6-15.3†	ESBL-producing *K. pneumoniae*	Colonization
Sehgal, 2007	Higher	OR 17.80, 95% CI 1.91-165.54†	ESBL-producing Gram-negative bacteria	Infection

We graded QoE as moderate owing to inclusion of observational studies with large effect estimates.

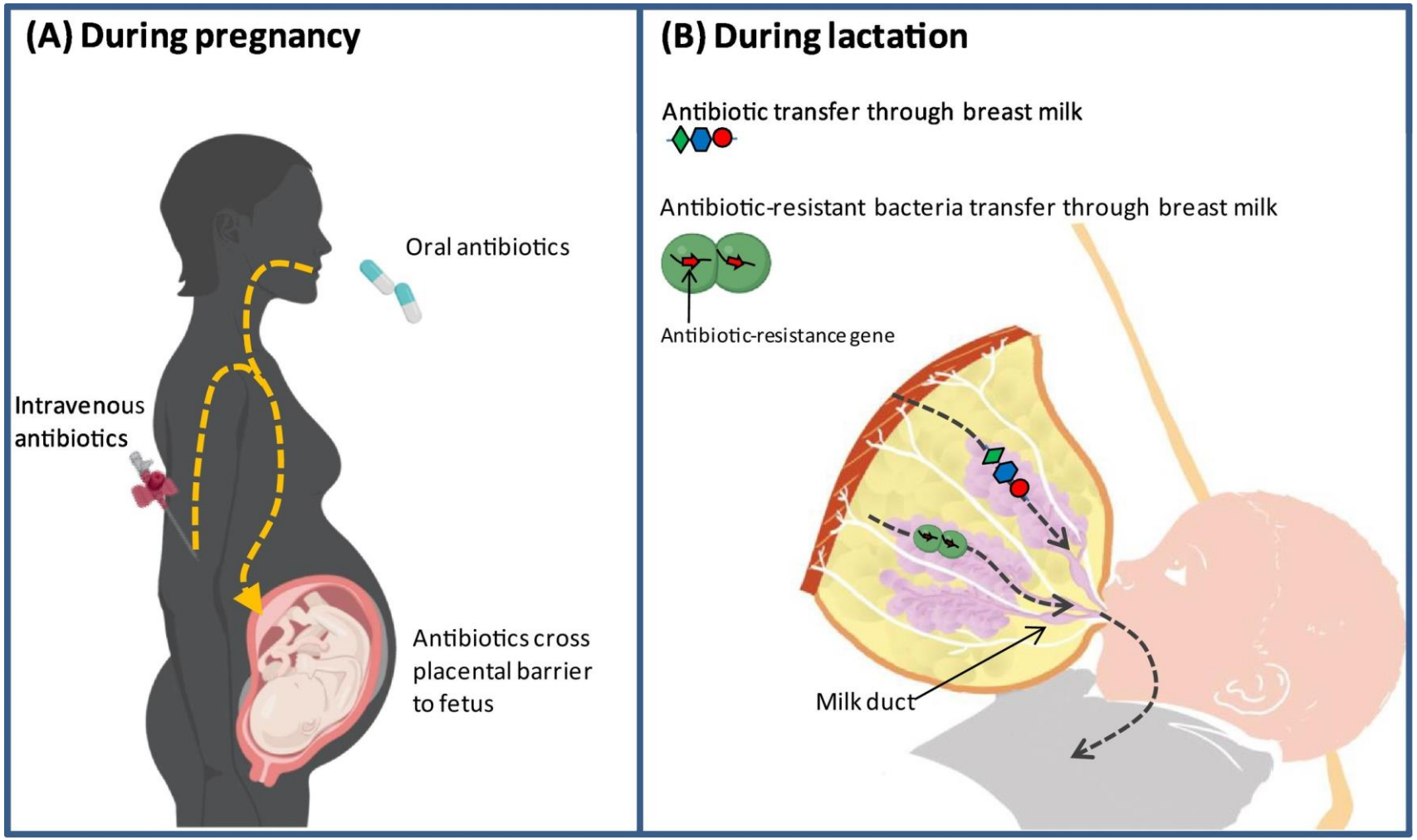
Impact of antibiotic on gut microbiota and resistance development (long vs. short duration)

(b) Antibiotic exposure - long duration compared with shorter duration (5 studies; 4281 neonates)

Study	Infection and/or colonization rates (Lower / Unchanged / Higher)	Risk estimates	Specific outcomes	Colonization or infection
Cantey, 2016		Not available	MDR Gram-negative bacteria	Colonization
Crivaro, 2007		OR 1.32, 95% CI 1.02-1.70†	ESBL-producing *S. marcescens* & *K. pneumoniae*	Colonization
Giuffre, 2016		Not available	MDR Gram-negative bacteria	Colonization
Le, 2008		OR 1.04, 95% CI 1.01-1.07†	ESBL-producing Gram-negative bacteria	Colonization
		OR 3.09, 95% CI 1.28-7.49†	ESBL-producing Enterobacteriaceae	Infection
Mammina, 2007		Not available	MDR Gram-negative bacteria	Colonization

We graded QoE as moderate owing to inclusion of observational studies that demonstrated a dose–response effect. RR, risk ratio.

Vertical transfer of antibiotics and antibiotic resistant strains across the mother/baby axis



Patangia et al; Trends Microbiol. 2022

Antibiotics misuse – Specific disadvantage in neonates

Short-term consequences

- Increased risk of
  - Sepsis including fungal infections

    (esp. with cephalosporins)
  - NEC
  - Death

Long-term consequences

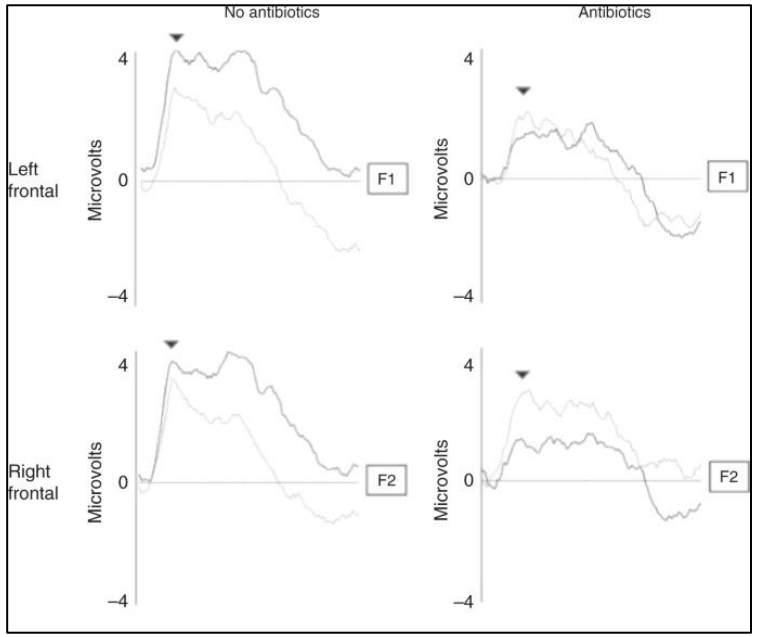
- Increased risk of
  - Allergic diseases: Asthma, eczema, celiac disease
  - Metabolic disease: Obesity
  - Inflammatory bowel disease

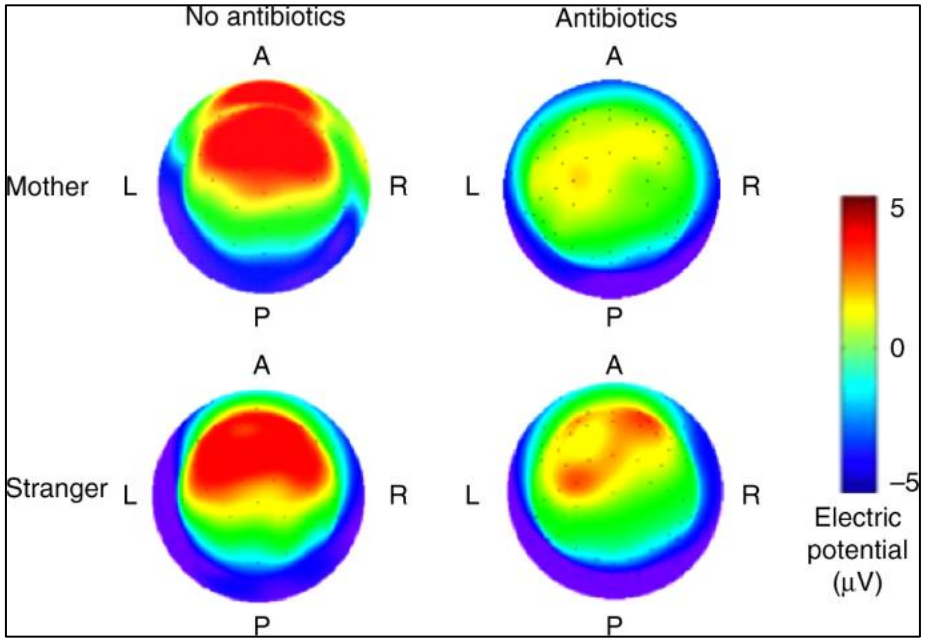
Association with above morbidities is:

1. **Dose-dependent**
2. **Type of antibiotic given (broad vs narrow spectrum)**

Alexander et al; J Pediatr 2011
Abdel Ghany et al; Ann Saudi Med. 2012
Ahmadizar et al; Pediatr Allergy Immunol. 2017

Effect of antibiotics on recognition memory at one-month of age





Otherwise healthy infants exposed to antibiotics soon after birth demonstrated altered auditory processing and recognition memory responses

Hickey et al; Pediatr Res. 2021

Antibiotic exposure within first 2 years of age & childhood health outcomes…

TABLE 1. Demographic and Clinical Characteristics of Children in the Study Cohort and Their Mothers Stratified by Antibiotic Exposure in the First 2 Years of Life[a]

Characteristic	Not exposed (n=4352)	Exposed (n=10,220)	All (N=14,572)
Children			
Sex			
Female	2223 (51.1)	4803 (47.0)	7026 (48.2)
Male	2129 (48.9)	5417 (53.0)	7546 (51.8)
Duration of follow-up (y)[b]	8.4 (6.1-10.4)	9.1 (6.5-11.7)	8.8 (6.4-11.4)
Birth weight (kg)	3.4 (3.1-3.7)	3.4 (3.1-3.8)	3.4 (3.1-3.8)
Ethnicity			
White	2951 (67.8)	7397 (72.4)	10348 (71.0)
Black	365 (8.4)	934 (9.1)	1299 (8.9)
Asian	338 (7.8)	617 (6.0)	955 (6.6)
Hawaiian/Pacific Islander	19 (0.4)	33 (0.3)	52 (0.4)
American Indian	18 (0.4)	28 (0.3)	46 (0.3)
Other/unknown	661 (15.2)	1211 (11.8)	1872 (12.8)
Cesarean section	940 (21.6)	2434 (23.8)	3374 (23.2)
Number of prescriptions			
1-2	—	4560 (44.6)	
3-4	—	2434 (23.8)	
≥5	—	3226 (31.6)	
Categories			
Penicillins	—	9306 (63.9)	
Cephalosporins	—	3401 (23.3)	
Sulfonamides	—	777 (5.3)	
Macrolides	—	3724 (25.6)	

Aversa et al; Mayo Clin Proc. 2021

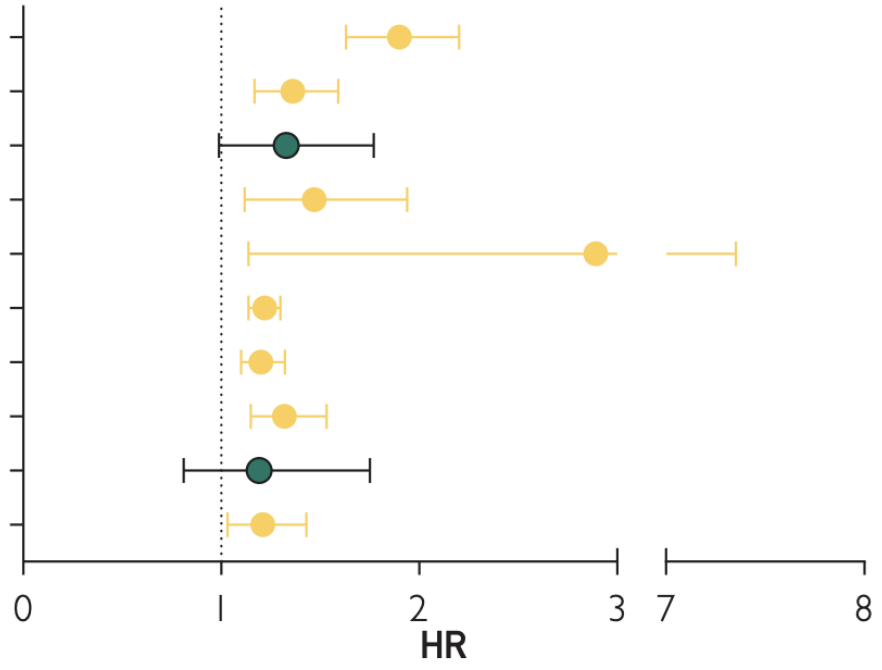
Antibiotic exposure within first 2 years of age & childhood health outcomes…

Immune system

Metabolic

Neurobehavioural

Condition	No. of subjects	No. of events	HR (95% CI)	*P* value
Asthma	14,299	1176	1.90 (1.63-2.20)	<.001
Allergic rhinitis	14,545	971	1.36 (1.17-1.59)	<.001
Food allergy	14,402	261	1.33 (0.99-1.77)	.054
Atopic dermatitis	14,166	297	1.47 (1.12-1.94)	.006
Celiac disease	14,569	45	2.89 (1.14-7.35)	.025
Overweight	12,873	4856	1.22 (1.14-1.30)	<.001
Obesity	13,649	2567	1.20 (1.10-1.32)	<.001
ADHD	14,572	1085	1.32 (1.15-1.53)	.001
Autism	14,571	142	1.19 (0.81-1.75)	.385
Learning disability	14,392	751	1.21 (1.03-1.43)	.022



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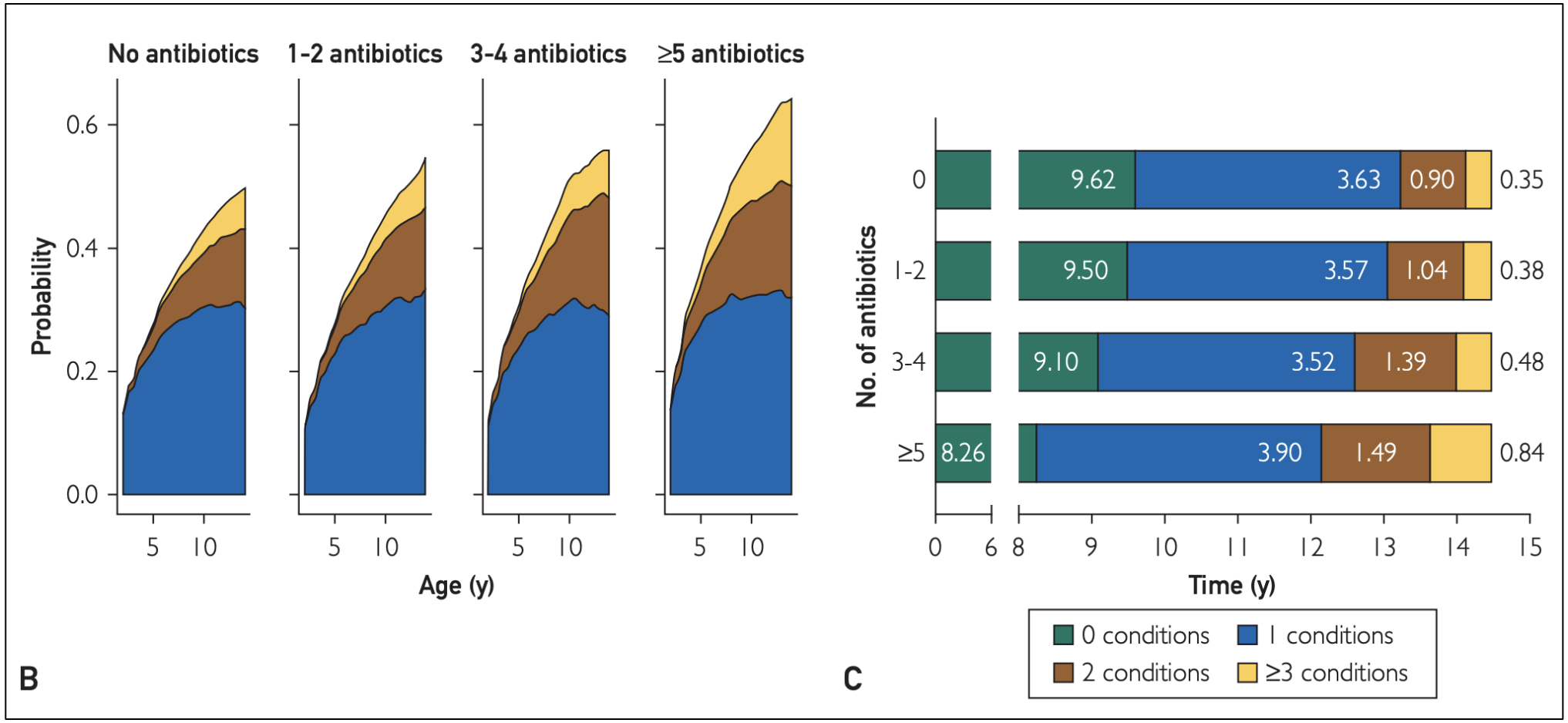
Aversa et al; Mayo Clin Proc. 2021

Antibiotic exposure within first 2 years of age & childhood health outcomes…



Aversa et al; Mayo Clin Proc. 2021

Key Messages

- Antimicrobial resistance is a global problem with huge burden more so in LMICs
- Misuse of antibiotics causes both short and long-term adverse effects
- These adverse effects may cause permanent disability demanding huge healthcare cost
- However, misuse of antibiotics is largely preventable by simple strategies


Thank You!