Childhood Pneumonia

Clinical presentation and Early Detection & Referral

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BURDEN

- **Globally**
  - Under 5 mortality: Major culprit
    - 14% deaths (WHO, 2019)
      - 2400 lives per day
      - 7.4 lakh per year
    - Pneumonia is a disease of poverty, a sign of inequality
      - 84% of child deaths from pneumonia in 30 countries mostly sub-Saharan Africa & Asia.
- **India**
  - **11 % of Global pneumonia deaths** (UNICEF 2019)
    - **Contributing factors: malnutrition**, low birth weight, non exclusive breast feeding, lack of immunisation, indoor pollution and overcrowding.
  - **Regional Disparity**: Kerala & Tamil Nadu reporting lower incidence rates

What is Pneumonia?

Pneumonia in Children: Definitions

- **Pathologist's Definition:**
  - **Inflammation of the lung parenchyma**, often caused by infection.
  - Histologically, it may show **neutrophilic infiltration**, **edema**, and **alveolar hemorrhage** depending on the causative organism.
- **Radiologist's Definition:**
  - **Chest X-ray: New infiltrates, consolidation, or opacities** in the lung fields.
  - The presence of **air bronchograms** or **pleural effusion** may suggest bacterial pneumonia, while **lobar consolidation** is indicative of more severe disease.

We need a clinician's definition of Pneumonia !

What symptoms or complaints would prompt a parent to bring a child to a healthcare facility?

TACHYPNEA
BREATHLESSNESS

WHEEZE

HEADACHE

ABDOMINAL
PAIN

DIFFICULTY IN
BREATHING

FEVER

COUGH

CHEST
PAIN


?
WHEEZE
HEADACHE
TACHYPNEA
BREATHLESSNESS
ABDOMINAL PAIN
FEVER
DIFFICULTY IN BREATHING
CHEST PAIN
COUGH

Which equipment is most useful for diagnosing pneumonia in children?

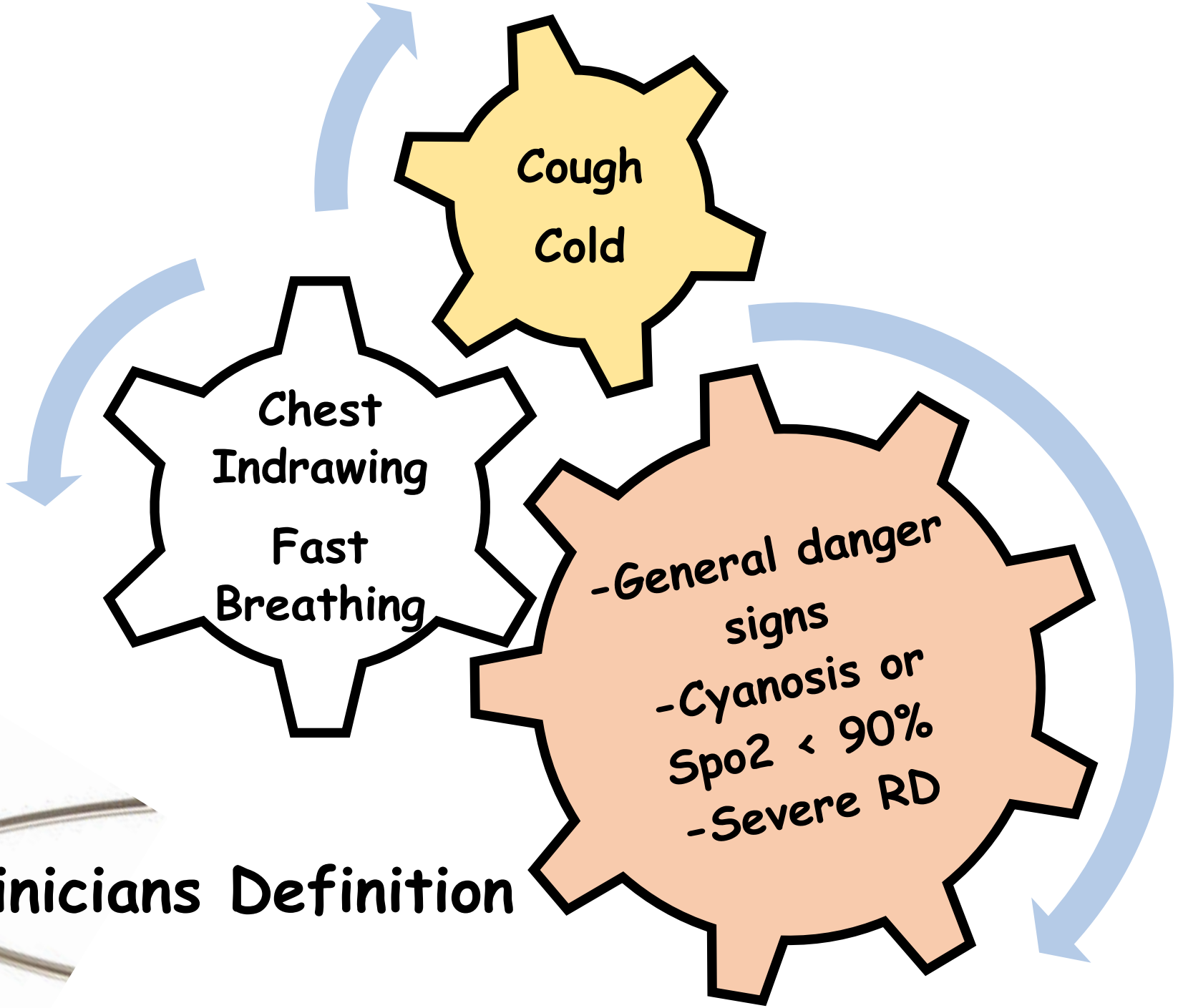
- A) Pulse Oximeter and Thermometer

- B) Stethoscope

- C) Chest X-ray

D) Watch

WHO

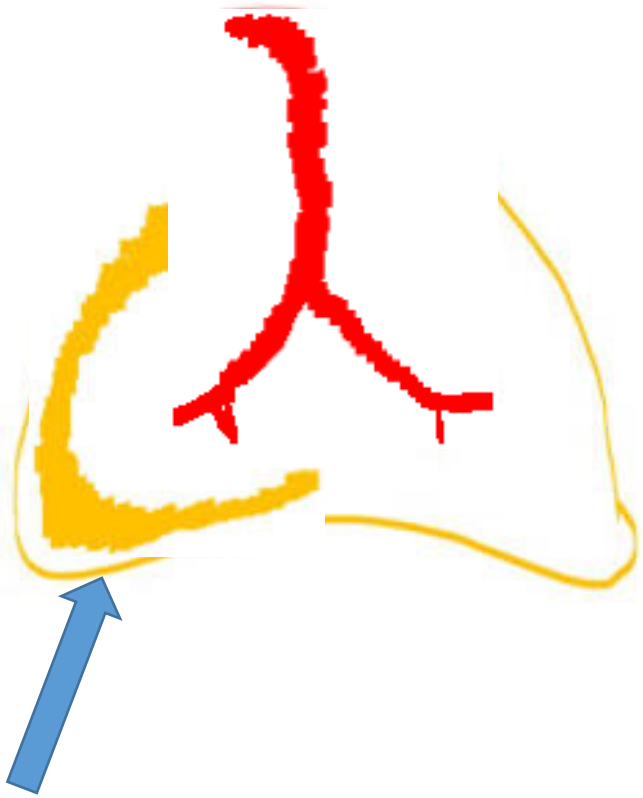


Clinicians Definition

Acute onset difficult breathing

Respiratory

Asthma
Bronchiolitis
Viral croup
Foreign body in the airways
Pneumonia
Effusion and Empyema
Pneumothorax



Non-Respiratory

Congestive heart failure
Raised intra-cranial tension e.g. Meningitis
Metabolic acidosis e.g. Diabetic Ketoacidosis, Renal Failure

What is fast breathing?

Fast breathing

Age	Respiratory rate (breath per minute)
< 2 months	> 60/min
2 to 12 months	> 50/min
> 12 months	> 40/min

To be counted for complete 60 seconds

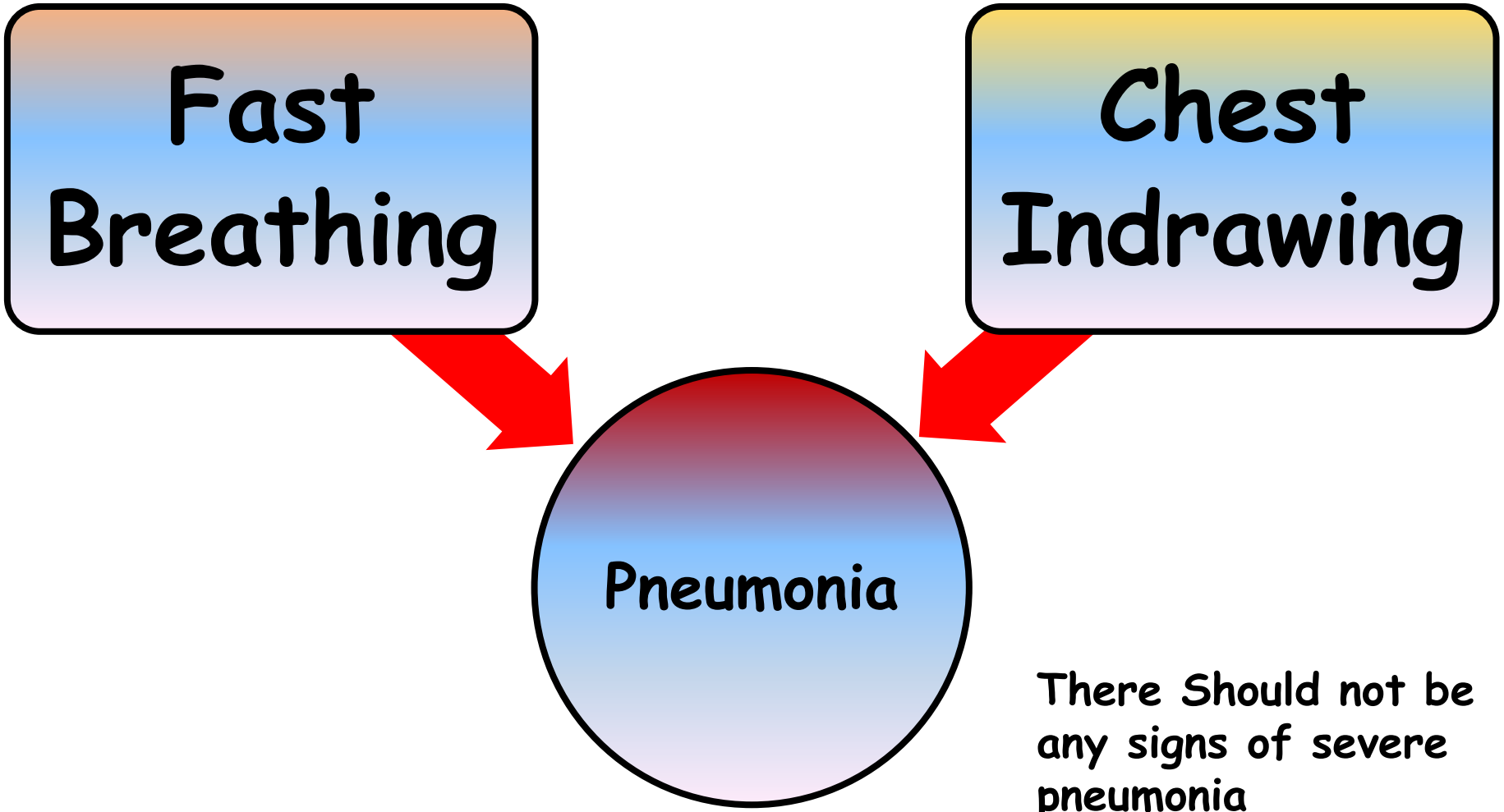
Respiratory rate

- <1 year age, RR of 70 breaths/min
  Sensitivity 63% and Specificity 89% for **Hypoxaemia**
- <5 years age, the WHO definitions for tachypnea
  Sensitivity 74% and specificity 67% for **Radiographically-defined Pneumonia**

Only fast breathing, No danger signs
  Radiological pneumonia 14%, lobar pneumonia 1%

Work of breathing, compared to fast breathing, is more indicative of the likelihood of pneumonia

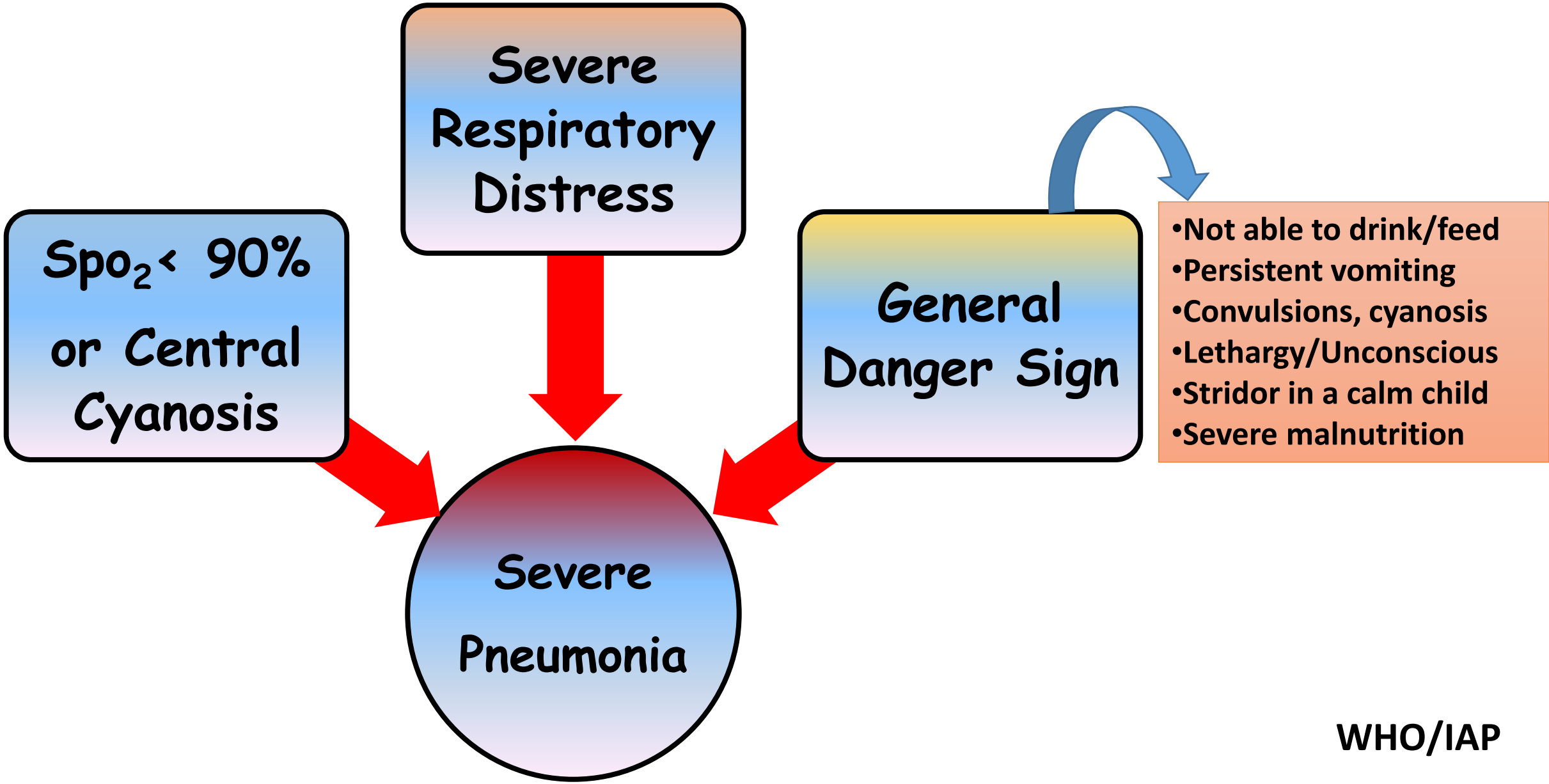
Cough or Difficulty in breathing with



There Should not be any signs of severe pneumonia

WHO/IAP

Cough or Difficulty in breathing with



WHO/IAP

Change in WHO classification

Clinical features	OLD	NEW
Cough/cold	NO PNEUMONIA: COUGH COLD	NO PNEUMONIA: COUGH COLD
Fast Breathing	**PNEUMONIA**	**PNEUMONIA**
Chest indrawing	**SEVERE PNEUMONIA**	
General danger signs	**VERY SEVERE PNEUMONIA**	**SEVERE PNEUMONIA**
Severe respiratory distress		
Central cyanosis		

Change in treatment approach

Clinical features	OLD	NEW
Cough/cold	Admission X Antibiotics X	Admission X Antibiotics X
Fast Breathing	Admission X Antibiotics √	Admission X Antibiotics √
Chest indrawing	Admit √ Antibiotics √	
General danger signs		
Severe respiratory distress		Admit √ Antibiotics √
Central cyanosis		

TREATMENT

NO PNEUMONIA: COUGH COLD	No admission, No antibiotics Soothe the throat and relieve cough with safe remedy Advise when to return
PNEUMONIA	No admission Oral Antibiotics Advise when to return
SEVERE PNEUMONIA	Admit Injectable Antibiotics Oxygen if saturation < 90%. Manage airway Treat high fever

What is the most prevalent cause of pneumonia throughout childhood?

A) *Streptococcus pneumoniae*
B) *Mycoplasma pneumoniae*
C) Viral infections
D) *Haemophilus influenzae* type b

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C) Viral infections
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Correct Answer: C) **Viral** infections, such as *Respiratory Syncytial Virus* (RSV), Influenza, and Parainfluenza

Most common agents causing CAP according to age

Newborn -3 months	1-6 months	6-12 months	1-5 yrs	> 5 yrs
Group B Streptococcus Enteric Gram-negative RSV	Viruses S pneumoniae H influenzae S aureus M catarrhalis Chlamydia trachomatis Ureaplasma urealyticum B pertussis	Viruses S pneumoniae H influenza S. aureus Moraxella catarrhalis	Viruses M. Pneumoniae C. pneumoniae S. pneumoniae	

Viruses **most prevalent cause of pneumonia throughout Childhood**

Streptococcus pneumoniae is the leading **bacterial** cause of CAP across all age groups

Coinfections, both with two or more **viruses, or with viruses and bacteria**, are very common. Coinfection rates **up to 75%** are commonly reported in **infants**

If there is additional wheeze!

Preschool Wheezer

- **1/4** infants- 1 episode by 9 months
- **1/2** children- 1 episode by 6yrs
- **Tendency to reoccur.**
- Onset is earlier in **males**

Is there a role of Bronchodilator ?

Wheezing on auscultation - present in 60-80% of lower chest indrawing despite excluding asthma

Hazir T et al. New Outpatient Short-Course Home Oral Therapy for Severe Pneumonia Study Group. Ambulatory short-course high-dose oral amoxicillin for treatment of severe pneumonia in children: a randomised equivalency trial. Lancet 2008; 371: 49-56.

Signs of pneumonia disappear in almost half of the cases with nebulization

Awasthi S, Agarwal G, Kabra SK, Singhi S, Kulkarni M, et al. (2008) Does 3-Day Course of Oral Amoxycillin Benefit Children of Non-Severe Pneumonia with Wheeze: A Multicentric Randomised Controlled Trial. PLoS ONE 3(4): e1991. doi:10.1371/journal.pone.0001991

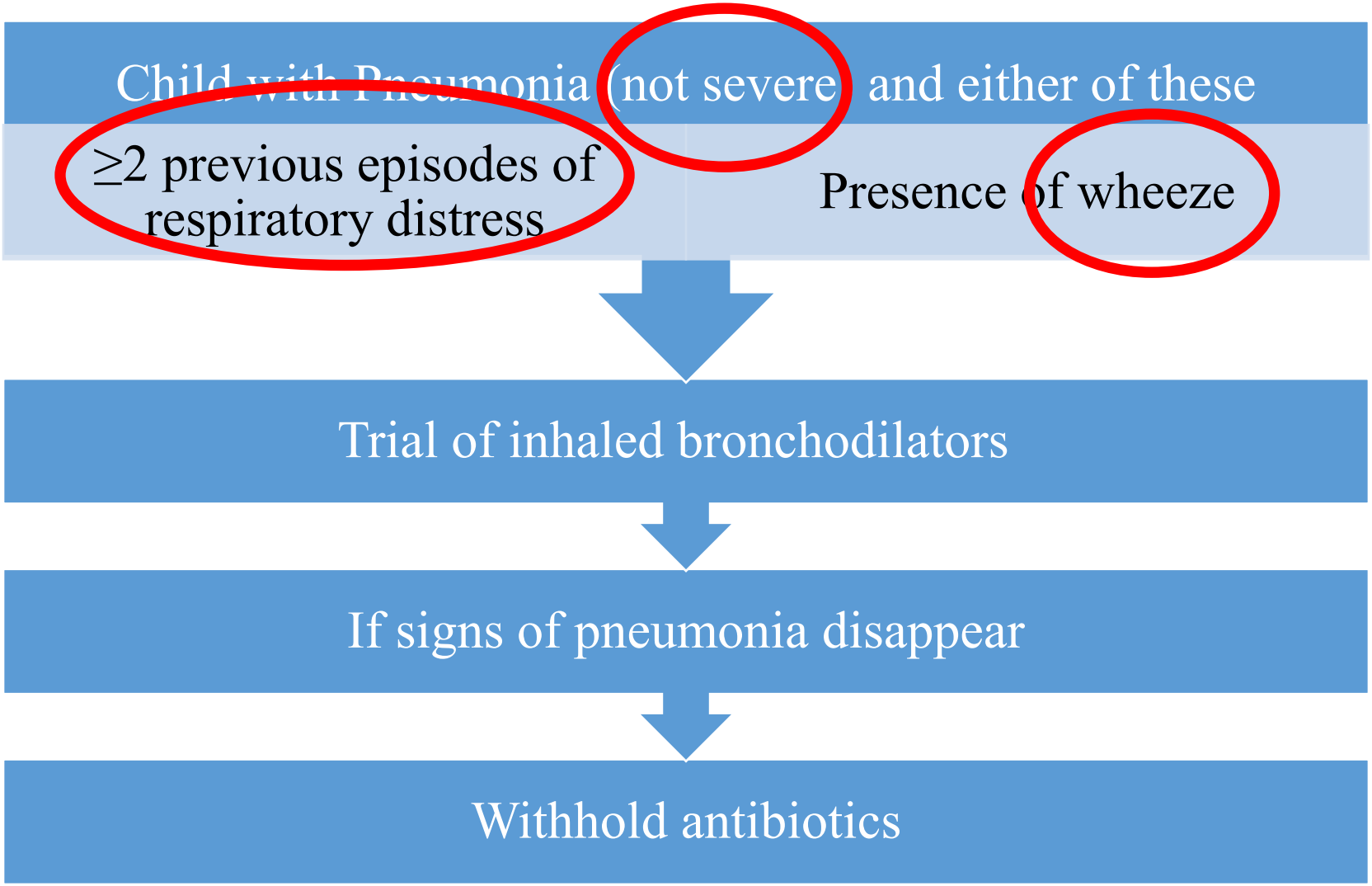
Thus there should be a role !

Table 8. Differe

Diagnosis		
Asthma	Asthma	– History of recurrent wheeze, chest tightness, some
Bronchiolitis	Bronchiolitis	– First episode of wheeze in a child aged < 2 years – Wheeze episode at time of seasonal bronchiolitis
Wheeze associated with cough or cold	Wheeze associated with cough or cold	– Wheeze always related to coughs and colds – No family or personal history of asthma, eczema, hay-fever – Prolonged expiration
Foreign body	Foreign body	– History of sudden onset of choking or wheezing – Wheeze may be unilateral – Air trapping with hyper-resonance and mediastinal shift – Signs of lung collapse: reduced air entry and impaired
Pneumonia	Pneumonia	– Fever – Coarse crackles – Grunting

Organization

When can we avoid antibiotics ?



Investigations

Which of the following investigations are routinely indicated in children with **non-severe community-acquired pneumonia**?

A) Chest X-ray
B) Microbiological investigations
D) Acute phase reactants
E) None of the above

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E) None of the above

Answer: E) None of the above

Should I get a chest X ray in all ?

Should **not be a routine investigation in** community acquired pneumonia
Signs and symptoms of pneumonia who are **not admitted** should **not have CXR**

BTS. Thorax 2011;66:ii1eii23. doi:10.1136/thoraxjnl-2011-200598

Severe pneumonia: Chest X-ray to identify pleural effusion, empyema, pneumothorax, pneumatocoele, interstitial pneumonia or pericardial effusion

WHO

- Seriously ill/Severe pneumonia
- Complications suspected
- Alternative diagnosis
- Severe Acute Malnutrition
- Post measles infections

Should I do Microbiological investigations in all ?

Not Routinely in mild disease or those being treated in community

Needed in: Who **fail to improve** and in those who have progressive **deterioration**

Available investigations

- **Blood culture**: Positivity is uncommon
- **Nasopharyngeal secretions and nasal swabs:** viral detection (PCR and/or immunofluorescence)
- **Serology: Acute and convalescent** for respiratory viruses, Mycoplasma and Chlamydia
- **Pleural fluid** for microscopy, culture, pneumococcal antigen detection and/or PCR

BTS. Thorax 2011;66:ii1eii23. doi:10.1136/thoraxjnl-2011-200598

Can Acute phase reactants differentiate b/w Virus/ Bacterial/ atypical organism ?

Acute phase reactants
- Procalcitonin
- Cytokines
- C reactive protein (CRP)
- ESR and
- White blood cell count

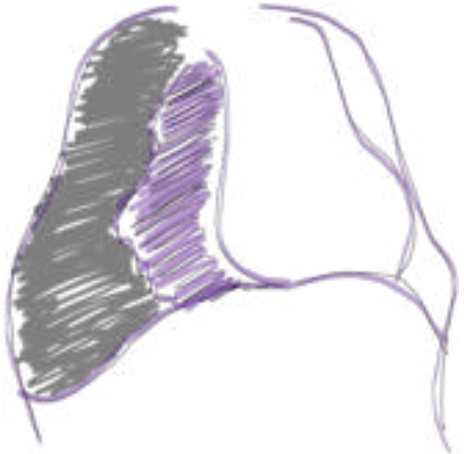
These reactants Individually and in combination
- No clinical utility in distinguishing viral from bacterial infections
- Should not be tested routinely

- **Acute phase reactants:**
  - No clinical utility in distinguishing viral from bacterial
  - Should not be tested routinely [A]
- **C reactive protein:**
  - Not useful in uncomplicated pneumonia
  - Should not be measured routinely. [A+]

BTS. Thorax 2011;66:ii1eii23. doi:10.1136/thoraxjnl-2011-200598

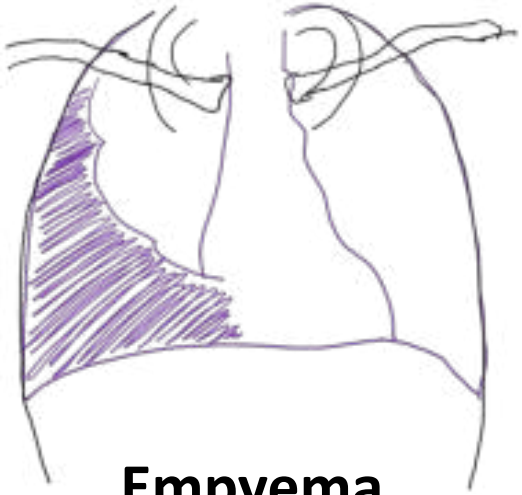
Complications

Lung abscess



Pneumothorax

Bronchiectasis



Empyema

When to refer to Intensive care units in acute pneumonia?

Cyanosis: Spo_2 < 92% on Fio_2 of ≥ 0.50

Shock

Sustained tachycardia or Inadequate blood pressure or

Need for pharmacologic support of blood pressure or perfusion

Need for ventillatory support

Requires invasive ventilation

Requires use of noninvasive positive pressure ventilation

Has impending respiratory failure

Altered mental status

Due to hypercarbia or hypoxemia as a result of pneumonia

When to refer for opinion?

- **Slowly resolving** pneumonia:
  - Persistence of CXR abnormalities for >1 month in a clinically improved host
- **Non-Resolving/ Persistent** pneumonia:
  - Persistence of symptoms and CXR abnormalities for >1 month in a child with LRTI
- **Recurrent** pneumonia:
  - Multiple episodes with evidence of complete resolution in between.
    - ≥ 2 episodes within 1yr or
    - ≥ 3 such episodes over any time period

When to discharge ?

- Respiratory distress has resolved
- No hypoxemia (oxygen saturation, > 90%)
- Feeding well
- Able to take oral medication or have completed a course of parenteral antibiotics
- Parents understand the signs of pneumonia, risk factors and when to return

Thank You

Which equipment is most useful for diagnosing pneumonia in children?

- A) Pulse Oximeter and Thermometer

- B) Stethoscope

- C) Chest X-ray

D) Watch

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Which of the following investigations are routinely indicated in children with **non-severe community-acquired pneumonia**?

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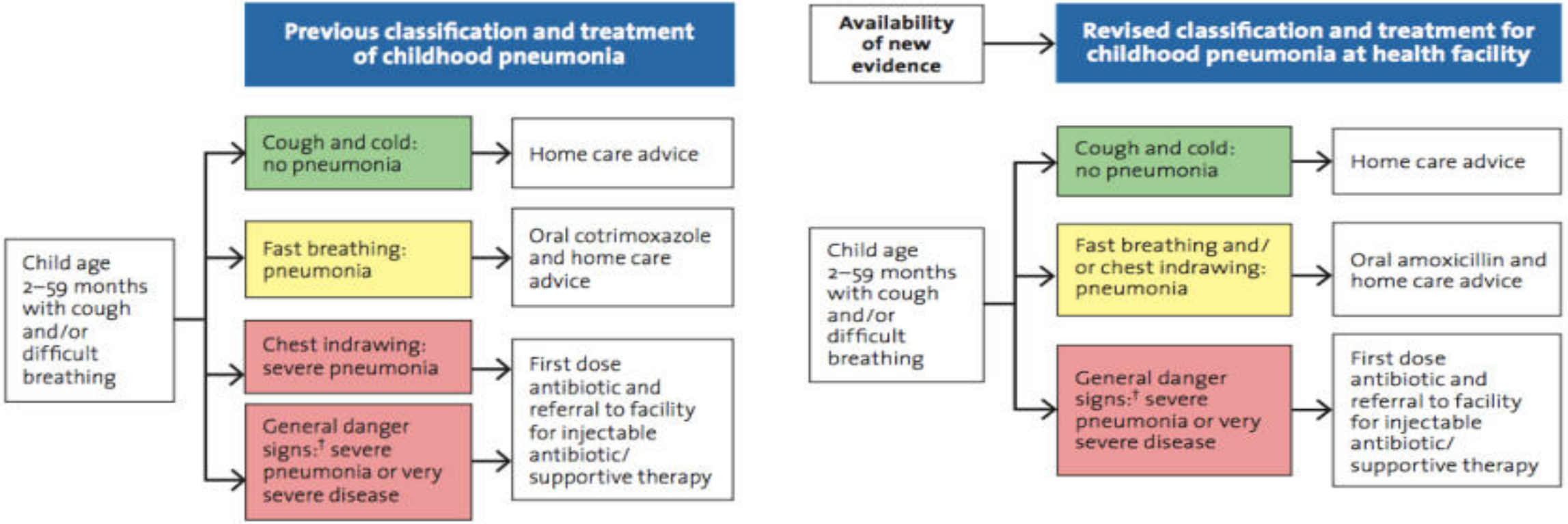
E) None of the above

Clinical Management of Severe Childhood Pneumonia

Dr Hema Gupta Mittal

Professor and In-charge Division of Pediatric Pulmonology , ABVIMS& RMLH Delhi

Definition: Severe Pneumonia : WHO definition



Danger signs: Grunt, Not able to drink, persistent vomiting, convulsions, lethargic or unconscious, stridor in a calm child or severe malnutrition

PRINCIPLES in Management of Severe Pneumonia

Assessment and management of respiratory distress

Antibiotics

Which, why, when, how , where…..

Other medications: Antivirals, nebulization, cough syrups etc

Respiratory and cough hygiene

Monitoring , Investigations and Complications

Prevention stratergies

Case

- Laxmi , 7 days old baby with
- refusal of feeds , breathing difficulty * 3 days
- O/E –baby is dull .RR :74/ min . Spo2 : 85%
- Multiple Pustules present over the trunk

Diagnosis ? Treatment ?

Antibiotics: Which ?When ??Why??

Etiology of Pneumonia

Bacteria	**Streptococcus pneumoniae, Hemophilus influenzae, Staphylococcus aureus,** Mycobacterium tuberculosis, Bordetella pertussis, Klebsiella pneumoniae
Viruses **(Most common)**	Respiratory Syncytial Viruses, Rhinovirus, Influenza Virus, Human Metapneumovirus, Adeno virus, Measles, CMV, EBV
Fungi	Aspergillus, Candida, Pneumocystis Jirovecii (immunocompromised)
Noninfectious	Aspiration of food /gastric acid, foreign bodies, hydrocarbons, lipid substances, hypersensitivity reactions, drug or radiation

Organism & Clues

Staphylococcus:Pyoderma, Measles

Pneumocystis:HIV

Pseudomonas, Staphylococcus: CF

Gram negative, Staph aureus: PEM

Gram negative, Aspergillus: Neutropenia

Anaerobes: Aspiration

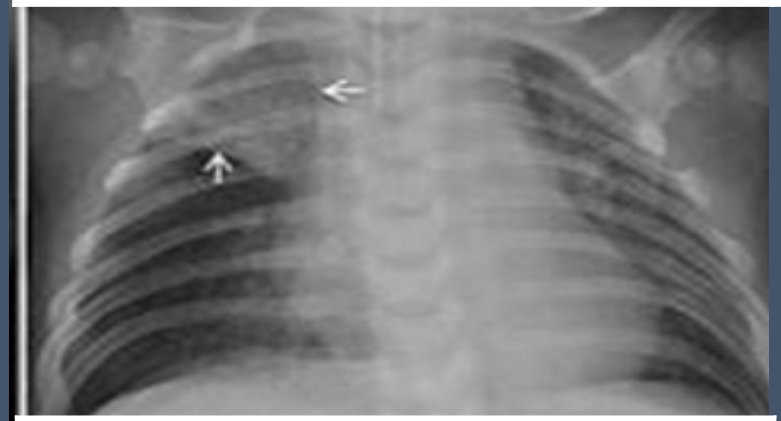
Common Etiology of Pneumonia in children in LMICs

Viruses are most common pathogens..
In 2015, RSV & Influenza accounted
for 20% & 10% cases, respectively.

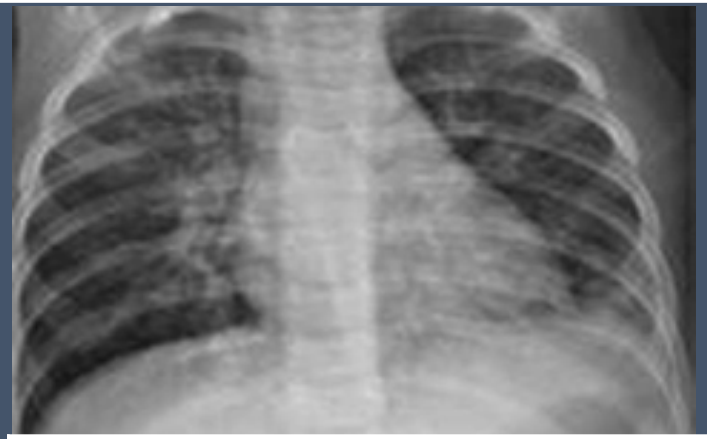
The increased use of pneumococcal conjugate vaccine (PCV) and *Haemophilus influenzae type b* (Hib) vaccine has **changed pneumonia etiology,** with ***Staphylococcus aureus*** **and** ***H. influenzae*** **non-type b now the commonest bacterial pathogens**

Differentiating etiologies

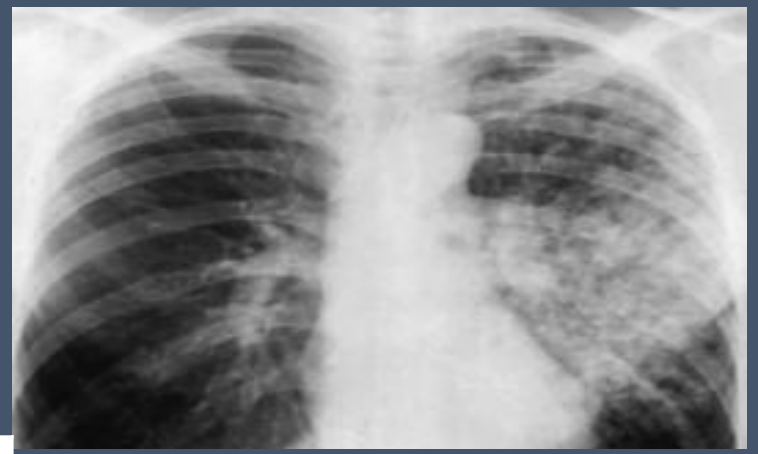
Bacterial	Viral	Atypical
More toxic, Rapid progression Lobar pneumonia Complications: Empyema, Abscess	Less toxic ,Follows URTI, Gradual ;Wheeze+/-, bronchiolitis ,Usually b/l	Less toxic, “walking pneumonia” Wheezing,diffuse Extra pulmonary manifestations++ -



Lobar consolidation+ air bronchogram;Patchy/Cavitatory/ Round pneumonia/ Pneumatoceles/ empyema



Diffuse GGO/Interstitial infiltrates/Multifocal patchy consolidation OR Lobar / segmental atelectasis, ARDS



Diffuse interstitial/ reticular pattern /Hilar lymphadenopathy/ Normal chest X-ray

Antibiotics recommendations: IPD

: ANTIBIOTIC THERAPY FOR PNEUMONIA/SEPSIS IN INFANTS <2 MONTHS

Antibiotic	Each Dose (mg/kg/dose)	Frequency		Route	Duration (Days)
		< 7days age	> 7days age		
Inj. Ampicillin*	50	12 hourly	8 hourly	IV, IM	7-10
And Inj. Gentamicin	5	24 hourly	24 hourly	IV, IM	7-10
Inj. Amikacin	15	24 hourly	24 hourly	IV, IM	7-10

*If concomitant meningitis is suspected, the drugs should be given IV and Inj. Cefotaxime 50 mg/kg IV 8 hourly is used instead of Ampicillin. The total duration of therapy in meningitis is 2-3 weeks.
In case of suspected staphylococcal infection, Injection Cloxacillin 50mg/kg 8 hourly is to be added to the regime.

R 3: Severe pneumonia WHO

1 st line: parenteral ampicillin (or penicillin) and gentamicin*5d

2nd line :Ceftriaxone: if failed on 1st line

Antibiotics recommendations: IPD

	Age <2m	>2m-5y	>5y
1st line	Cefotaxime/Ceftriaxone ± gentamicin/amikacin	Ampicillin	Ampicillin
2nd line	Cefotaxime/Ceftriaxone ± gentamicin/amikacin Piperacillin tazobactam/ Cefoperazone sulbactam	Co -amoxyclav OR Cefotaxime OR ceftriaxone	Co -amoxyclav OR Cefotaxime OR ceftriaxone or Azithromycin
Stap aureus	Ceftriaxone+cloxacillin OR cefuroxime or Coamoxyclav +gentamicin or amikacin 2nd line ceftriaxone +vancomycin/clindamycin	Ceftriaxone+cloxacillin OR cefuroxime or Coamoxyclav or cefazolin 2nd line ceftriaxone +vancomycin/clindamycin	Ceftriaxone+cloxacillin OR cefuroxime or Coamoxyclav or cefazolin 2nd line ceftriaxone +vancomycin or clindamycin

Characteristics and Management: Staph Pneumonia

	MSSA	MRSA
Clinical setting Age group Course & outcome complications	Community Higher Less severe Lesser	Healthcare/community Younger More severe, ICU admissions Higher:pneumatoceles, Pleural effusion
Treatment Duration	Cefazolin (50 mg/kg/d, BD or TID) /Clox (100mg/Kg TID) +/- Aminoglycoside (gentamicin (5–7 mg/kg/d, OD) Or Amikacin (15 mg/kg/d, OD) 7 to 10 days	Vancomycin (40 mg/Kg/d in QID) /Clindamycin(20 mg/kg/d, TID or QID) Linezolid (10 mg/kg/d), TID 14 d if no complications 4-6 weeks if complications

Viral Pneumonias and Antivirals

- No effective antivirals available for most viral pneumonias (few exceptions)
- Anti-virals used to treat sporadic or epidemic or pandemic viral pneumonia include: Oseltamivir, Zanamivir, Peramivir, Ribavirin, Remdesivir (off label), Ganciclovir
- Empirical antibiotics **should be** used in severe viral pneumonias in hospitals/ICU

- Influenza/CMV/Adenovirys/ RSV/ rhino…
- SARS CoV 2 and Covid 19 : lessons learnt !!!!

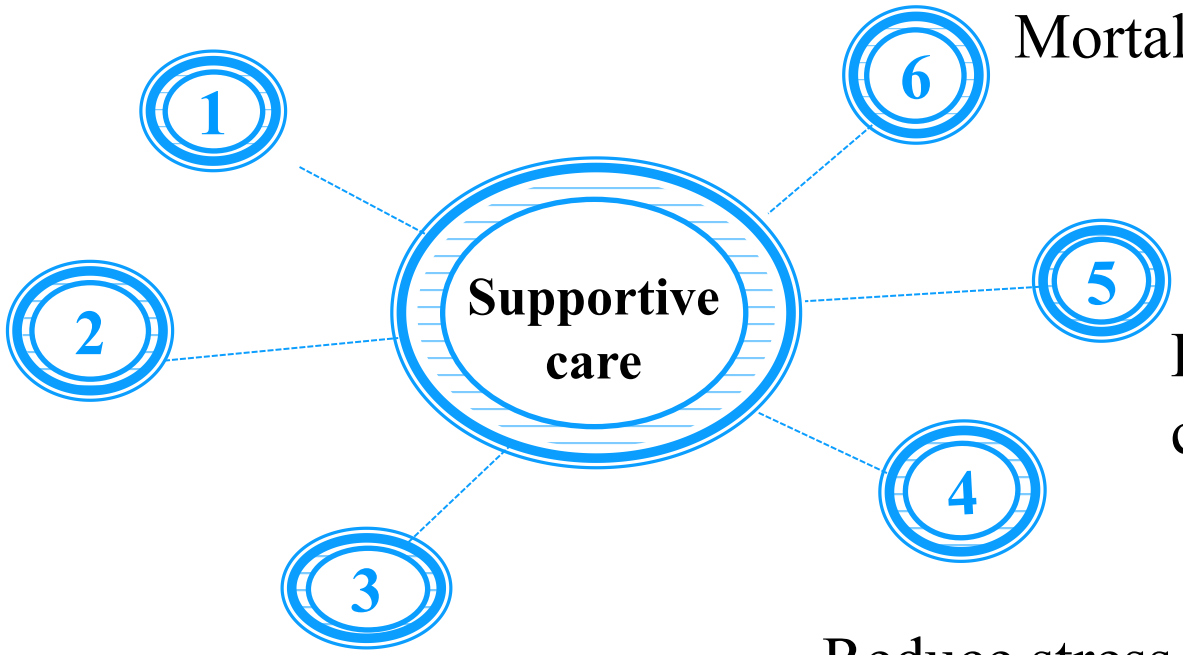
Case 1

- Laxmi , 7 days old baby with
- refusal of feeds , breathing difficulty * 3 days
- O/E –baby is dull .RR :74/ min . Spo2 : 85%
- Multiple Pustules present over the trunk

Diagnosis ? Treatment ?

- Admit
- Severe Pneumonia with Sepsis
- Probably Staphylococcal
- Vancomycin plus an aminoglycoside

SUPPORTIVE CARE (ADDITIONAL CARE)



Increase Oxygenation

Reduce work of Breathing

Support faster recovery

Reduce stress by psychological support to Children & Family

Reduce long term complications

Reduce Morbidity and Mortality

Oxygen therapy

- Why important: Hypoxia
  - ✓Common occurrence in pneumonia (severe & complicated)
  - ✓Increases mortality
- Goal: SpO2 > 92-94%
- Indications
  - ✓Severe pneumonia(grunting/cyanosis/Severe lower chest in-drawing)
  - ✓Respiratory rate ≥70 breaths/min
  - ✓Hypoxia (Sat <90%)

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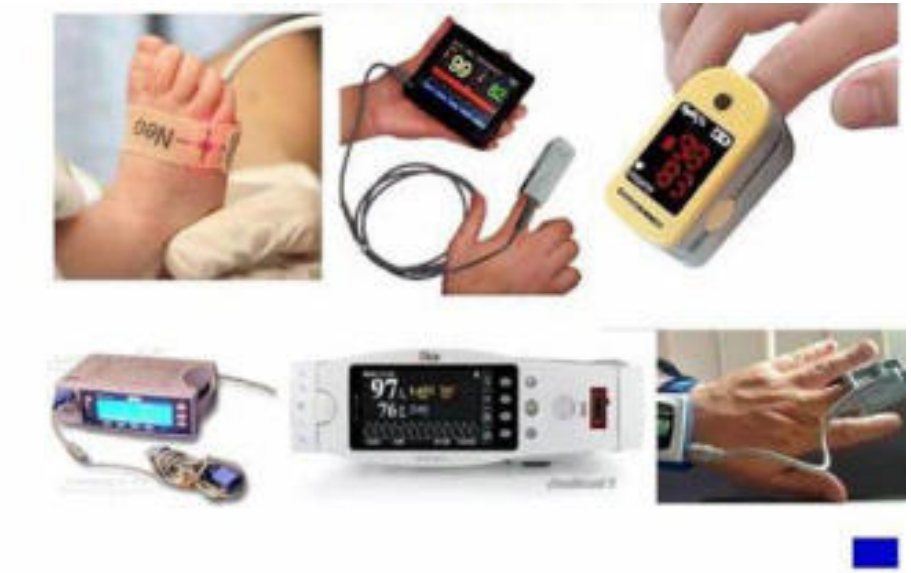
*If oxygen saturation < 90%, refer as Severe Pneumonia or Very Severe Disease
**If the child has wheezing, give 3 doses of nebulized salbutamol for 20 minutes; or 2-4 puffs of salbutamol MDI (at a gap of 2-3 min between each puff) with spacer repeated every 20 minutes and if there is improvement continue bronchodilators under monitoring
*** If referral is not feasible or refused, manage with oral amoxicillin twice a day and injection gentamicin once a day for 7 days in consultation with MO PHC and daily assessment (see table 4)

S Guidelines

Methods of oxygen administration

- Heated, humidified oxygen
- Nasal prongs or a nasal or nasopharyngeal catheter (no face or head mask)
- Oxygen flow-rate with canula, head box, and face mask ???
- Other devices: CPAP, HHHFNC, Invasive ventilation



Fluid therapy: why important ?

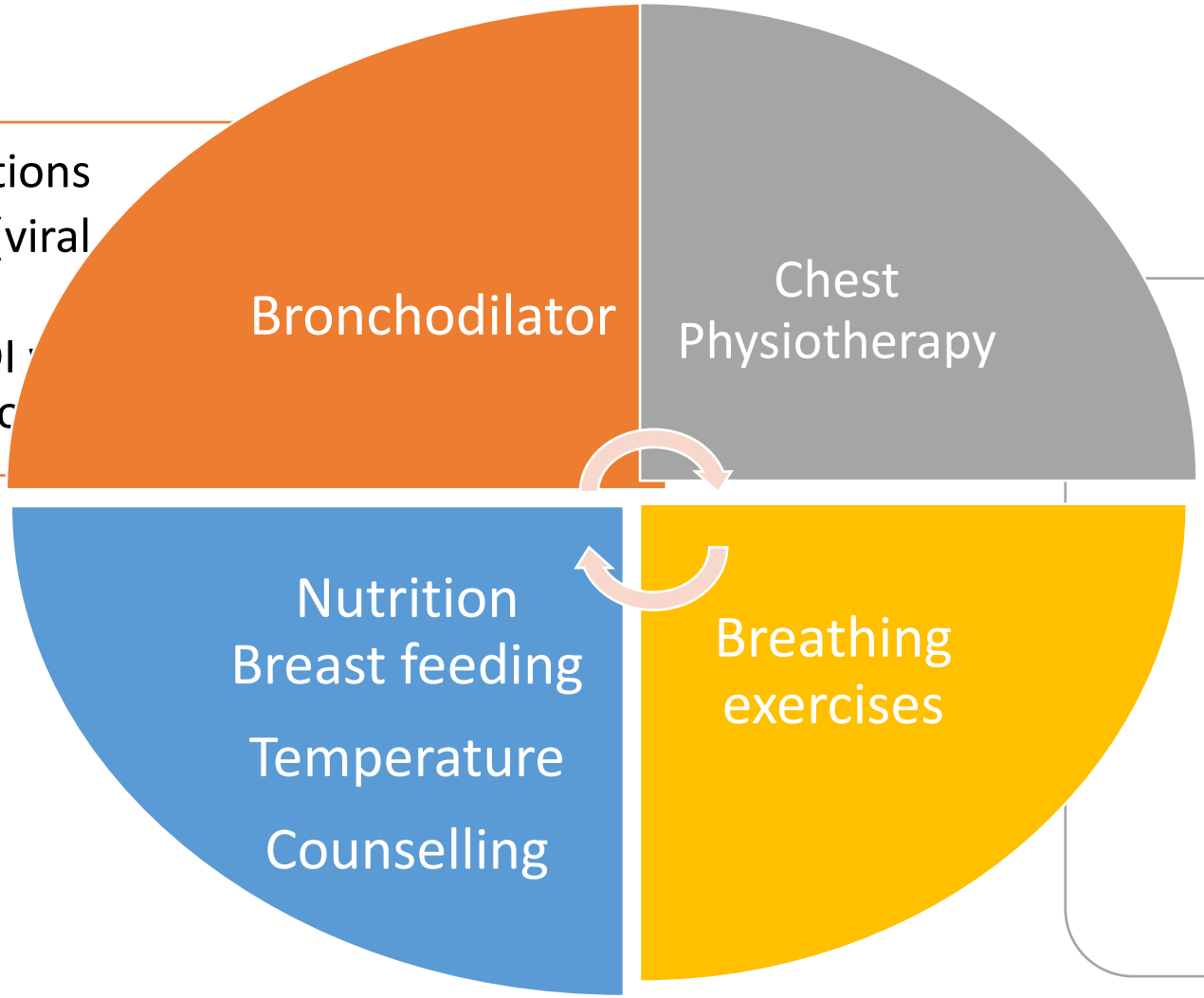
- Unable to maintain their fluid intake because of breathlessness or fatigue
- Non-severe cases: breast-feeding or oral fluid/feed
- Options in severe case: Naso-gastric or Intravenous fluid therapy
- Indication of IV fluids
  - ✓Neonates & young children with severe distress
  - ✓Persistent vomiting
- Monitor fluid balance & serum electrolyte (e.g., Na^+): *SIADH is likely in severe & complicated cases*

Other Medications

- Fever
  - ✓Paracetamol (@15mg/kg/dose) to keep child comfortable (avoid tepid sponging)
- Cough
  - ✓Avoid cough suppressants.
  - ✓Intake of adequate fluids.
  - ✓Household remedies (Tulsi, ginger, honey)
  - ✓No role of nebulization

- Vomiting (post-tussive)
  - ✓Anti-emetics routinely not required
  - ✓If persistent vomiting: anti-emetics
- Maintain proper hydration
- Identifying signs of deterioration/ serious illness and complications
- Access to referral facility (providing a 'safety net')

- No routine indications
- If severe wheeze (viral pneumonia)
- may be given MDI spacer/Nebulizatic



- Remove inflammatory exudates & trachea-bronchial secretions, and airway obstructions
- (No conclusive evidence)

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Counselling in Pneumonia

- **Counselling** to Parents, Family & the Child
- **Why Counselling ?**
  - Parents & Children Under stress
  - Psychological morbidities (post ICU care)
- -posttraumatic stress disorder, anxiety disorder, depression.
  - Financial stress
  - Worry about recovery & long-term complications
  - **Counselling** about Proper Diet, danger signs, supportive care , follow up etc.

- **Multidisciplinary Approach: most beneficial**
- **post–intensive care unit patients.**

Respiratory Hygiene and Cough Etiquette

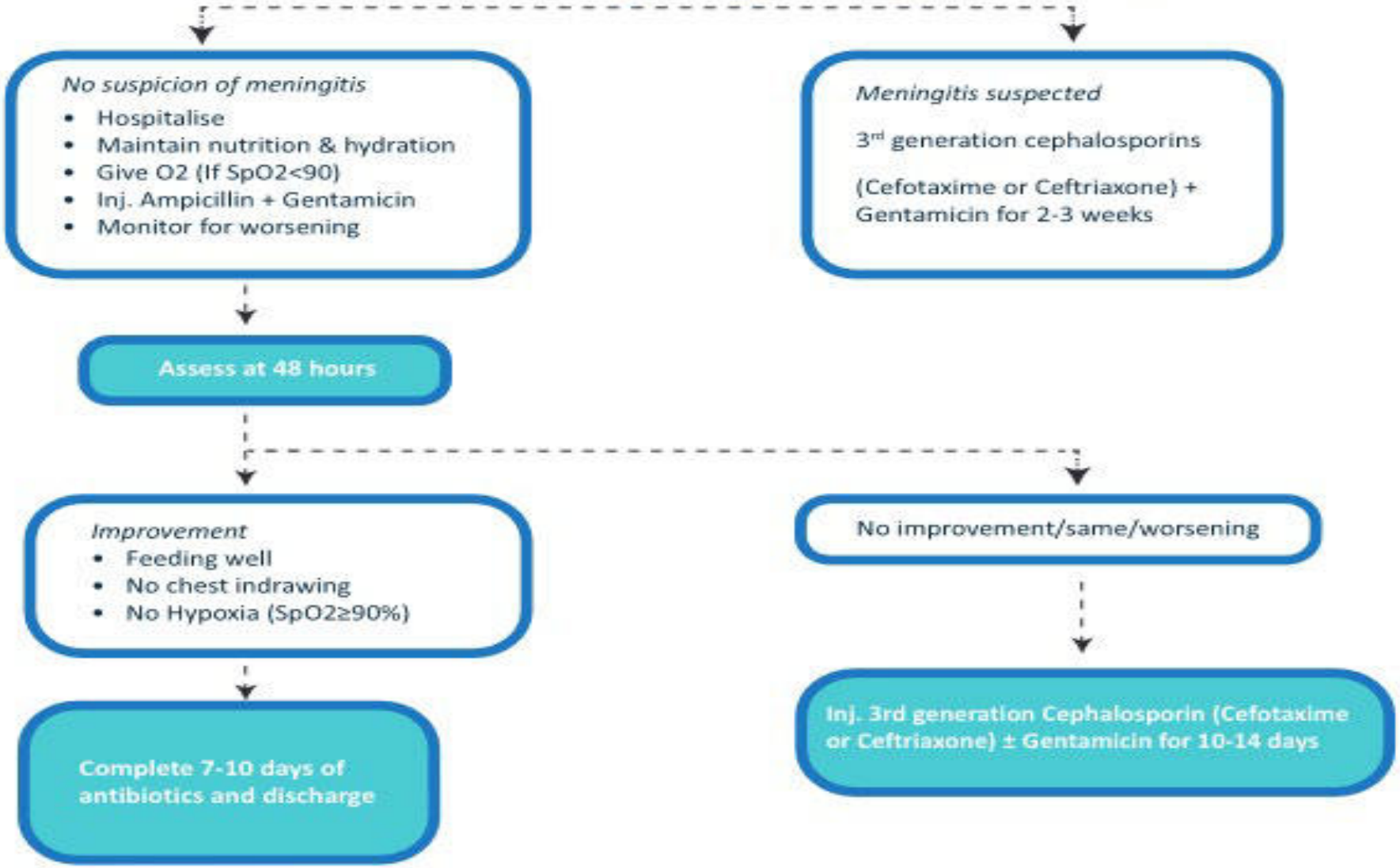
Cover your mouth and nose with a tissue when coughing or sneezing

Dispose of the tissue afterwards

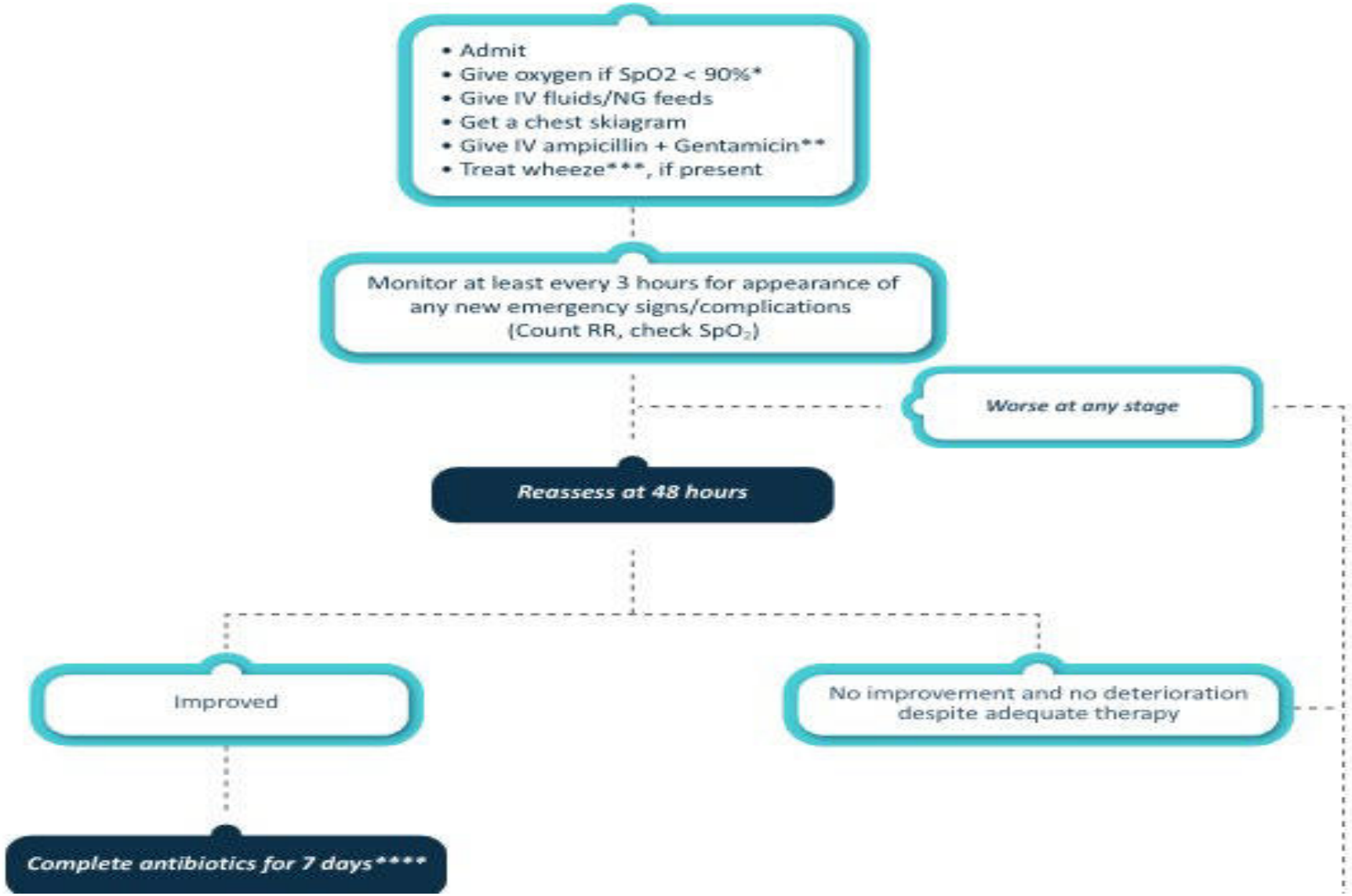
After coughing or sneezing, wash your hands with soap and water

Wear a mask if you are coughing or sneezing

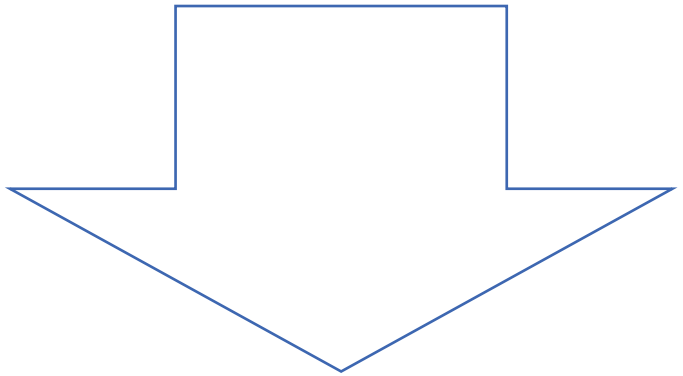
Severe Pneumonia in a young infant (≤ 2 months)



Management of Severe Pneumonia cases (2-59 months) admitted in health facilities



Monitoring



Clinical

VITALS(RESPIRATORY RATE/

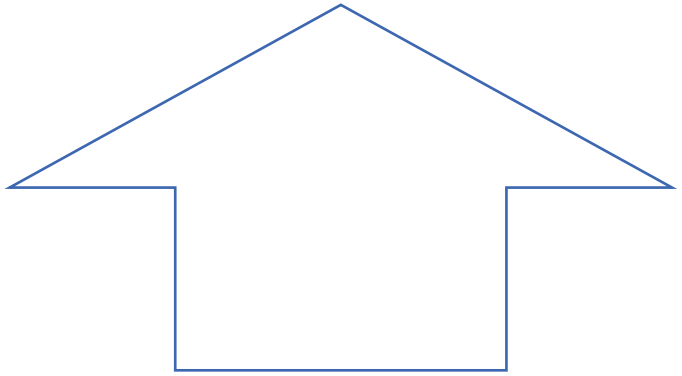
DISTRESS: grunting/retractions/ nasal flaring/ head bobbing

, temperature/

PULSEOXIMETRTY(cyanosis)

DANGER SIGNS: hypoglycemia/sepsis in small infants

Laboratory



. Chest X-ray :All cases of Severe pneumonia, non improving or Diagnostic dilemmna

- Blood investigations (CRP, TLC, procalcitonin/ blood culture)
  - Do not reliably differentiate bacterial vs. viral

For detection of viruses: Polymerase chain reaction (PCR): may be useful

- Interpreted with caution, as healthy or in URTI may have positive. Availability and cost

Chest ultrasound :emerging POC test

CHEST CT : NO ROUTINE USE : Suppurative parenchymal complication: abscess/ necrotizing pneumonia/ necrosis, Pleural complications ,Diagnostic dilemma

•

Case

- 7 yr old Rakesh – treated for pneumonia in a district hospital for 10 days with oral antibiotics brought with persistent fever and increasing Respiratory distress
- H/o Lt sided chest pain , dull note and absent breath sounds in Lt infarscapular area.
- **Diagnosis ? Drugs of choice ? Duration of therapy ?**

- Lt Empyema
- Parenteral
- Cefotaxime or Ceftriaxone plus Clinadamycin

Non- Response to Initial Empirical Therapy

??Complications

Empyema

Abscess

??Different pathogen

Mycobacterium tuberculosis

Mycoplasma

COVID 19

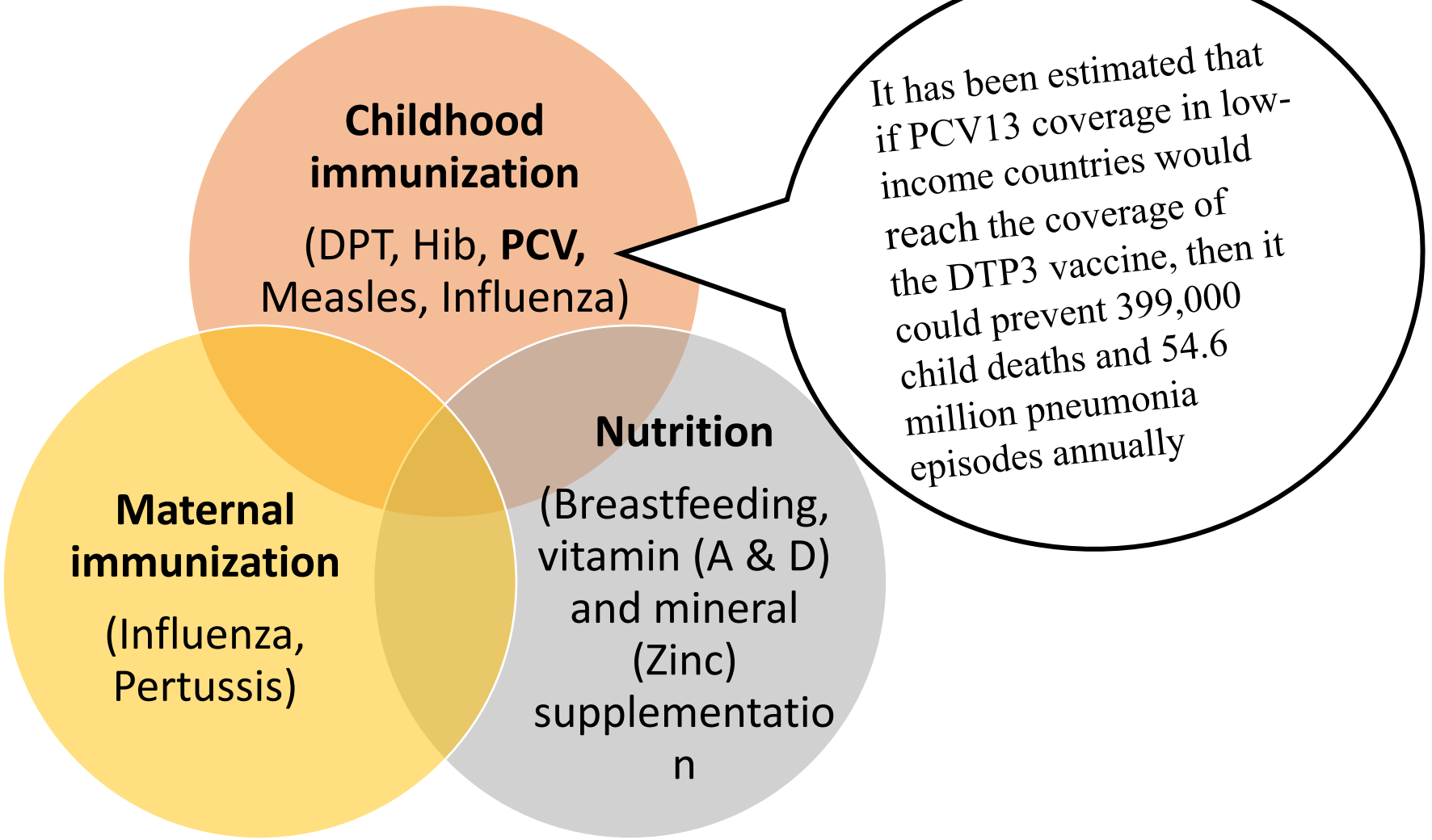
??Drug resistance

B lactam producing Hib, Drug resistant staph aureus including community acq methicillin resistance

Highest risk factors for childhood Pneumonia deaths in India :2017

PROTECT, PREVENT AND TREAT

Prevention of Pneumonia



Key messages

Pneumonia still highest cause of U5 mortality Globally and India

SEVERE PNEUMONIA:EARLY RECOGNIZION/ APPROPRIATE ANTIBIOTICS/ PULSE OXIMETRY/OXYGEN THERAPY

Non responsive pneumonia: Think COMPLICATIONS!!!

After malnutrition growing pollution (indoor &outdoor): Risk factor

IMPACT OF AIR POLLUTION ON CHILDREN

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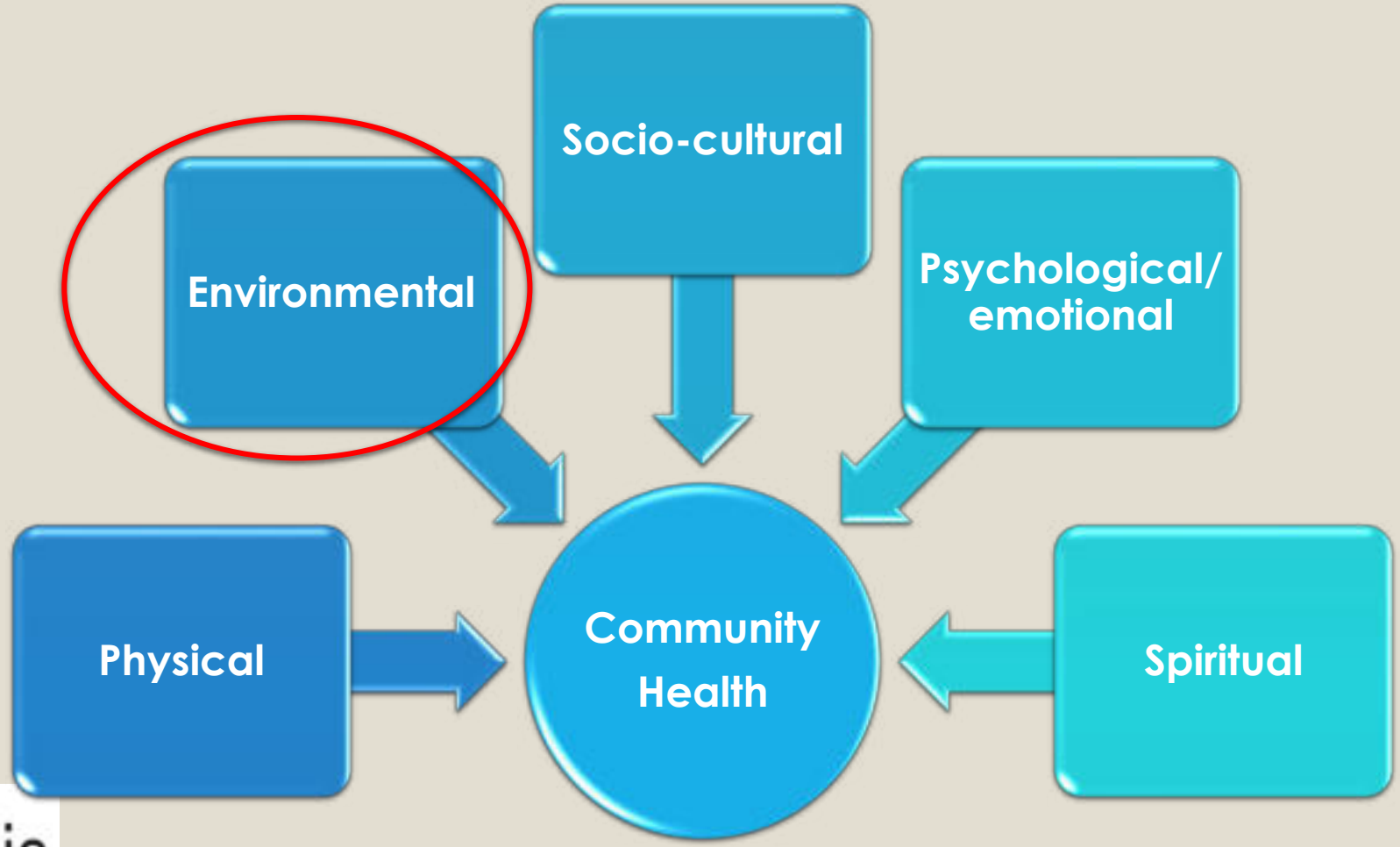
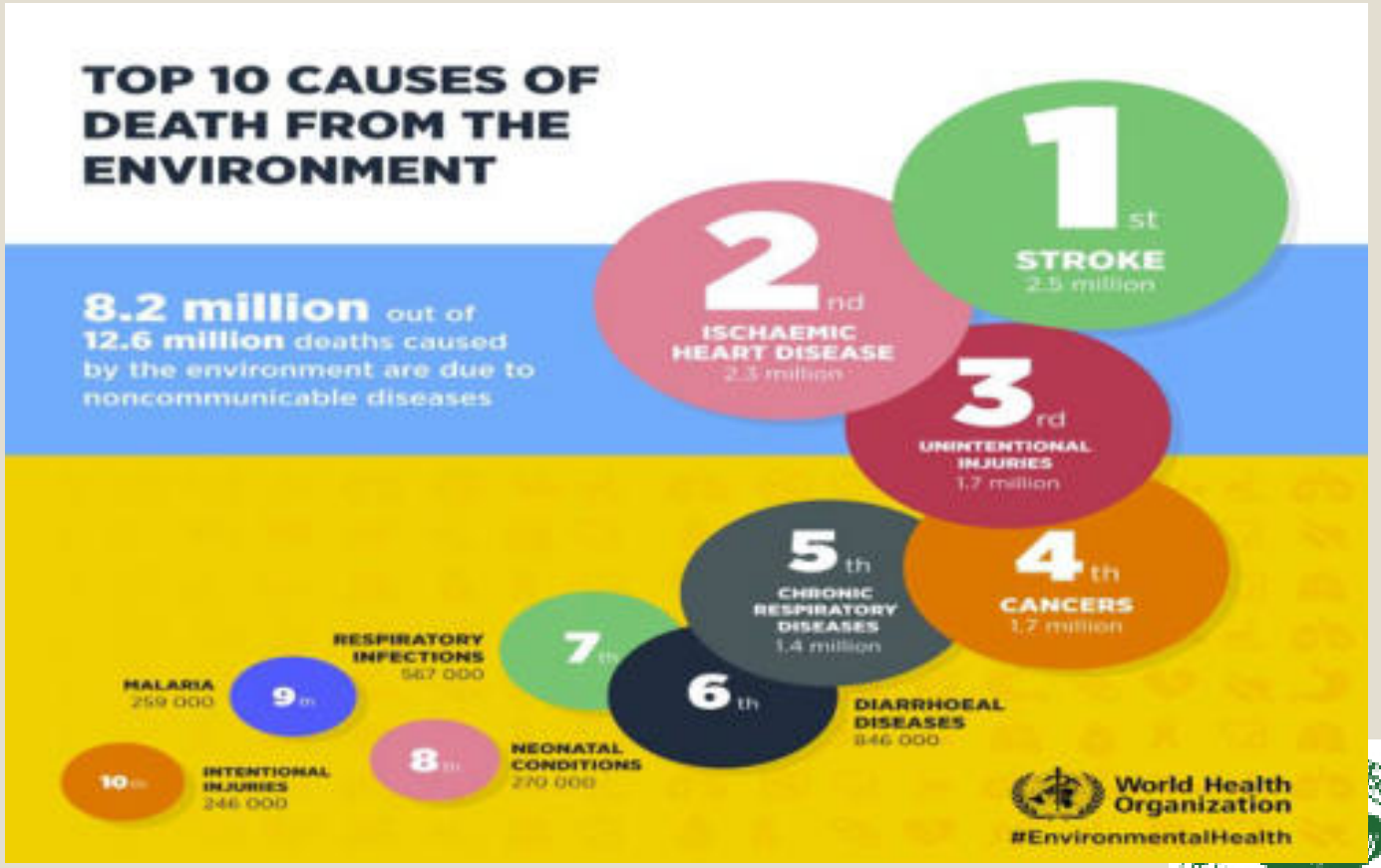
अखिल भारतीय आयुर्विज्ञान संस्थान ALL INDIA INSTITUTE OF MEDICAL SCIENCES शरीरमाद्यं खलु धर्मसाधनम्

Why Environmental health?



Burden of disease attributed environmental exposure

- 24% of diseases and 23% of mortality globally



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Levels of Environmental Risks

Level 0	Level 1	Level 2	Level 3	Level 4
	Environmental/ occupational risks	Unsafe water, sanitation, and handwashing	Unsafe water source	
			Unsafe sanitation	
			No handwashing with soap	
		Air pollution	Particulate matter pollution	Ambient particulate matter pollution
				Household air pollution from solid fuels
			Ambient ozone pollution	
		Other environmental risks	Residential radon	
			Lead exposure	
		Occupational risks	Occupational carcinogens	
			Occupational asthmagens	
			Occupational particulate matter, gases, and fumes	
			Occupational noise	
			Occupational injuries	
			Occupational ergonomic factors	

Global Burden of Disease Study (GBD) risk factor hierarchy (adapted from Stanaway et al. 2018).

WHO Air Quality Standards - 2021

Pollutant	Averaging time	2005 AQGs	2021 AQG level
$PM_{2.5}$, µg/m³	Annual	10	5
	24-hour[a]	25	15
PM_{10}, µg/m³	Annual	20	15
	24-hour[a]	50	45
O_3, µg/m³	Peak season[b]	–	60
	8-hour[a]	100	100
NO_2, µg/m³	Annual	40	10
	24-hour[a]	–	25
SO_2, µg/m³	24-hour[a]	20	40
CO, mg/m³	24-hour[a]	–	4

Revision of NAAQ Standards are in process

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National Ambient Air Quality Standards (2009)

Sr. No	Pollutants	Time Weighted Average	Concentration in Ambient Air	
			Industrial, Residential, Rural, and Other Areas	Ecologically Sensitive Area
1	Sulphur dioxide (SO_2), µg/m³	Annual*	50	20
		24 hours**	80	80
2	Nitrogen dioxide (NO_2), µg/m³	Annual*	40	30
		24 hours**	80	80
3	Particulate matter (Size <10 µm) or PM_{10} µg/m³	Annual*	60	60
		24 hours**	100	100
4	Particulate matter (Size<2.5 µm) or $PM_{2.5}$ µg/m³	Annual*	40	40
		24 hours**	60	60
5	Ozone (O_3), µg/m³	8 hours**	100	100
		1 hours **	180	180
6	Lead (Pb), µg/m³	Annual*	0.50	0.50
		24 hours**	1.0	1.0
7	Carbon monoxide (CO), mg/m³	8 hours**	02	02
		1 hours **	04	04
8	Ammonia (NH_3), µg/m³	Annual*	100	100
		24 hours**	400	400
9	Benzene (C6 H6) , µg/m³	Annual*	05	05
10	Benzo(a) pyrene (BaP)- particulate phase only, ng/m³	Annual*	01	01
11	Arsenic (As), ng/m³	Annual*	06	06
12	Nickel (Ni), ng/m³	Annual*	20	20

Ecologically sensitive areas:
Areas in which developmental activities is prohibited.
Eg:-Murud-Janjira , Dahanu, Mahabaleshwar-Panchgani, Sultanpur etc.

MAJOR AIR POLLUTANTS

	Classification	Examples
Based on source of origin	Natural air pollutants	dust, sea-salt, forest fires
	Anthropogenic air pollutants	stationary point sources, mobile sources, waste disposal landfills, controlled burning etc
Based on method of origin	Primary air pollutants	Sulphur dioxide (**SO_2**), Carbon monoxide (**CO**), Lead (**Pb**), Ammonia (**NH_3**)
	Secondary air pollutants	**Ozone**, Nitrogen dioxide (**NO_2**), Photochemical smog
Based on chemical composition	Gaseous air pollutants	SO_2, NO_X, O_3, CO
	Particulate air pollutants	**PM10**, **PM2.5**, PM1

Why there is need to take the action on Air Pollution effects?

Responsible for One in every eight death in India [1]

Second most common leading risk factor (DALY) in India[2]

- 99% of India's population exposed to more than recommended (10 µg/m³)

1.India State-Level Disease Burden Initiative Collaborators Nations within a nation: variations in epidemiological transition across the states of India, 1990-2016 in the Global Burden of Disease Study. Lancet.2017 Dec 2;390(10111):2437-2460. doi: 10.1016/S0140-6736(17)32804-0. Epub 2017. 14

2. Gorai AK, Tchounwou PB, Biswal SS, Tuluri F.Spatio-Temporal Variation of Particulate Matter($PM_{2.5}$) Concentrations and Its Health Impacts in a Mega City, Delhi in India.Environ Health Insights. 2018 Aug 19;12:1178630218792861. doi: 10.1177/1178630218792861. eCollection 2018

Ai S, Qian ZM, Guo Y, Yang Y, Rolling CA, Liu E, et alLong-term exposure to ambient fine particles associated with asthma: A cross-sectional study among older adults in six low- and middle-income countries. Environ Res. 2019 Jan;168:141-145. doi: 10.1016/j.envres.2018.09.028. Epub 2018 Sep 24.

3.Upadhyay A, Dey S, Chowdhury S, Goyal P. Expected health benefits from mitigation of emissions from major anthropogenic $PM_{2.5}$ sources in India: Statistics at state level. Environ Pollut. 2018 Nov;242(Pt B):1817-1826. doi: 10.1016/j.envpol.2018.07.085. Epub 2018 Jul 24

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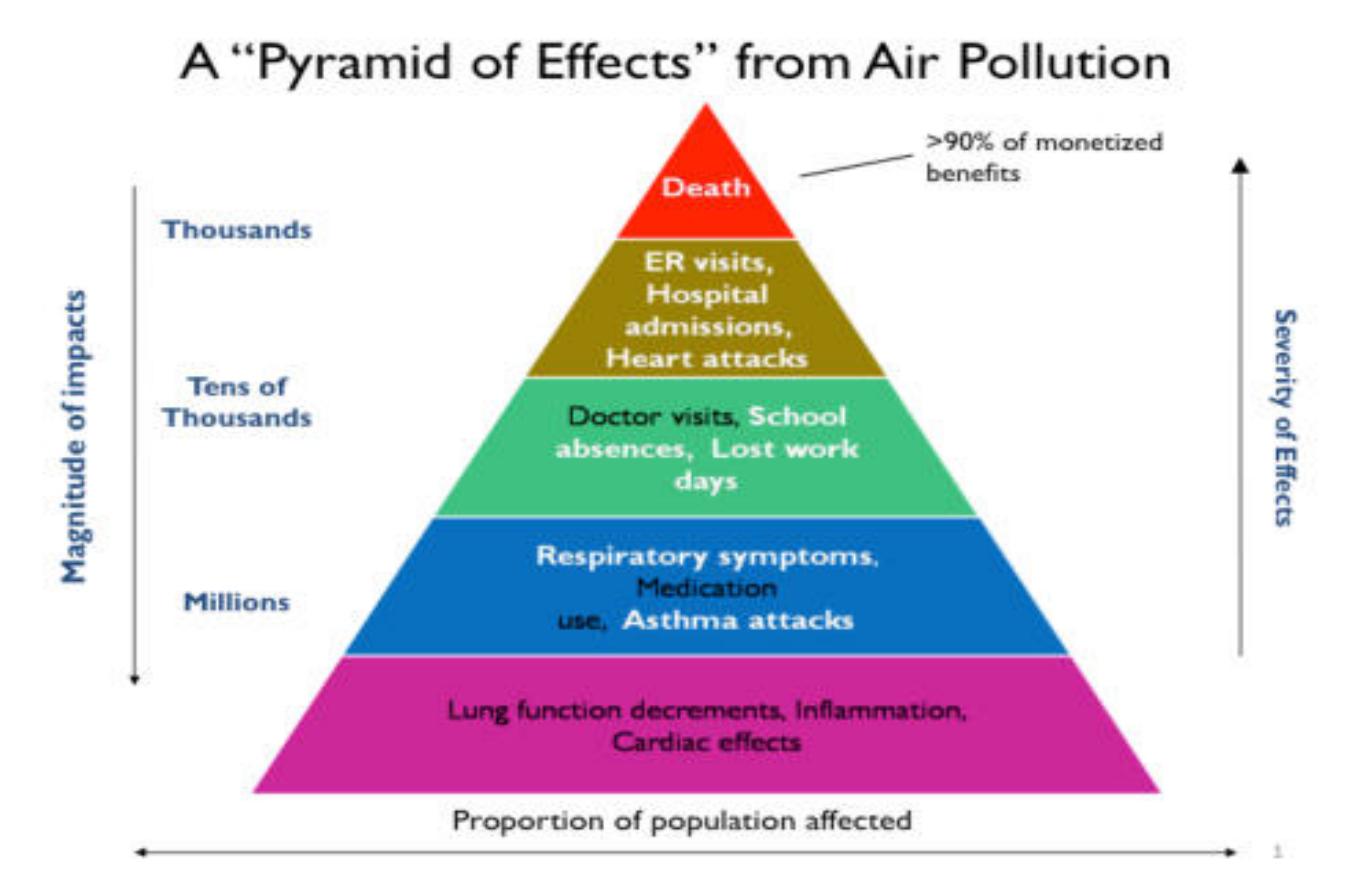
Variety of impacts



Source: https://www.epa.gov/benmap/how-benmap-ce-estimates-health-and-economic-effects-air-pollution

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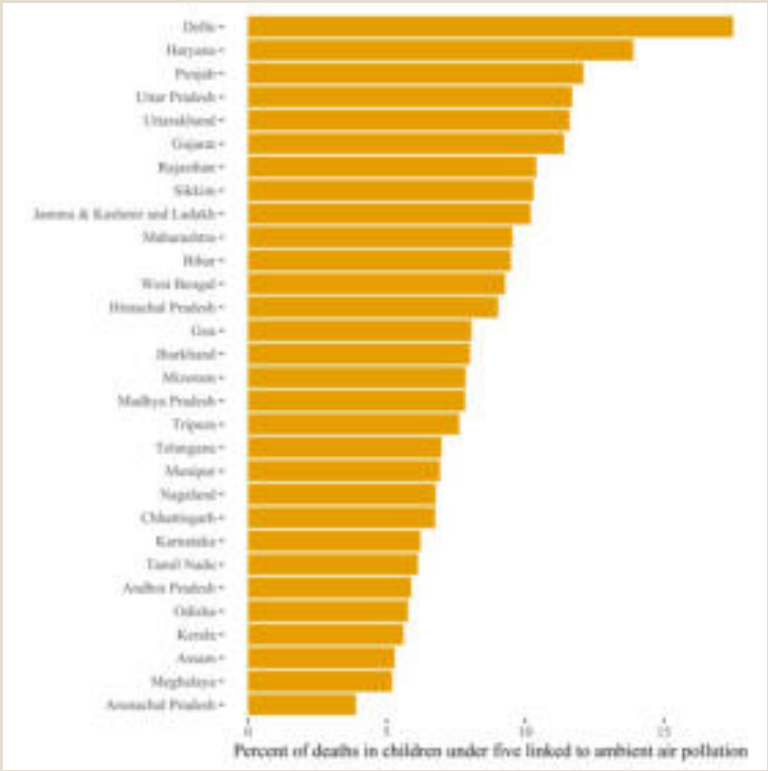
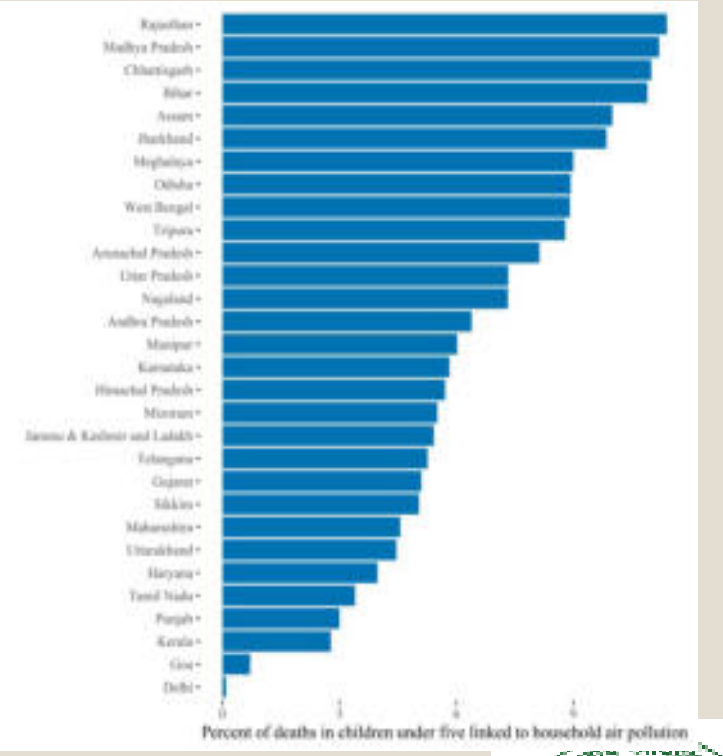
Air Pollution and Child mortality

2nd leading risk factor for deaths in children under 14 years

16% of all deaths in children





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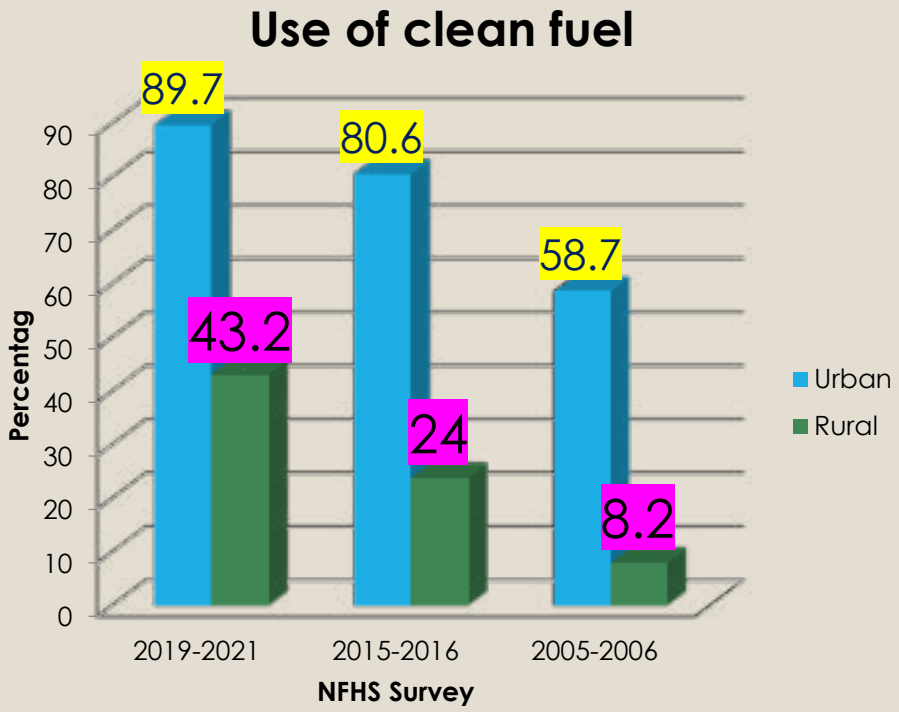
Pandey, A, Michael Brauer, Maureen L. Cropper, Kalpana Balakrishnan, Prashant Mathur, Sagnik Dey, Burak Turkgulu, et al. . Health and Economic Impact of Air Pollution in the States of India: The Global Burden of Disease Study 2019. The Lancet Planetary Health. 2021,5 (1): e25–38. https://doi.org/10.1016/S2542-5196(20)30298-9.

Air Pollution and Child mortality



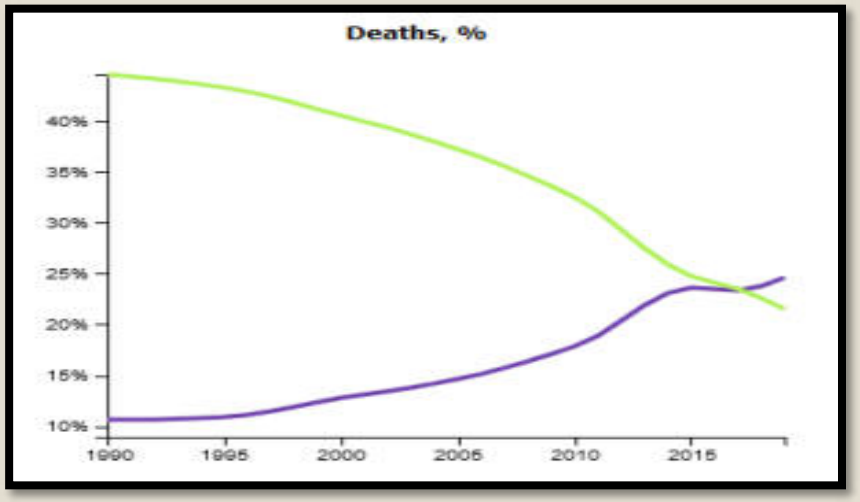


Figure 2: Percentage of LRIs linked to ambient air pollution (purple) and household air pollution (green) since 1990

State wise and urban/rural disparity exists

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Exposure of Air Pollution in Intra – Uterine life

- Low birth weight and preterm birth are leading risk factors for death in the first month of life.
- India ->exposure to air pollution was linked to the deaths of 116,000 infants within the first month of being born.
- Archana Patel et al (2015) **- increased risk of perinatal mortality among households using polluting fuels (adjusted relative risk (aRR) 1.44, 95 % CI 1.30-1.61)**
- A study in Chennai, that a **10 µg/m^3** increase during pregnancy was associated with a **4 g (95% CI:1.08 g, 6.76 g)** decrease in birth-weight

Ghosh R, Causey K, Burkart K, Wozniak S, Cohen A, Brauer M. Ambient and household PM2. 5 pollution and adverse perinatal outcomes: A meta-regression and analysis of attributable global burden for 204 countries and territories. PLoS medicine. 2021 Sep 28;18(9):e1003718.

Balakrishnan K, Ghosh S, Thangavel G, Sambandam S, Mukhopadhyay K, Puttaswamy N, Sadasivam A, Ramaswamy P, Johnson P, Kuppuswamy R, Natesan D. Exposures to fine particulate matter (PM2. 5) and birthweight in a rural-urban, mother-child cohort in Tamil Nadu, India. Environmental research. 2018 Feb 1;161:524-31.

Patel AB, Meleth S, Pasha O, Goudar SS, Esamai F, Garces AL, Chomba E, McClure EM, Wright LL, Koso-Thomas M, Moore JL, Saleem S, Liechty EA, Goldenberg RL, Derman RJ, Hambidge KM, Carlo WA, Hibberd PL. Impact of exposure to cooking fuels on stillbirths, perinatal, very early and late neonatal mortality - a multicenter prospective cohort study in rural communities in India, Pakistan, Kenya, Zambia and Guatemala. Matern Health Neonatol Perinatol. 2015 Jul 21;1:18.

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Exposure of air pollution during childhood

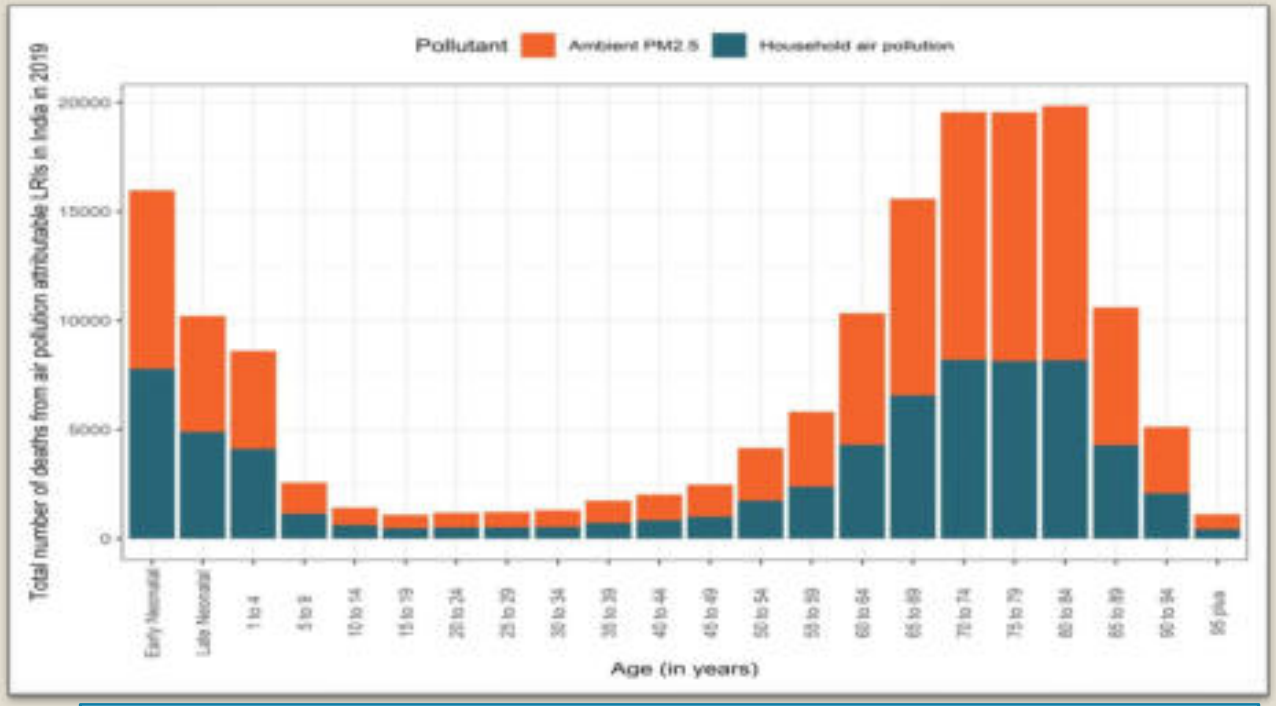

Figure 3:: Distribution of lower respiratory infection (LRI) deaths in 2019 linked to PM2.5 and household air pollution, by age (years, except early neonatal [0 to 6 days] and late neonatal [7 to 27 days]).

- Exposure to air pollution **reduce lung function among children**
- Continuous exposure to (PM10, PM2.5 nitrogen dioxide) can cause **respiratory infections among children**

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Exposure of air pollution during childhood

- **Short term exposure**
- Ear, nose, and throat irritation
- Aggravated conditions such as allergies and asthma
- Eczema

- **Long term exposure**
- New cases of childhood asthma
- Increase the risk of developing chronic respiratory diseases such as COPD **during adulthood**
- Childhood anaemia
- Allergic rhinitis
- Neurodevelopmental outcomes
- Stunting in children

Salvi SS, Kumar A, Puri H, Bishnoi S, Asaf BB, Ghorpade D, Madas S, Agrawal A, Kumar A. Association between air pollution, body mass index, respiratory symptoms, and asthma among adolescent school children living in Delhi, India. Lung India. 2021 Sep-Oct;38(5):408-415. doi: 10.4103/lungindia.lungindia_955_20. PMID: 34472517; PMCID: PMC8509169.

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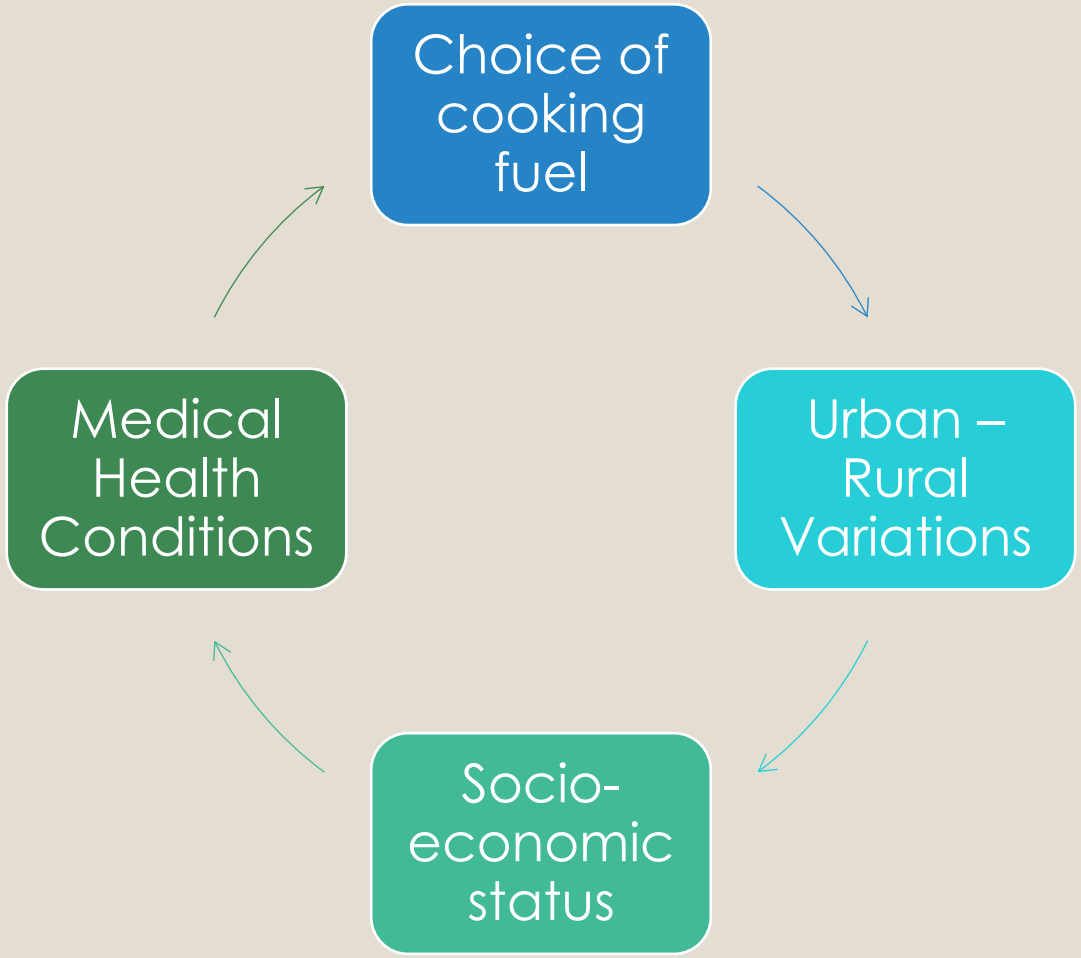
Determinants of the health impacts related to air pollution in children



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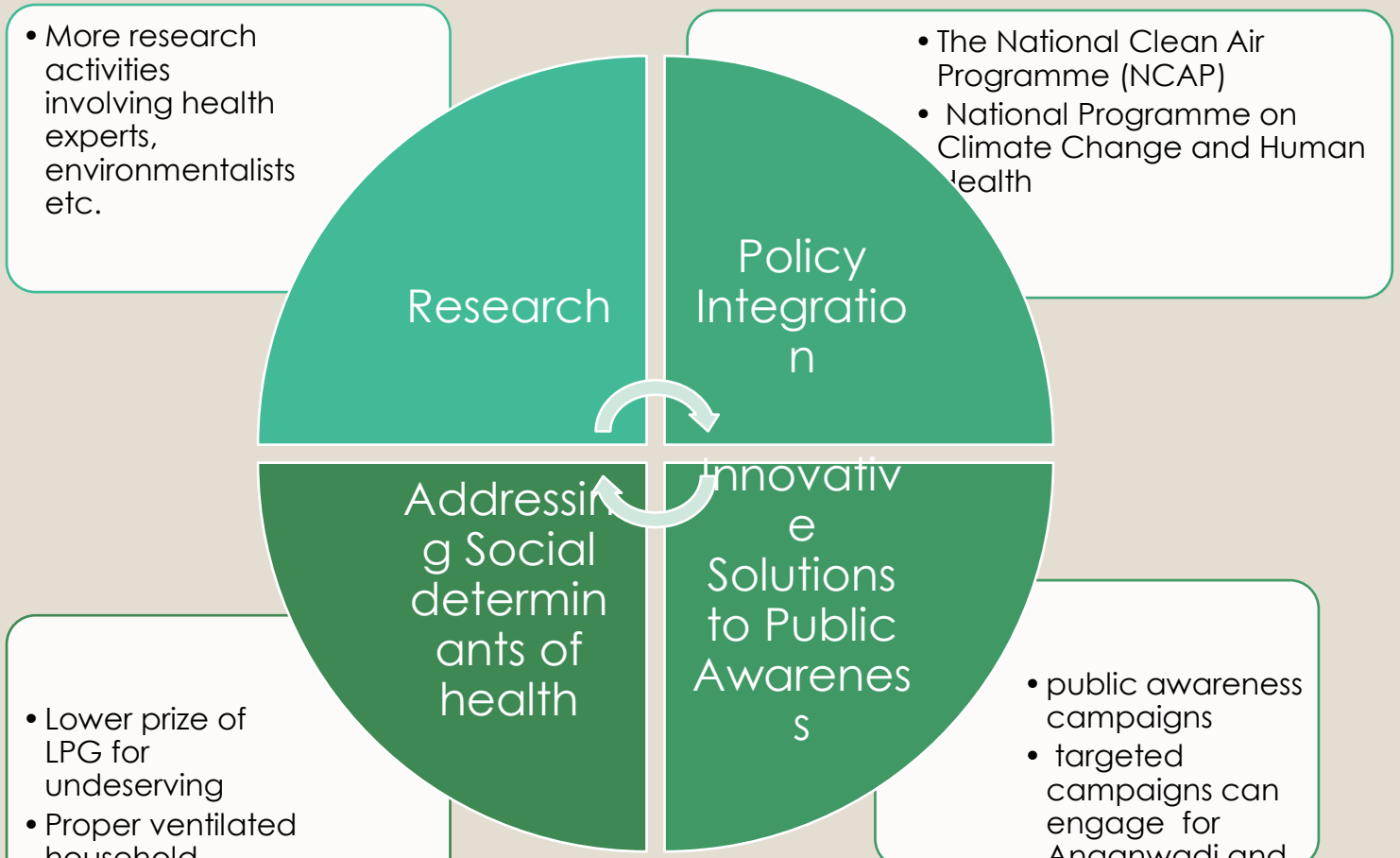
Recommendations



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ACTION REQUIRED

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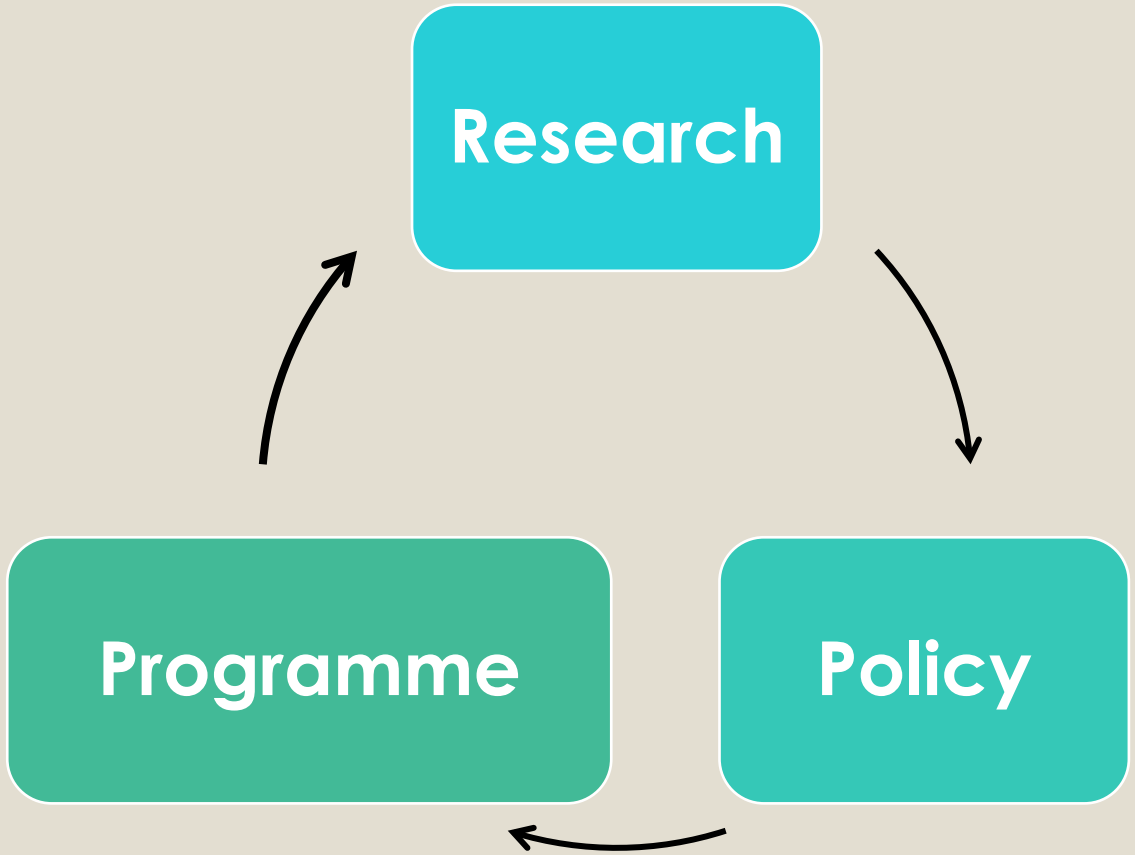
Addreesing Air Pollution and NCDs



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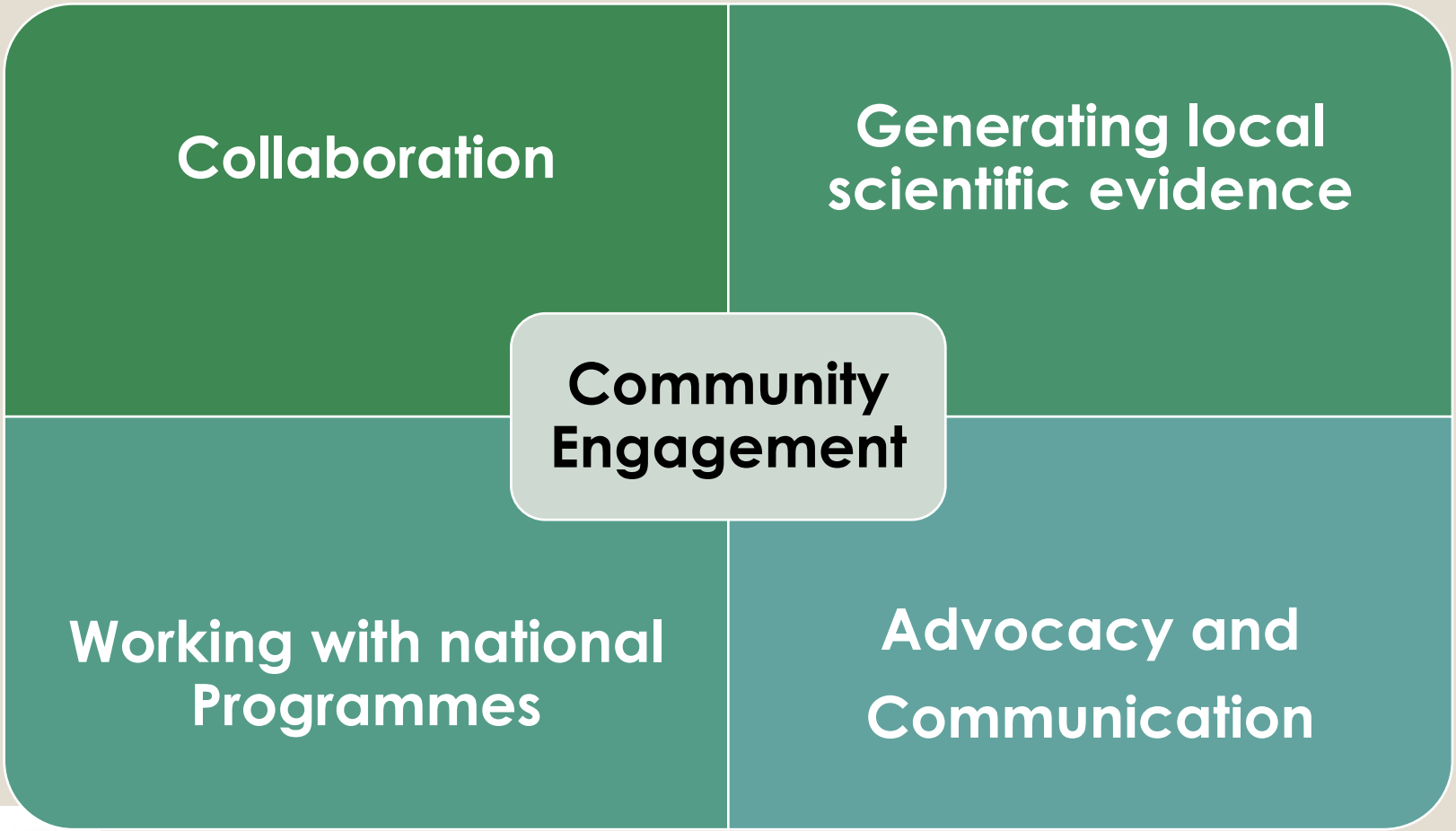
Domains for Action



AIIMS - IIT Delhi collaboration – Capitalizing on strengths

Strengths
- Epidemiology
- Medical Sciences
- Running Cohort
- Network development

Strengths
- Exposure measurement
- Technology use and GIS
- Modeling

Institutional mechanism is key for sustainability

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AIIMS – IIT Study at Ballabgarh

Mortality burden of ambient $PM_{2.5}$ exposure in Delhi NCR

(CCM, AIIMS – IIT Delhi Joint Project)

Objectives

Development of a mortality model by collating cause-specific mortality data and generating high-resolution $PM_{2.5}$ exposure data for Delhi NCR

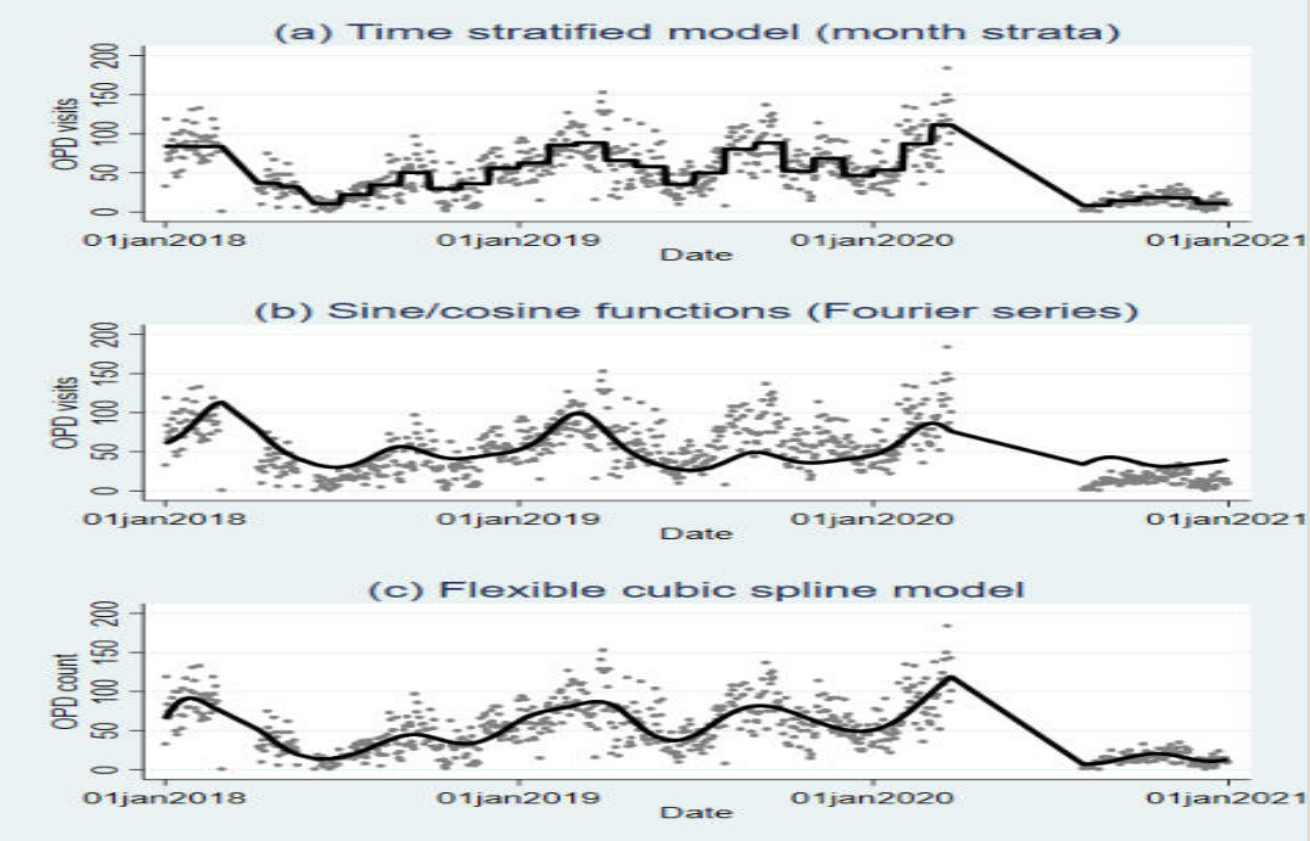
Estimate mortality burden due to short-term exposure to ambient $PM_{2.5}$ in Delhi NCR

	IRR	p-value	95% Confidence Interval	
Total deaths	**1.105**	0.000	1.068	1.144
Respiratory Diseases	**1.026**	0.353	.971	1.085
CVD	**1.043**	0.127	.988	1.102

PI - Harshal Ramesh Salve (AIIMS) – Sagnik Dey (IIT D)

Article under peer review. PI do not quote

PM 2.5 Exposure and OPD consultation for Cardio-respiratory illness – CRHSP Ballabgarh



PM 2.5 (7 day Lag)

IRR – 1.02 (1.01 – 1.04)

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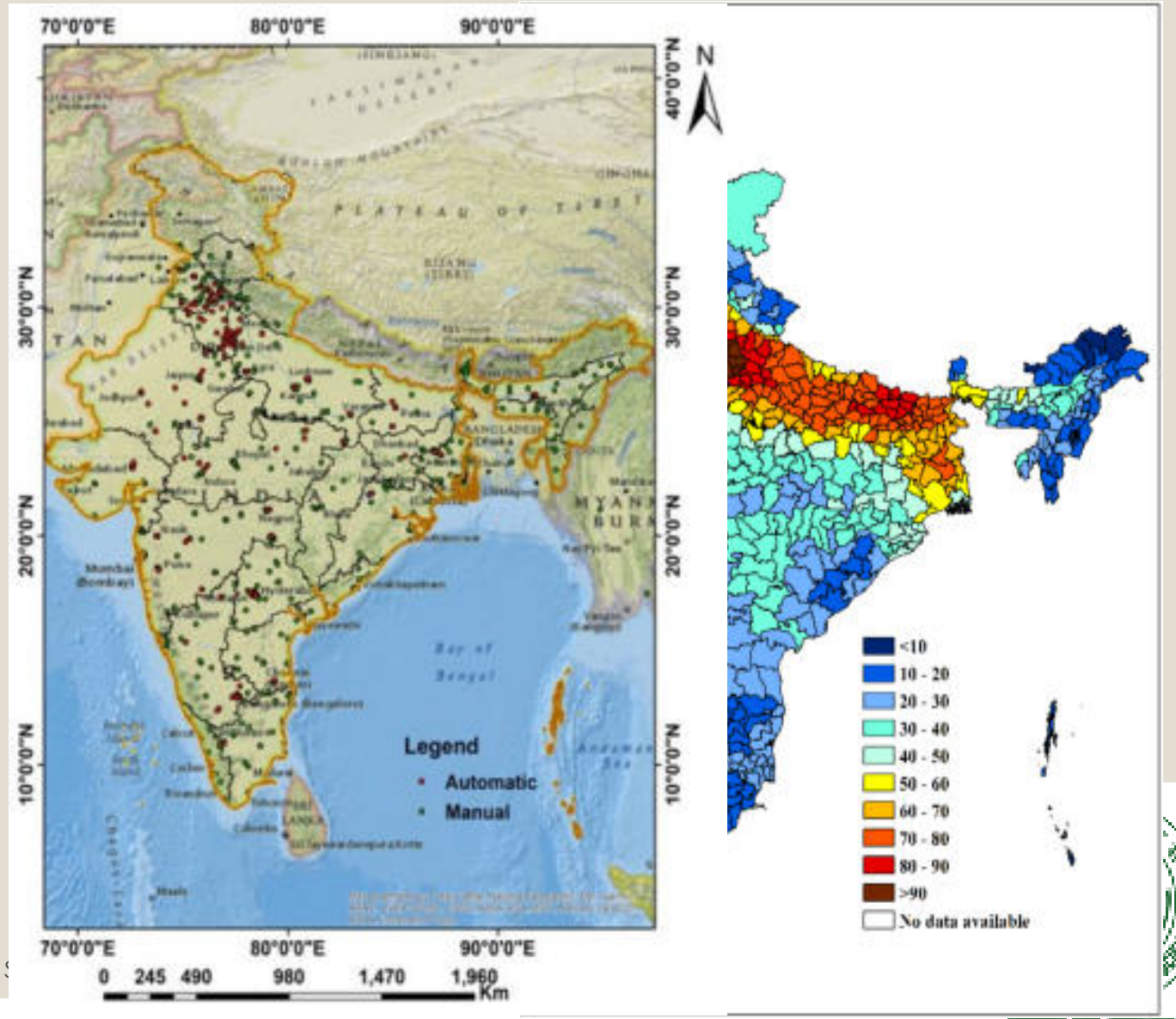
Sources of Air Pollution data

- Reference-grade monitoring network ($PM_{2.5}$, PM_{10}, SO_2, NO_2, O_3, Benzene, CO, etc.); expected to double by 2024 under the National Clean Air Programme (NCAP)
- Satellite-based $PM_{2.5}$ database at 1 km (other pollutants: NO_2, SO_2, O_3 etc.)
- Other networks like BC from IMD and ISRO; MAPAN and SAFAR networks
- Personal exposure monitoring in indoor microenvironments from past and existing cohorts



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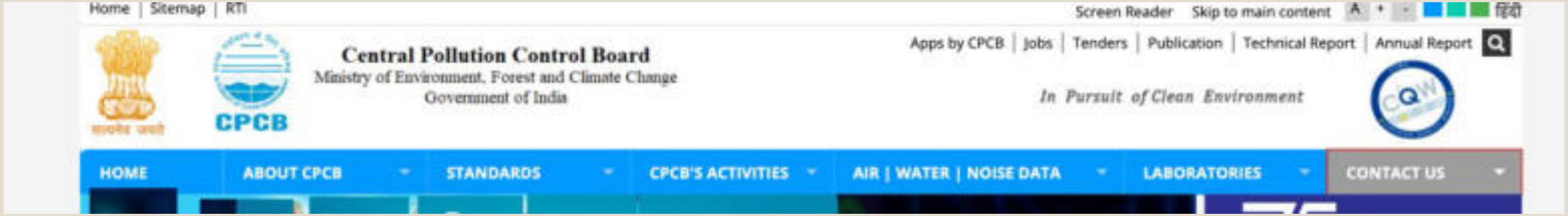
Sources of Air Pollution data



https://cpcb.nic.in

http://safar.tropmet.res.in/RESEARCH-14-7-Details

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Collaborative for Air Pollution and Health Effects Research-India

Objectives

- To build partnerships among research institutions to develop and implement research studies on health effects of air pollution
- To facilitate development of collaborative research proposals to fill critical evidence gaps
- To conduct capacity building exercises/programs targeted at early career researchers

Capher-India: Steering Committee

Dr. Anand Krishnan
All India Institute of Medical Sciences New Delhi

Dr. Kalpana Balakrishnan
Shri Ramchandra Institute of Higher Education and Research Chennai

Dr. Santu Ghosh
St John Medical College, Bengaluru

Dr. Aparajita Chattopadhyay
Indian Institute of Population Sciences, Mumbai

Professor Chandra Venkataraman
IDP Climate Studies, IIT Bombay

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Email: capherindia@gmail.com, Ph: 91-11-26593366

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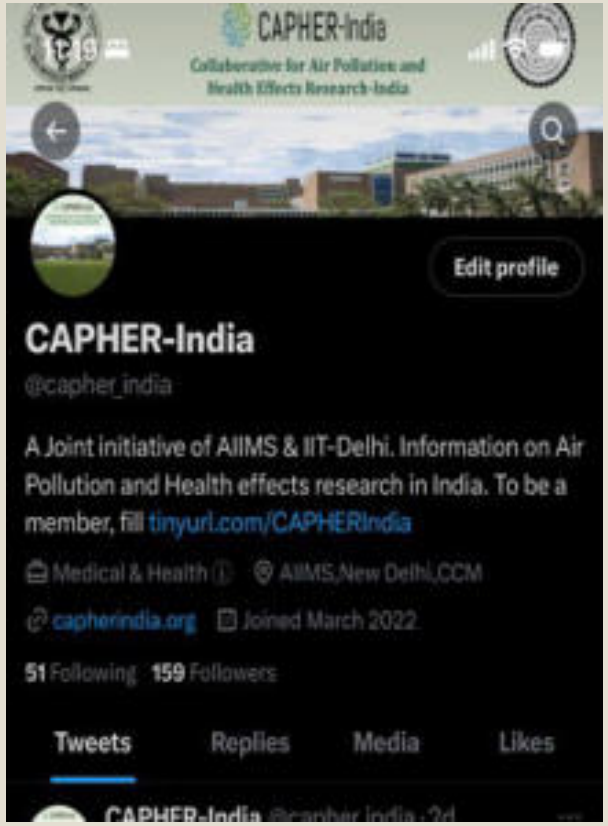
How to join CAPHER – India network

- Find us on Twitter for updates on CAPHER activities and upcoming events
- Write to the secretariat- capherindia@gmail.com
- To join the network, please complete the form - https://tinyurl.com/CAPHERIndia



Challenges ahead

- Changing priorities of policy makers
- Lack of opportunities for integration
- Geographically restrictive approach
- Medium, long term goals are missing - Mostly A knee jerk reaction is observed

PROGRAMME

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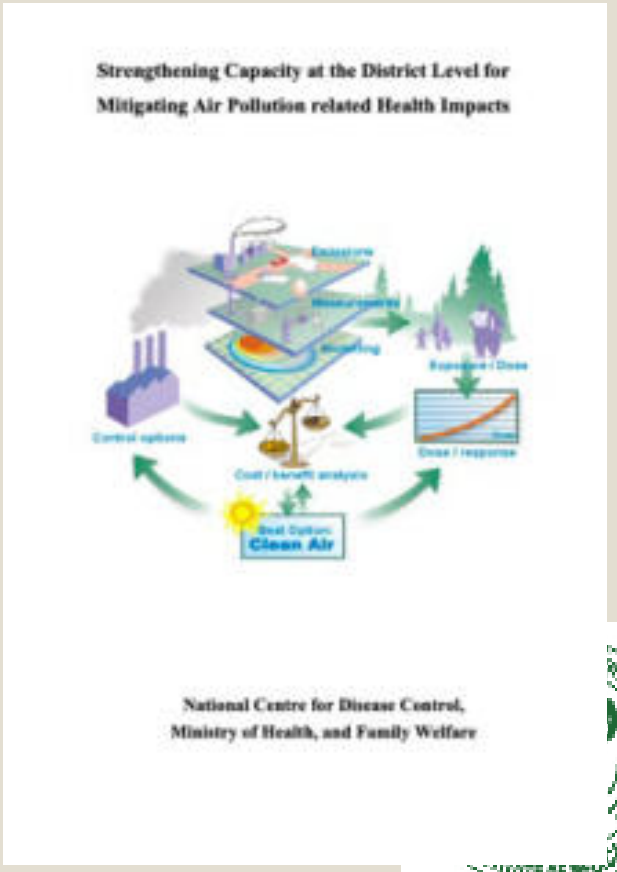
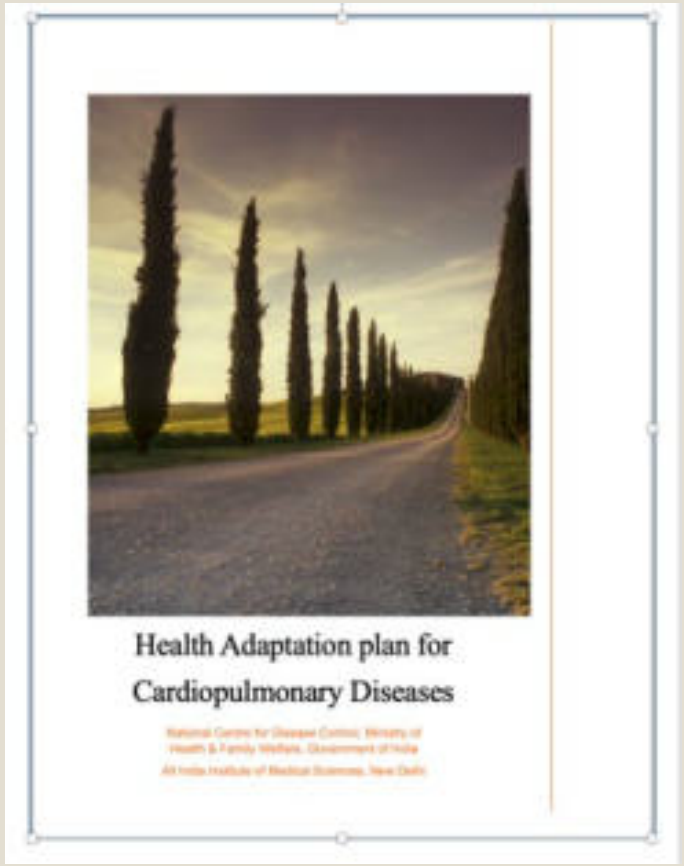
Capacity building of Health officials



Centre for Excellence for Cardiopulmonary diseases under NPCCHH



Developed Training manual for State and District level officers in CC and Cardio-respiratory diseases

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Actions needed at programme level

National Programme for Climate Change and Human Health (NPCCHH)

Specific actions at policy level

- **Integration of health and environmental measures policy decisions serve to protect and improve health**
- **End health harmful subsidies**
- **Develop healthy and efficient transport options, such as combining rapid transit with walking/cycling**
- **Invest in health and evidence generation**
- **Provide safe housing conditions**
- **Regulate potentially health-harmful industries**
- **Select energy options, while considering health impacts and their financial implications**

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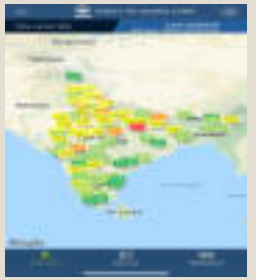
Specific actions at individual level

Decongestion of traffic by using Public transport and environment friendly vehicles



Air quality monitoring

Use of N95 Mask

Efficient use of energy, use of clean fuel

Proper waste disposal

Tree Plantation and conservation

Balanced diet with more consumption of fruits and vegetables

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The Way Forward

- Continued Knowledge and skill enhancement of the self – Contribution in Science by generating local evidence
- Involvement of Medical colleges/ institutions
- Understand and priorities the local environmental risks and community needs
- Strategic communication to the Policy makers
- Strengthening of Programme
- Collaboration and Partnership

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Passion, Perseverance and Partnership
are essential for essential for **advancing science**

Together wE Achieve More

THANK - YOU

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