



COMMON CONDITIONS & EMERGENCIES IN PEDIATRICS

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SESSION OBJECTIVES

1. Participants will describe global leading causes of death in children under 5 years of age.
2. Participants will identify common pediatric illnesses and emergencies in children under 5 years of age in resource-poor settings.
3. Participants will describe steps to creating simple, evidence-based treatment protocols.
4. Participants will discuss the role of maternal education in improved outcomes for children under 5 years of age.

AGENDA

1. Review global mortality and morbidity statistics in children under five
2. Discuss specific illnesses and emergencies in under fives, using cases
3. Provide tips on creating simple, evidence-based treatment protocols
4. Elaborate on the multifaceted role of the missionary physician/
healthcare worker (HCW) in resource poor communities
5. Highlight the effect of maternal education on child survival, drawing
from field experience

GLOBAL MORTALITY STATISTICS



Source: <https://madeit.com.au>

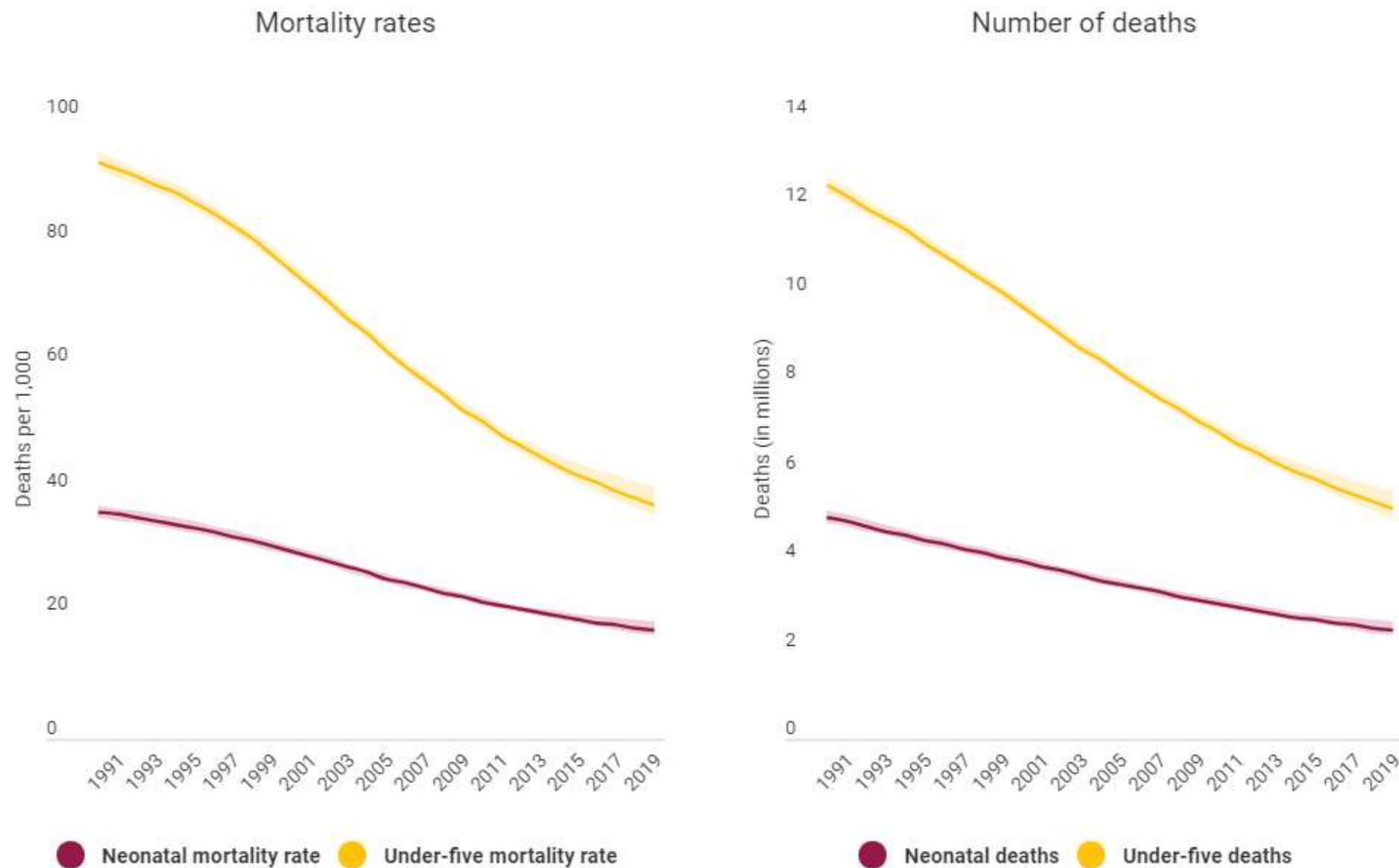
In 2019 an estimated 5.2 million children under 5 years died - mostly from preventable and treatable causes

2.4 million deaths occurred in newborns under 28 days old

1.5 million deaths occurred in children aged 1 to 11 months

1.3 million deaths in 1 to 4-year old children

Global mortality rates and number of deaths by age, 1990–2019



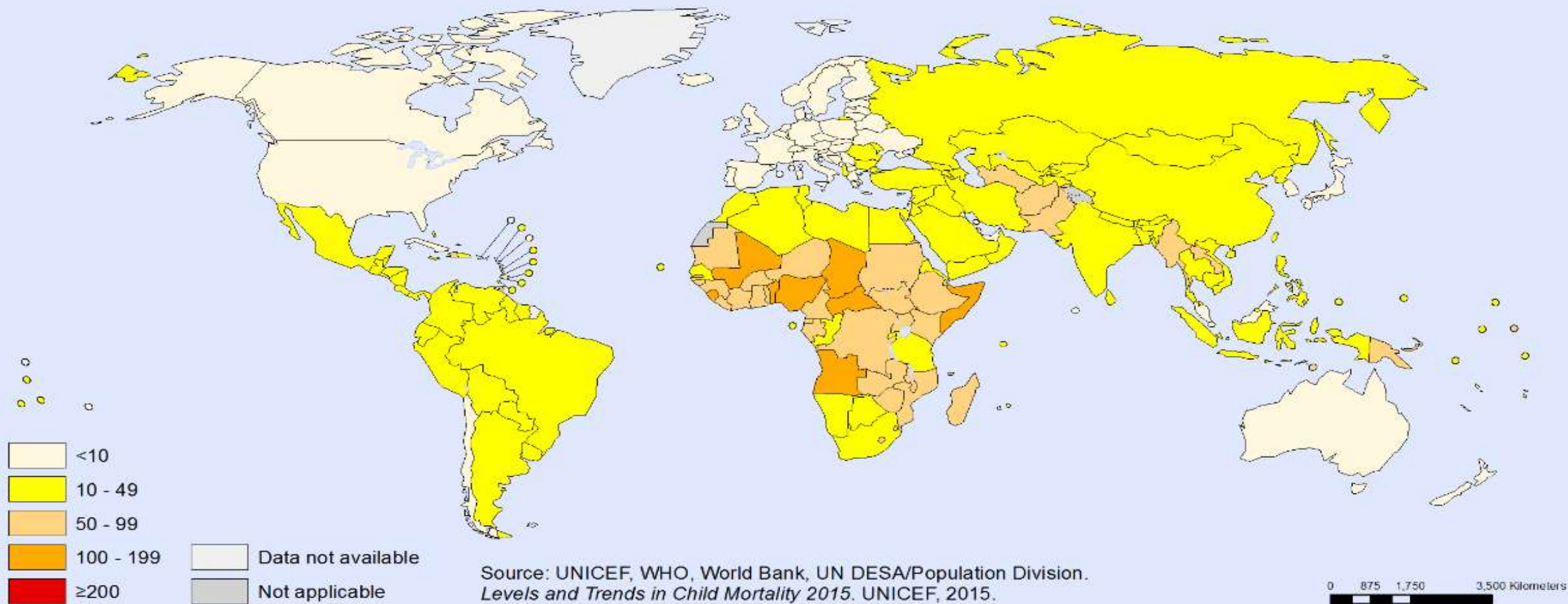
Source: United Nations Inter-agency Group for Child Mortality Estimation (UN IGME) 2020

GEOGRAPHIC DISTRIBUTION

- 52% of children under 5 years live in Sub-Saharan Africa and Central and Southern Asia
- Over 80% of the 5.2 million under-five deaths in 2019 occurred in these regions
- Half of all under-five deaths in 2019 occurred in 5 countries: Nigeria, India, Pakistan, the Democratic Republic of the Congo and Ethiopia



Under-five mortality rate (probability of dying by age 5 per 1000 live births), 2015



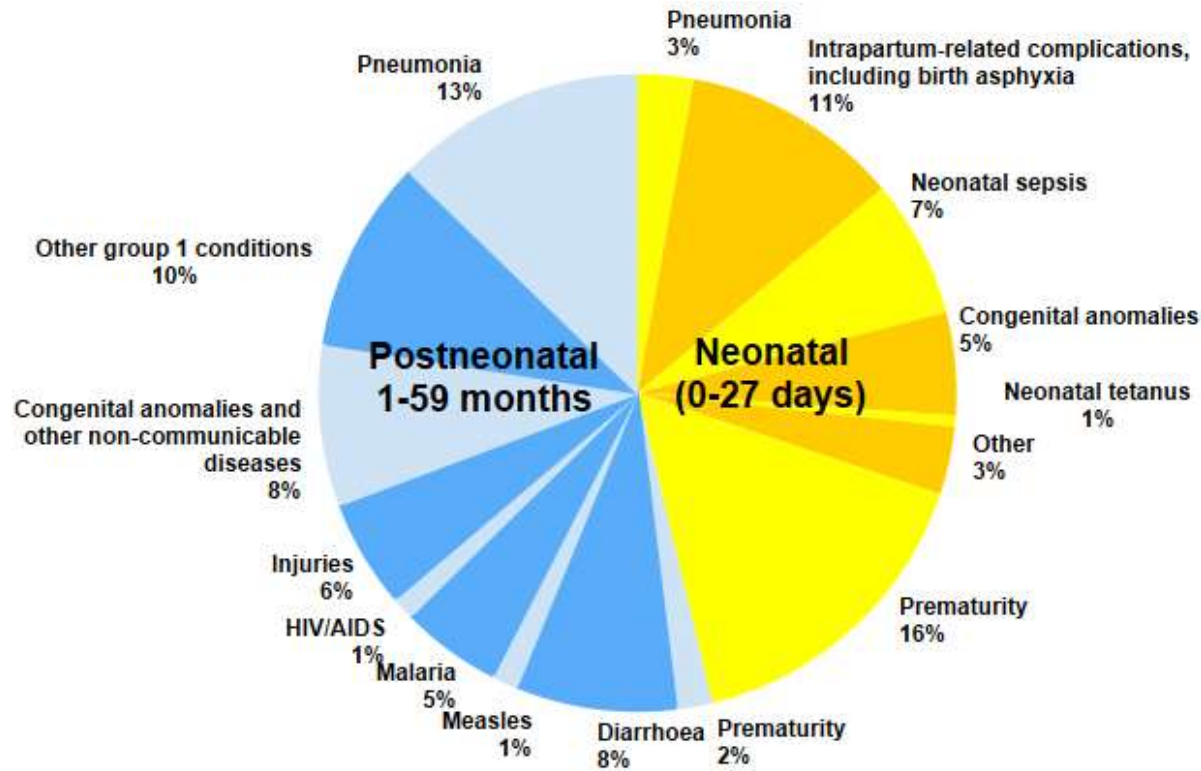
The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization
Map Production: Health Statistics and
Information Systems (HSI)
World Health Organization



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UNDER-5 GLOBAL LEADING CAUSES OF DEATH



Neonatal disorders - preterm birth complications, birth asphyxia/trauma, congenital anomalies

Infectious diseases – malaria, pneumonia, diarrhea, measles, meningitis

Malnutrition – underlying condition that impacts child survival significantly

Source: WHO-MCEE methods and data source for child causes of death 2000-2016

SUSTAINABLE DEVELOPMENT GOALS

- The Sustainable Development Goals (SDGs) adopted by the United Nations in 2015 were developed to promote healthy lives and well-being for all children
- SDG Goal 3.2.1 - to end preventable deaths of newborns and under-5 children by 2030, has two targets:
 - Reduce newborn mortality to at least as low as 12 per 1 000 live births in every country
 - Reduce under-five mortality to at least as low as 25 per 1,000 live births in every country

MALARIA



MALARIA

- Every 2 minutes, a child dies of malaria
- ~ 228 million cases of malaria reported in 2018 worldwide
- About 405 000 malaria deaths occurred in 2018
- In 2018, children under 5 accounted for 67% (272 000) of all malaria deaths worldwide
- Sub-Saharan Africa accounts for 93% of malaria cases and 94% of malaria deaths

MALARIA

- Vector-borne, life-threatening disease caused by *Plasmodium* parasites through the bites of infected female *Anopheles* mosquito
- Of the 5 parasite species that cause malaria in humans, *P. falciparum* is the most deadly



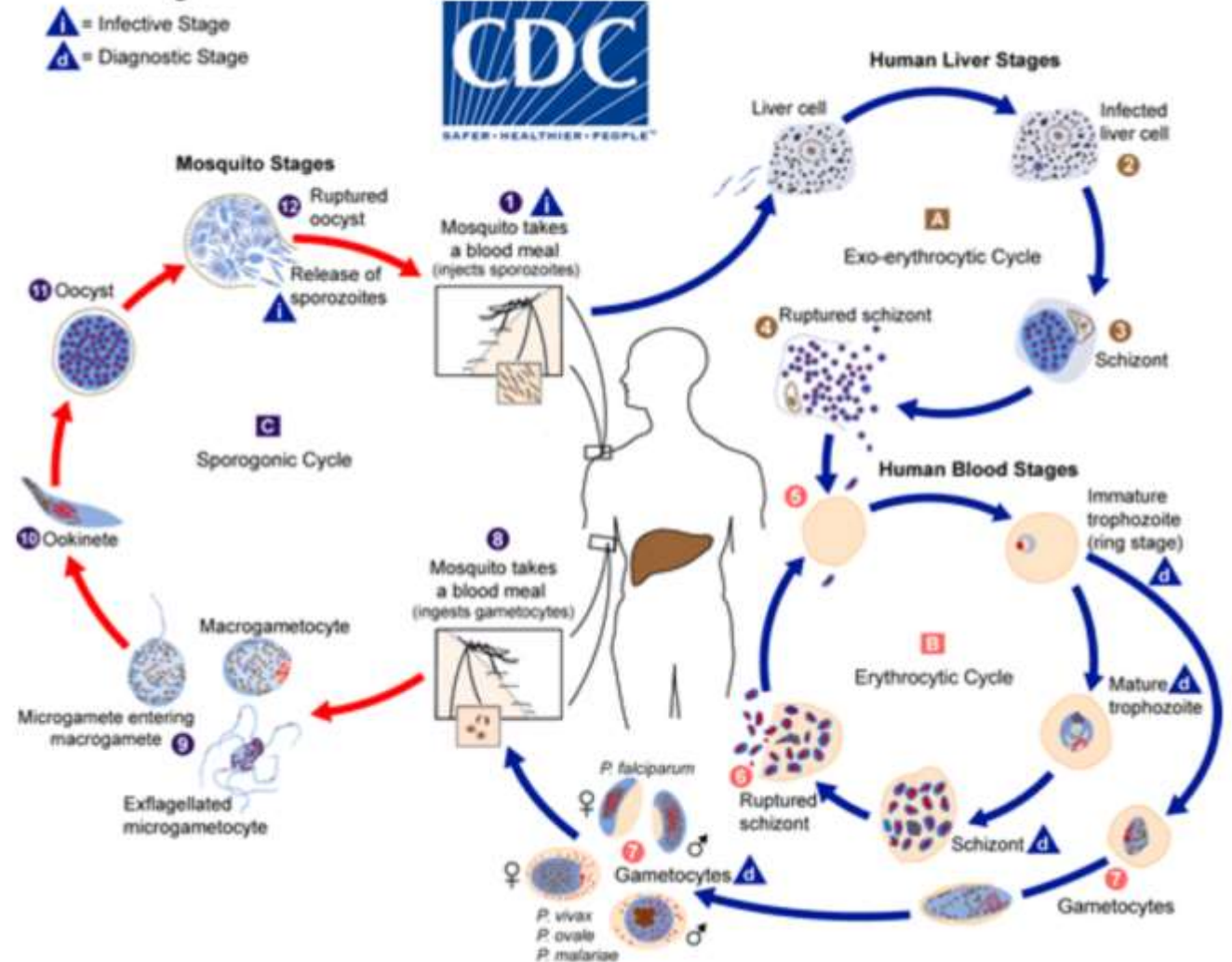
<https://medicalxpress.com/news>

MALARIA TRANSMISSION

Life Cycle in Man

- During a blood meal, a malaria-infected female *Anopheles* mosquito inoculates sporozoites into the human host ①
- Sporozoites infect liver cells ②
- Sporozoites mature into schizonts ③
- Ruptured schizonts release merozoites ④
- Merozoites infect red blood cells ⑤
- Ring stage trophozoites mature into schizonts that rupture & release merozoites ⑥
- Some parasites differentiate into gametocytes ⑦

Life Cycle

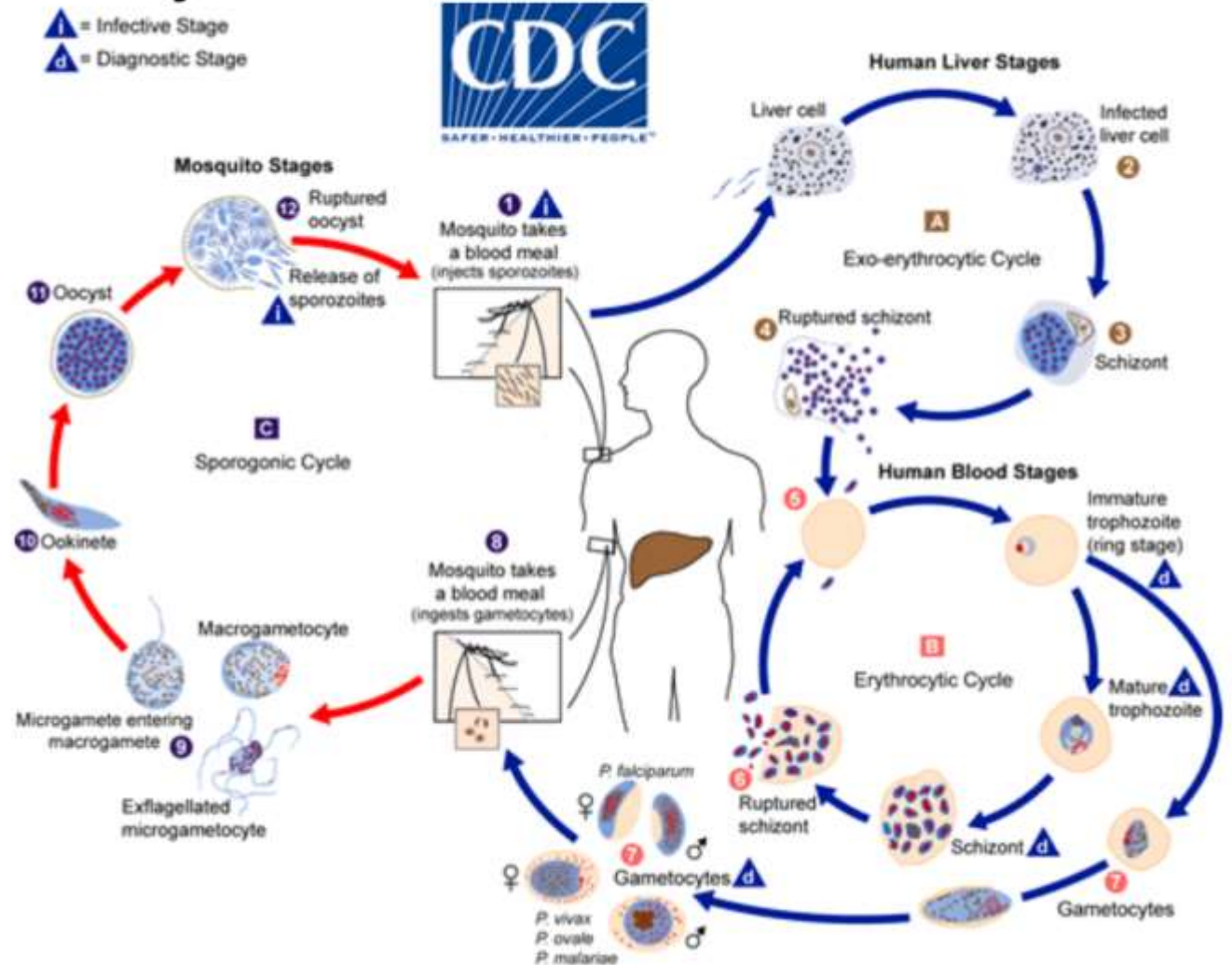


MALARIA TRANSMISSION

Life Cycle in Mosquito

- Gametocytes are ingested by *Anopheles* mosquito during a blood meal (8)
- In the mosquito's stomach, microgametes (M) penetrate the macrogametes (F) generating zygotes (9)
- Zygotes become ookinetes (10)
- Ookinetes invade the midgut wall of the mosquito and become oocysts (11)
- Oocysts grow, rupture, and release sporozoites (12)
- Sporozoites migrate to the mosquito's salivary gland
- Inoculation of the sporozoites into a new human host perpetuates the life cycle

Life Cycle



MALARIA TRANSMISSION

Malaria can also be transmitted through

- blood transfusion
- organ transplant
- shared use of needles or syringes contaminated with blood
- the placenta from mother to fetus (“congenital” malaria)

MALARIA

- Incubation period of 10–15 days
- Classic symptoms - high fever, headache, and chills, rigors
- Other symptoms develop as the disease progresses - nausea, vomiting, arthralgia, myalgia, abdominal pain, signs of hemolysis
- Left untreated, *P. falciparum* malaria can progress to severe illness and death

MANAGEMENT OF MALARIA

- Early diagnosis and treatment of malaria reduce disease, prevent deaths, and reduce malaria transmission
- WHO recommends that all cases of suspected malaria be confirmed using parasite-based diagnostic testing (either microscopy or rapid diagnostic test) before administering treatment
- Empiric treatment based on clinical symptoms should only be considered when a parasitological diagnosis is not possible or available within 2 hours of presentation
- The best available treatment, particularly for *P. falciparum* malaria, is artemisinin-based combination therapy (ACT)

MALARIA COMPLICATIONS

- Cerebral malaria
- Hypoglycemia
- Acute renal failure
- Severe anemia
- Vascular collapse & shock



MALARIA PREVENTION

- Vector control is the main way to prevent and reduce malaria transmission
 - insecticide-treated mosquito nets for all populations at risk of malaria
 - indoor residual spraying
- Prophylaxis for non-immune and special populations
- Malaria vaccine, [RTS,S/AS01 \(RTS,S\)](#) is the first and, to date, the only vaccine to show that it can significantly reduce malaria, and life-threatening severe malaria, in young African children

PNEUMONIA & DIARRHEA

- ~19000 children under 5 years die every day
- About 29% of all under-5 deaths are due to pneumonia and diarrheal diseases
- Majority of the deaths occur in the first 2 years
 - 72% from diarrhea
 - 81% from pneumonia

PNEUMONIA & DIARRHEA

Childhood diarrhea and pneumonia have significant overlap because of shared risk factors, including

- Undernutrition
- Suboptimal breastfeeding
- Zinc deficiency



PNEUMONIA



PNEUMONIA

Etiologic Agent	Mortality/Morbidity Statistics
<i>S pneumoniae</i>	33% of deaths worldwide 18% of severe cases
Influenza virus	11% of deaths worldwide 7% of severe cases
<i>H influenzae</i> type b	16% of deaths worldwide 4% of severe cases
<i>Staphylococcus aureus</i>	
non-typhoidal <i>Salmonella</i>	

PNEUMONIA

Other etiologic agents:

- *Klebsiella pneumoniae* (especially in malnourished children and neonates)
- *Mycoplasma pneumoniae*
- *Chlamydia pneumoniae* (in children older than 3 years)
- *Mycobacterium tuberculosis* (especially in HIV-positive children)
- respiratory viruses e.g. parainfluenza, human metapneumovirus, adenovirus, coronavirus*
- *Bordetella pertussis*

PNEUMOCOCCAL PNEUMONIA

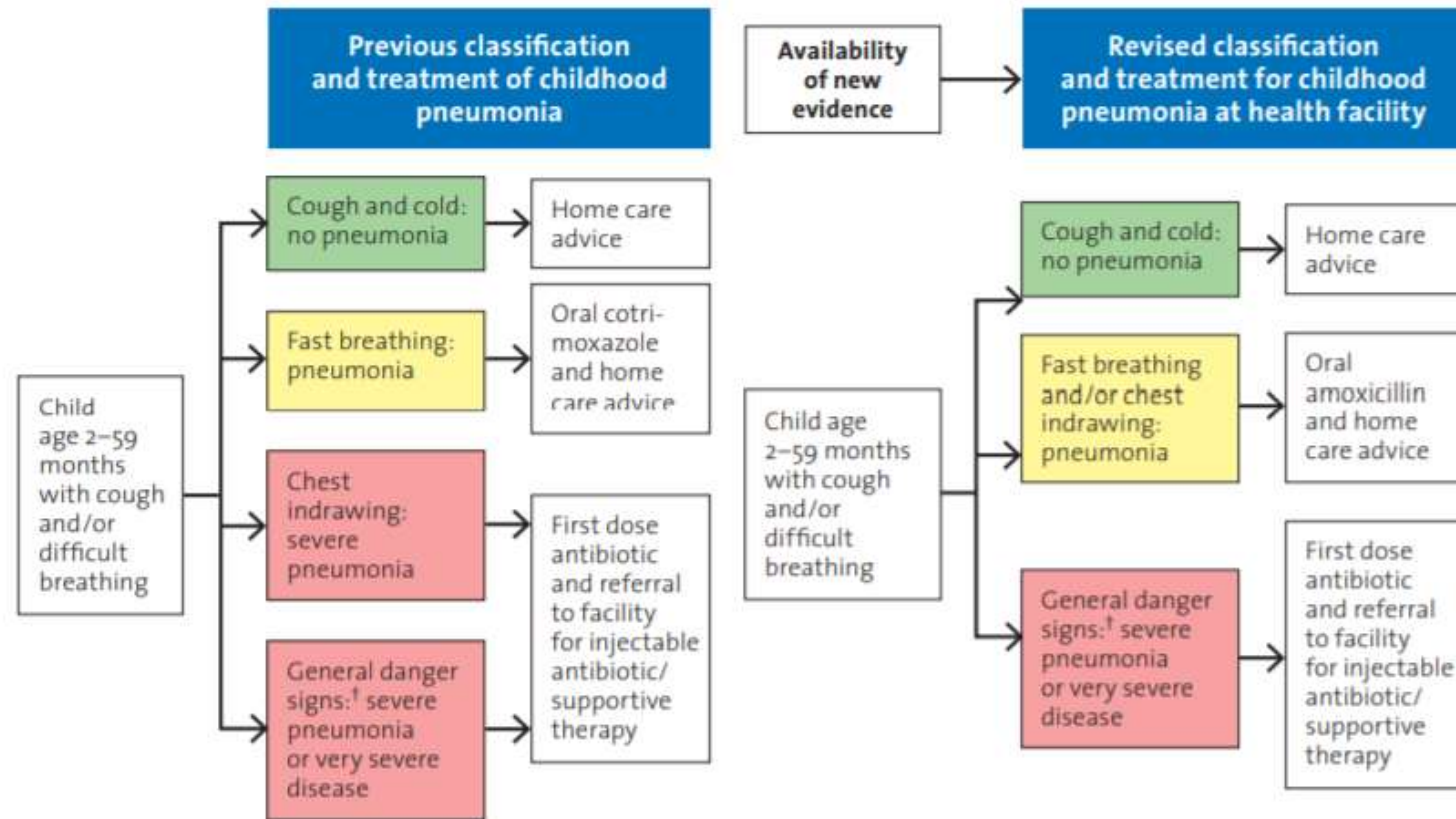
- Over 90 pneumococcal serotypes have been identified
- Nasopharyngeal carriage rates in children range from 21% (industrialized countries) >90% (resource-limited countries)
- Droplet transmission from person to person
- Most prevalent during winter months or dry season

PNEUMOCOCCAL PNEUMONIA

- Commonly acquired in the community
- Typically preceded by a viral upper respiratory tract infection
- *S pneumoniae* colonize the trachea and then gain access to the lungs
- Less commonly, may arise from direct seeding of lung tissue from bacteremia
- Proliferation of organism in lower airway and alveoli generate inflammatory response both locally and systemically, with resultant clinical presentation

PNEUMONIA PRESENTATION

Comparison of previous and revised classification and treatment of childhood pneumonia at health facility



† Not able to drink, persistent vomiting, convulsions, lethargic or unconscious, stridor in a calm child or severe malnutrition.

Source: Revised WHO classification and treatment of childhood pneumonia at health facilities

PNEUMOCOCCAL PNEUMONIA

Doses of amoxicillin for children 2–59 months of age with pneumonia

TOOLS	CATEGORY OF PNEUMONIA	AGE/WEIGHT OF CHILD	DOSAGE OF AMOXICILLIN DISPERSIBLE TABLETS (250 mg)
iCCM tool for community health workers: no change	Fast breathing pneumonia	2 months up to 12 months (4–<10 kg)	1 tab twice a day x 5 days (10 tabs)
		12 months up to 5 years (10–19 kg)	2 tabs twice a day x 5 days (20 tabs)
IMCI tool for professional health workers at health facilities: revised	Fast breathing and chest indrawing pneumonia	2 months up to 12 months (4–<10 kg)	1 tab twice a day x 5 days (10 tabs)
		12 months up to 3 years (10–<14 kg)	2 tabs twice a day x 5 days (20 tabs)
		3 years up to 5 years (14–19 kg)	3 tabs twice a day x 5 days (30 tabs)

Source: Revised WHO classification and treatment of childhood pneumonia at health facilities

COMPLICATIONS & LONG-TERM EFFECTS

- Risk of major sequelae is higher in children under 2 years than in those aged 2–4 years
- Risk of at least one long-term major sequela - 5.5% in non-severe pneumonia
- In severe pneumonia (hospitalized) the risk increased to 13.6%
- Most common sequela was reduction in lung volume

DIARRRHEAL DISEASES



Source: Red Book® 2018, 2018

GMHC 2020

DIARRHEA

- Rotavirus is the most common cause of severe and fatal diarrhea worldwide
 - accounts for 28% of severe cases
 - associated with 28% of fatal cases
- *V cholerae* causes roughly 1% of severe diarrhea worldwide
- Other infective causes of severe diarrhea with dehydration include
 - other viruses (norovirus, astrovirus, adenovirus)
 - bacteria (pathogenic *Escherichia coli*, *Shigella*, *Campylobacter*, *Salmonella*)
 - parasites (*Giardia lamblia*, *Entamoeba histolytica*, and *Cryptosporidium*)

DIARRHEA

- Infectious diarrhea arises from direct invasion of the epithelial lining of the gastrointestinal tract by microbial agents
- Resultant widespread destruction of absorptive epithelium produces inefficient water absorption and increased fluid in the lumen
- With poor oral intake or profuse vomiting and negative fluid balance, dehydration and electrolyte imbalance are inevitable

DEHYDRATION CLASSIFICATION

<p>Two of the following signs: Lethargic or unconscious Sunken eyes Not able to drink or drinking poorly Skin pinch goes back very slowly</p>	<p>SEVERE DEHYDRATION</p>	<p>If child has no other severe classification: - Give fluid for severe dehydration (Plan C). OR <i>If child also has another severe classification: Refer URGENTLY to hospital with mother giving frequent sips of ORS on the way. Advise the mother to continue breastfeeding.</i> If child is 2 years or older, and there is cholera in your area, give antibiotic for cholera</p>
<p>Two of the following signs: Restless, irritable Sunken eyes Drinks eagerly, thirsty Skin pinch goes back slowly</p>	<p>SOME DEHYDRATION</p>	<p>Give fluid, Zinc supplements and food for some dehydration (Plan B) <i>If Child also has a severe classification: - Refer URGENTLY to hospital with mother giving frequent sips of ORS on the way.</i> <i>Advise the mother to continue breastfeeding.</i> Advise mother when to return immediately. Follow-up in 5 days if not improving If confirmed/suspected symptomatic HIV, follow-up in 2 days if not improving</p>
<p>Not enough signs to classify as some or severe dehydration</p>	<p>NO DEHYDRATION</p>	<p>Give fluid, Zinc supplements and food to treat diarrhoea at home (Plan A) Advise mother when to return immediately. <i>Follow-up in 5 days if not improving.</i> If confirmed/suspected symptomatic HIV, follow-up in 2 days if not improving</p>

COMPLICATIONS & LONG-TERM EFFECTS

- For an otherwise healthy child, a single episode of diarrhea is typically self-limiting and has no long-term sequelae
- The odds of growth stunting by age 2 years increased by 1.13 for every five episodes of diarrhea
- The proportion of stunting that could be attributed to five or more episodes of diarrhea before 2 years of age was 25%

PNEUMONIA & DIARRHEA MANAGEMENT

- The Integrated Management of Childhood Illnesses approach in health facilities has improved quality of care provided at health facilities
- The Integrated Community Case Management of pneumonia, diarrhea, and malaria improves access to care, and community health workers can safely and effectively treat patients

PNEUMONIA & DIARRHEA MANAGEMENT

- Early diagnosis and prompt treatment is critical for child survival
- Co-trimoxazole with amoxicillin are first-line antibiotics for pneumonia
- Encourage the use of cost-effective prevention—e.g. exclusive breastfeeding, vaccines, and access to clean water
- Promote treatment with simple, inexpensive antibiotics, oral rehydration salts, and zinc

Diarrhoea



Vitamin A
supplementation



Vaccination : rotavirus



Safe water
& improved sanitation



Low-osmolarity ORS, zinc
& continued feeding

Protect



Breastfeeding
promotion & support



Adequate complementary
feeding

Prevent



Measles
Vaccination



Handwashing
with soap



Prevention of HIV

Treat



Improved care seeking
behaviour and referral



Improved case management
at community and health
facility levels



Continued feeding

Pneumonia



Vaccination
(PCV, Hib, pertussis)



Reduced household
air pollution



Antibiotics
for pneumonia



Oxygen therapy
(where indicated)

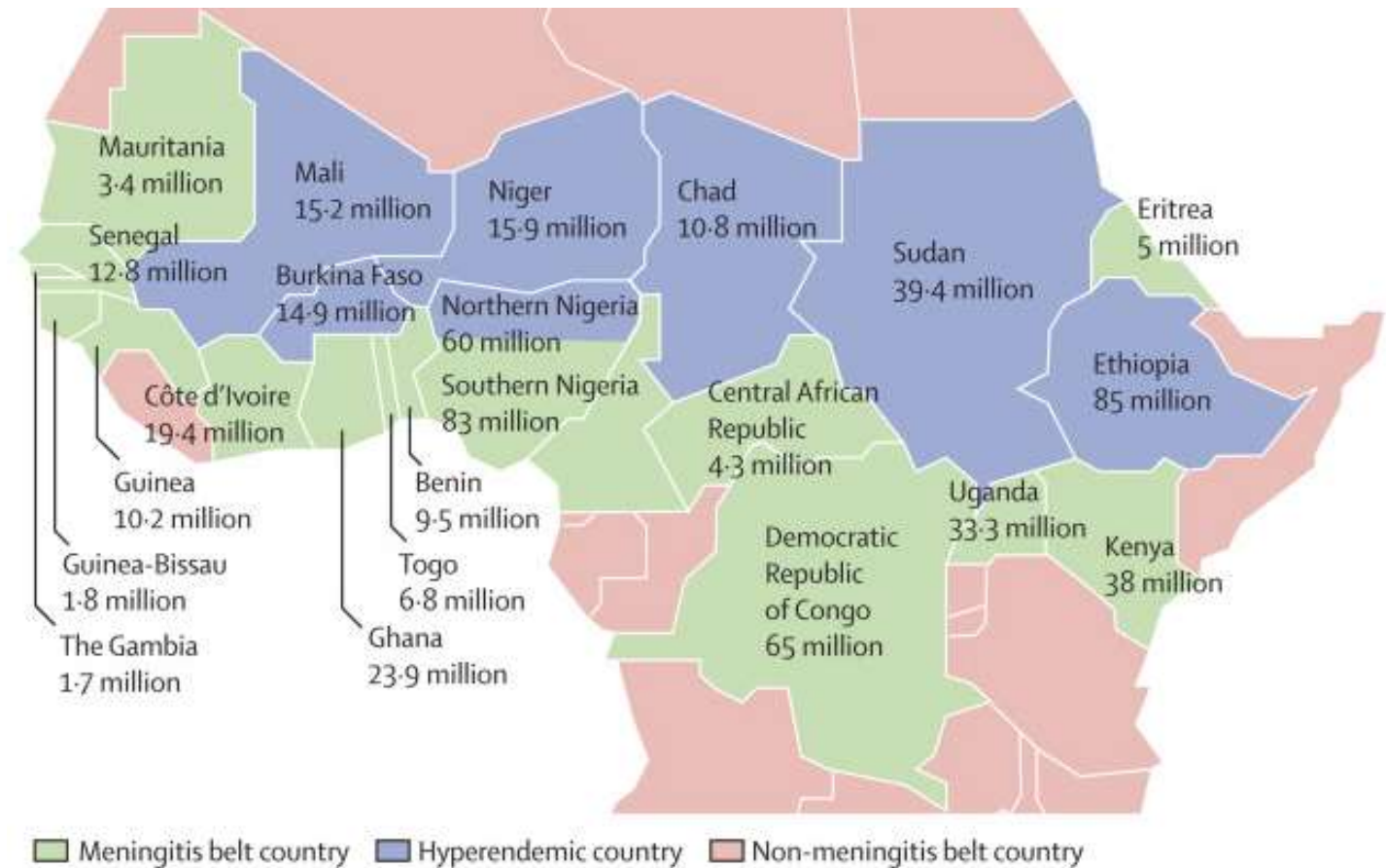
“Children who are poor, hungry, and living in remote areas are most likely to suffer from these “forgotten killers”, and the burden that pneumonia and diarrhea places on their families and on health system”

MENINGOCOCCAL MENINGITIS



MENINGOCOCCAL MENINGITIS

- Meningococcal meningitis' highest disease burden is in the meningitis belt of sub-Saharan Africa
- ~30 000 cases are reported each year in this region
- *Neisseria meningitidis* bacteria, has the potential to cause large epidemics, specifically, serogroups A, B, C, W, X, Y



MENINGITIS TRANSMISSION

- During the dry season (December to June), dust winds, cold nights and upper respiratory tract infections combine to damage the nasopharyngeal mucosa, increasing the risk of meningococcal disease
- Overcrowding aids disease transmission

MENINGITIS

- *N. meningitidis* only infects humans, and is transmitted via droplets of nasopharyngeal secretions from carriers or infected persons
- Most common symptoms - stiff neck, high fever, sensitivity to light, confusion, headaches and vomiting; bulging fontanelle in infants
- Severe form presents as meningococcal disease or septicemia, characterized by hemorrhagic rash and rapid circulatory collapse

MENINGOCOCCAL MENINGITIS

- Even with early diagnosis and treatment, 8% to 15% of patients die, often within 24 to 48 hours after the onset of symptoms
- If untreated, meningococcal meningitis is fatal in 50% of cases and 10% to 20% develop severe sequelae



Source: www.netmums.com

MENINGITIS

- Meningococcal meningitis is a medical emergency
- In-patient management at a hospital or health center with isolation and droplet precautions
- Immediate parenteral antibiotic therapy must be started, ideally after lumbar puncture
- However, investigative procedure should not delay treatment
- Penicillin, ampicillin and ceftriaxone are first line drugs

PREVENTION OF MENINGITIS

Chemoprophylaxis

- Antibiotic prophylaxis for close contacts
- Ciprofloxacin antibiotic is the antibiotic of choice for adults
- Rifampin for children
- Ceftriaxone an alternative

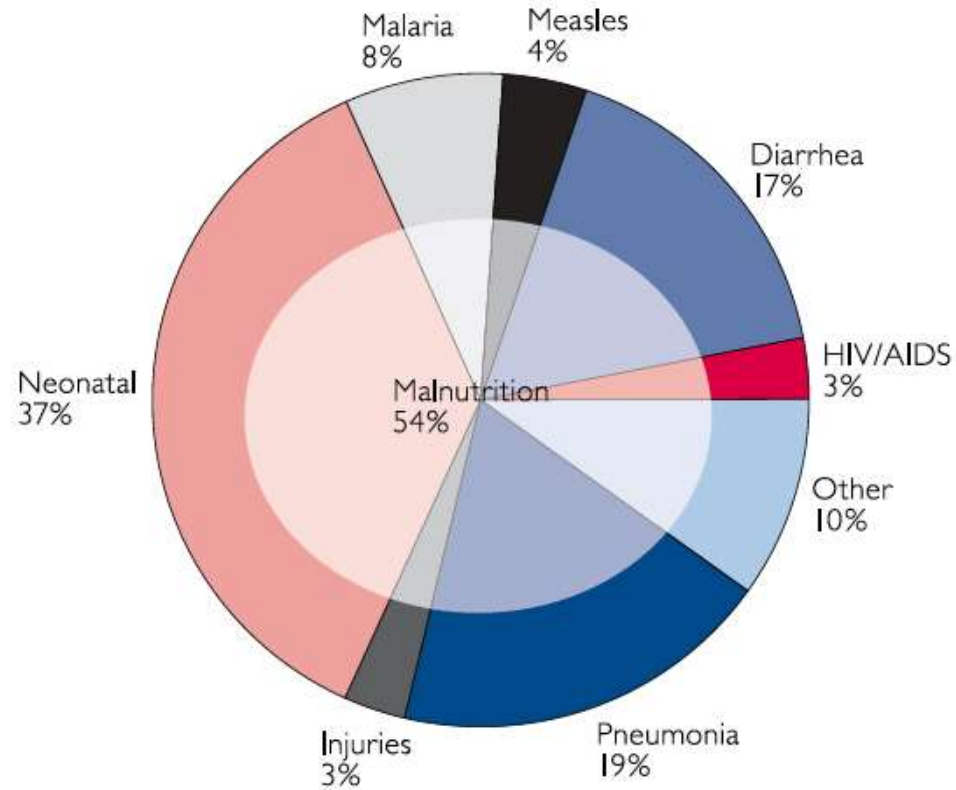
Vaccination

- Types available: polysaccharide, conjugate, protein vaccines
- New meningococcal A conjugate vaccine introduced in Africa for ages 1 to 29 years, in 2010, with reported 58% decline in meningitis incidence

MALNUTRITION



MALNUTRITION



Note: Percents do not total 100 due to rounding.

Source: The Lancet 365:1147-1152 Adapted from WHO, 2005

In 2019, globally 144 million children under the age of 5 years of age were stunted, 47 million wasted, 14 million severely wasted, and 38 million overweight



WASTING

THE GOAL

By 2025, reduce and maintain childhood wasting to less than 5%

WHY IT MATTERS



Children become wasted when they lose weight rapidly because of

infection or food insecurity



Wasting increases risk of **stunted growth, impaired cognitive development & non-communicable diseases** in adulthood



Wasting increases risk of **deaths from infectious diseases** such as diarrhoea, pneumonia and measles.



Wasting is linked with the other global nutrition targets:

- **stunting**
- **anaemia in women**
- **breastfeeding**
- **low birth weight**
- **childhood overweight**

Updated October 2016

RECOMMENDED ACTIONS

SCALE UP TREATMENT

WHAT?

Scale up coverage of services for the identification and treatment of wasting

HOW?

Improve the identification, measurement and understanding of wasting



COORDINATION

WHAT?

Improve coordination between key government ministries

HOW?

Link treatment strategies for acute malnutrition to prevention strategies for wasting and stunting throughout the life-course



BUILD THE EVIDENCE

WHAT?

Develop evidence for effective prevention strategies

HOW?

Rapidly develop evidence to reduce the burden of wasting, which can then be translated into policy actions



SCOPE OF THE PROBLEM

Globally nearly

51 million children

under 5 are moderately or severely wasted

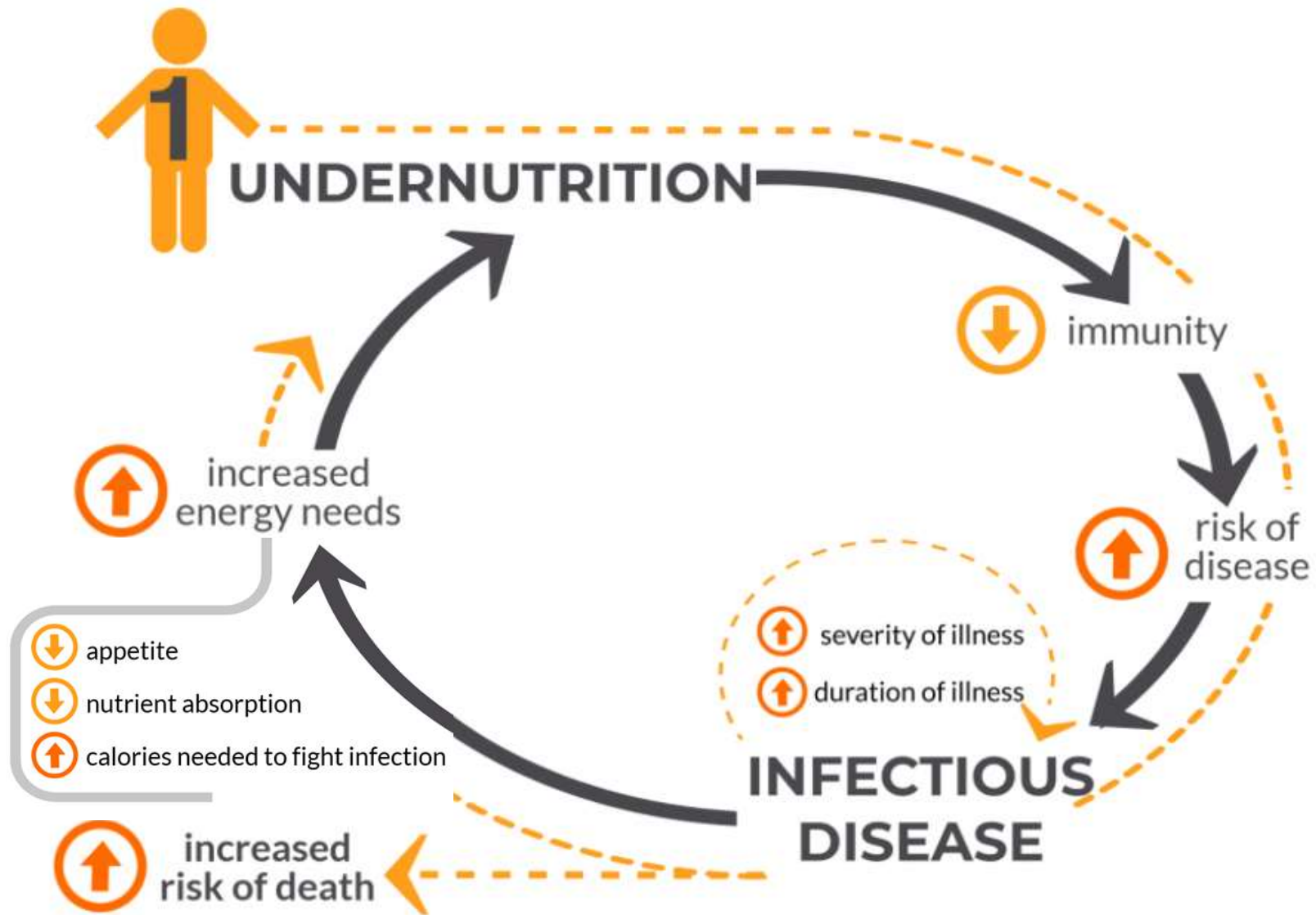
The current global levels of severe wasting are responsible for up to **2 million** deaths annually



A child that is wasted is

11 times more likely to die

than a healthy child



Source: <https://immunizationevidence.org/featuredissues/undernutrition-and-infectious-disease/>

NEONATAL DISEASES



Source: JHPIEGO

NEONATAL DISEASES

- Globally, neonatal deaths declined from 5 million (1990) to 2.4 million (2019)
- In 2019, neonatal deaths accounted for 47% of deaths among children under five globally - 33% died on day of birth, 75% die within the first week of life
- Sub-Saharan Africa had the highest neonatal mortality rate of 27 deaths per 1,000 live births, followed by Central and Southern Asia with 24 deaths per 1,000 live births (2019)

NEONATAL DISEASES

A child born in sub-Saharan Africa or in Southern Asia is 10 times more likely to die in the first month than a child born in a high-income country

NEONATAL DISEASES

Leading causes of neonatal deaths

- Preterm birth
- Intrapartum-related complications Infections
- Birth defects



NEONATAL DISEASES

- Newborns' survival and health is highly dependent on access to and quality of prenatal care, skilled care at birth, postnatal care for mother and baby, and care of small and sick newborns
- Women who receive midwife-led continuity of care (MLCC) provided by professional midwives, educated and regulated to international standards, are 16% less likely to lose their baby and 24% less likely to experience pre-term birth

DANGER SIGNS IN NEWBORNS

- not feeding well
- convulsions
- central cyanosis
- drowsy or unconscious
- movement only when stimulated
- no movement at all if breathing at 60 bpm or higher
- grunting
- severe chest indrawing
- raised temperature, $> 38\text{ }^{\circ}\text{C}$
- hypothermia, $< 35.5\text{ }^{\circ}\text{C}$

EMERGENCY MANAGEMENT OF DANGER SIGNS

- Open and maintain airway
- Give oxygen by nasal prongs if the young infant is cyanosed or in severe respiratory distress or hypoxic (oxygen saturation < 90%)
- Give bag and mask ventilation with oxygen (or room air if oxygen is not available) if there is apnea, gasping or respiratory rate too slow (< 20)
- Insert venous cannula
- Give ampicillin (or penicillin) and gentamicin – IV or IM

EMERGENCY MANAGEMENT OF DANGER SIGNS

- If drowsy, unconscious or convulsing, check blood glucose
- If glucose < 2.2 mmol/l (< 40 mg/100 ml), give 10% glucose IV at 2 ml/kg, then continue IV infusion of 5 ml/kg/h of 10% glucose for the next few days while oral feeds are built up
- If unable to check blood glucose quickly, assume hypoglycemia and give IV glucose. If unable to insert an IV drip, give expressed breast milk or glucose through a nasogastric tube
- Give phenobarbital if convulsing
- Monitor the infant frequently

ESSENTIAL NEWBORN CARE

- All babies should receive the following:
 - thermal protection (e.g. dry the baby, promoting skin-to-skin contact between mother and infant)
 - clamp and cut cord at least 1 minute after birth, practice hygienic umbilical cord care
 - early and exclusive breastfeeding (within the first hour of birth)
 - preventive care (e.g. immunization BCG and Hepatitis B, vitamin k and ocular prophylaxis)
 - assess for signs of serious health problems or need of additional care (e.g. low-birth-weight, sick or newborn of an HIV-infected mother)

SIMPLE, EVIDENCE BASED TREATMENT PROTOCOLS

- Utilize local (often unavailable), regional or national data or evidence
- Adapt existing protocols – no need to re-invent the wheel
- Use appropriate, culturally sensitive language – level of CHWs
- Build a strong team of trainers within the HCWs and CHWs – “See one, Do one, Teach one”
- Keep things simple – tackle one issue at a time
- Partnership - engage all stakeholders and get buy-in on health priorities



DISTANCE LEARNING COURSE

Introduction

Self-study modules



TRAINING RESOURCES



<https://gpnotebook.com/homepage.cfm>



<http://icatt-impactt.org> – online training resource



<https://www.who.int/infant-newborn/en/>



https://www.who.int/maternal_child_adolescent/documents/9789241506823/en/

“Maternal education is the single most significant determinant of child mortality”

MATERNAL EDUCATION & CHILD SURVIVAL

- Maternal education – both formal (schooling) and informal (skills training) as a means of empowerment
- Mothers' attendance of primary and secondary education was associated with a 28% and 45% reduction, respectively, in the odds of infant mortality compared to infants born to illiterate mothers

MATERNAL EDUCATION & CHILD SURVIVAL

- Maternal school attainment is correlated with maternal literacy
- Maternal literacy and media exposure mediate part of the effect of schooling on health knowledge
- Health knowledge includes mothers' knowledge of vaccines, contraceptives, uses of medicines, and causes and preventions of HIV/AIDS

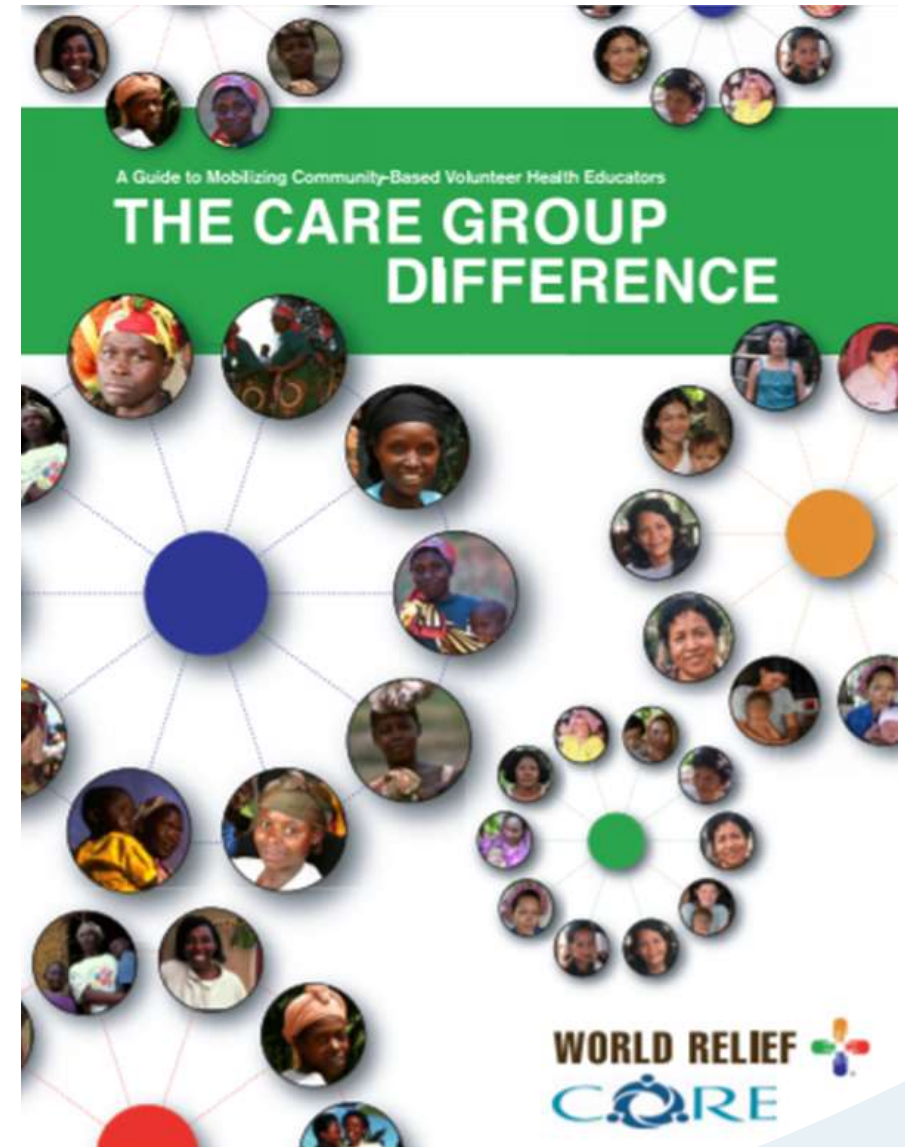
MATERNAL EDUCATION & CHILD SURVIVAL

- Each additional year of education caused a 10 % and 16.6 % lower probability of a child dying before 5 years in Malawi and Uganda, respectively[†]
- Maternal health knowledge is a significant predictor of maternal health behaviors, controlling for schooling, literacy skills, media exposure



MATERNAL EDUCATION & CHILD SURVIVAL

- https://coregroup.org/wp-content/uploads/media-backup/documents/Resources/Tools/tops_care_group_training_manual_2014.pdf
- http://caregroupinfo.org/docs/Care_Group_Manual_ENGLISH.pdf



TAKE HOME MESSAGES

- Majority of the global leading causes of death in children under five years are curable and preventable
- An integrated approach to promoting child survival is key to success
- Investing in maternal health knowledge is crucial for achieving the target under-five SDGs
- Let's do it - Protect, Prevent and Treat

“So it is not the will of your Father who is in heaven that one of these little ones perish”

Matthew 18:14



THANK YOU
& GOD BLESS

BIBLIOGRAPHY

- <https://www.who.int/news-room/facts-in-pictures/detail/malaria>
- <http://redbook.solutions.aap.org/chapter.aspx?sectionid=189640129&bookid=2205>
- [https://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736\(13\)60692-3.pdf](https://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736(13)60692-3.pdf)
- https://apps.who.int/iris/bitstream/handle/10665/79207/WHO_FWC_MCA_13_01_eng.pdf;jsessionid=B9B41EF2D6C6CDD12DF4B710EB84D688?sequence=1
- https://apps.who.int/iris/bitstream/handle/10665/79200/9789241505239_eng.pdf?sequence=1
- https://www.who.int/gho/child_health/mortality/neonatal/en/
- <https://www.ichrc.org/chapter-36-danger-signs-newborns-and-young-infants#main-content>
- <https://www.who.int/news-room/fact-sheets/detail/preterm-birth>
- <https://apps.who.int/iris/bitstream/handle/10665/259269/WHO-MCA-17.07-eng.pdf?sequence=1>
- <https://www.who.int/news-room/fact-sheets/detail/meningococcal-meningitis>
- www.thelancet.com Vol 381 April 27, 2013
- <https://childmortality.org/>
- <https://www.who.int/test/others/gappd/#>
- <https://www.who.int/test/others/gappd/#>