**Pneumonia and Otitis Media**

**Detailed History of Presenting Illness (HPI)**

**PNEUMONIA**
- Fever
- Rigors (chills)
- Cough
- Wheeze
- Tachypnoea
- Pleuritic chest pain

**OTITIS MEDIA**
- Pain in Ear
- Exudate from ear (if tympanic membrane integrity is compromised)
- Low-grade fever
- Poor appetite
- Irritability
- Usually v. young (<2 y.o)

**Differential Diagnoses (DDx)**

**PNEUMONIA DDx**
- Bacterial or Viral Pneumonia:
  - Recurrent Lower Respiratory Tract Infection due to immune suppression
  - Tuberculosis
  - Pertussis (whooping Cough, respective of age group)

**NON-INFECTIONOUS CAUSES THAT CAN PRESENT AS PNEUMONIA:**
- Congestive Heart Failure,
- pulmonary infiltrates with eosinophilia,
- pulmonary hemorrhage,
- Goodpasture’s syndrome, (hypersensitivity, basement membrane antibodies)
- pulmonary embolism,
- neoplastic disease,
- radiation injury,
- inhalation injury,
- pulmonary contusion,
- bronchiolitis obliterans with organizing pneumonia (BOOP),
- Wegener's granulomatosis (diffuse connective tissue disease, aetiology unknown)
- collagen-vascular disorders
- (including rheumatoid lung disease, SLE, scleroderma),
- amyloidosis,
- sarcoidosis,
- interstitial pneunonitis (e.g., farmers, bird breeders),
- drug reactions (e.g., hydrochlorothiazide, asbestos, silicosis, bleomycin etc.)

**OTITIS MEDIA DDx**
- pharyngitis,
- dental disease,
- temporal mandibular joint (TMJ) disease,
- external otitis

**Pertinent Findings on History (Hx)**

**PNEUMONIA**
- History of crowded living conditions
- Previous chest infections
- Previous antibiotic treatment
- Travel overseas
- Duration of symptoms

**OTITIS MEDIA**
- Tympanic membrane previously perforated?
- Recurrent ear infections with purulent discharge?
- Recurrent / frequent upper respiratory tract infections
- Recent paroxysms of swimming in stagnant water
Findings on Examination (Ex)

PNEUMONIA

**VITALS:**

- **Temperature** → Elevated
- **BP** → less than 60 diastolic → !! DANGER !!
- **Pulse** → increased due to cardiac compensation
- **Resp Rate** → increased (if over 30, → !! DANGER !!)

**Observation:**

- Cyanosis
- Dyspnoea + cough + wheezing
- Unwell but active / irritable (in infants)
- Mucopurulent discharge from nose if URTI preceded pneumonia

**Palpation:**

- Chest expansion reduced on affected side
- INCREASED vocal fremitus on affected side

**Percussion:**

- DULL percussion

**Auscultation:**

- BRONCHIAL breath sounds
- INCREASED vocal resonance
- Medium, late or Pan-inspiratory crackles as pneumonia resolves
- Pleural Rub may be present

**OTITIS MEDIA**

**Observation:**

- Redness → CHECK TONSILS!!  ADENOIDS?  WALDEYERS RING?...
- Serous or purulent exudate from the ear

**Otoscopy:**

Above: NORMAL  Above: Schematic Anatomy  Above: Acute Otitis Media

Otitis media is defined by an abnormal tympanic membrane (TM).

Four aspects of the tympanic membranes:

- **Position** (full, bulging, retracted).
- **Color** (red, yellow, or white).
- **Translucency** (opaque, poorly visualized landmarks).
- **Mobility** (moves poorly when either positive or negative pressure is applied).

**Differentiating normal from abnormal**

**A normal TM will be**

- in a neutral position
- with a pearly gray color,
- with easily visible landmarks (translucent),
- with good mobility to both positive and negative pressure.

**A TM that has fluid or pus behind it** will be

- dull or full appearing,
- with an abnormal color (yellow, red, or occasionally blue),
- without landmarks,
- without normal mobility.

!!! CONE OF LIGHT ALWAYS FACES ANTERIORLY !!!
Tests and Investigations: PNEUMONIA

CHEST X-RAY: Looking for CONSOLIDATION and/or EFFUSION; lobar consolidation = pneumonia

Above: pediatric X-ray with Rt mid lobe involvement

Above: typical Rt lower lobe pneumonia

BLOOD TESTS:

PULSE OXYMETRY
- Expecting lower than 95%, due to air flow disruption to an entire lobe. <85% = HOSPITALISE!

FBC
- Expecting elevated WBCs due to inflammatory process (IF BACTERIAL),
- …or WBCs grossly low due to neutropenia/immunocompromise which precipitated infection
- Hematocrit under 30%

LFT
- Hope for normal; will affect the nature of antibiotics used

SERUM BIOCHEMISTRY
- SODIUM: should be LOW
- POTASSIUM: should be LOW
- CREATININE: bad sign if abnormal (= muscle tissue destruction OR kidney malfunction)
- Blood Urea Nitrogen: kidney function: IF ELEVATED, !! DANGER !! kidney failure may ensue

SEROLOGY (not so useful in community acquired Pn.)
- M. pneumoniae infection:
  A single IgM antibody titer of >1:16, a single IgG antibody titer of >1:128, or a fourfold or greater rise in the IgG titer obtained by indirect immunofluorescence is diagnostic.

- C. pneumoniae infection:
  A single IgM antibody titer of 1:20, a single IgG antibody titer of 1:128, or a fourfold or greater rise in the IgG titer obtained by micro-indirect immunofluorescence is diagnostic.

- A single Legionella antibody titer of 1:256 or a fourfold rise to a titer of 1:128 suggests acute legionellosis. A highly sensitive and specific urinary antigen test is available to detect L. pneumophilia serogroup 1 in patients with pneumonia; this organism accounts for ~70% of L. pneumophilia infections.

BLOOD CULTURE
- Culture at aerobic and anaerobic conditions, test discovered organisms for antibiotic resistances
- Bacteraemia is RARE (10%to30%) but DANGEROUS in pneumonia.
- Positive blood or pleural fluid culture is generally considered diagnostic of the etiology of pneumonia.

SPUTUM MICROBIOLOGY
- If you can’t get a good sample from an infant or a demented elder… ➔ FIBROPTIC BRONCHOSCOPY (??)
- CULTURE FOR RESISTENCES !! VITAL !!
Tests and Investigations: OTITIS MEDIA

EXUDATE CULTURE is difficult to obtain (contamination)

25% are culture negative (viral) + another 25 percent of cases of culture positive AOM will resolve spontaneously and have no benefit from antibiotic therapy

THEREFORE organism is usually guessed by community prevalence (?)

BUT: If there is no response to antibiotics, need to perform TYMPANOCENTESIS

(c complications justify it: OM may result in meningitis, facial nerve involvement, sensorineural hearing loss etc.)

Disease Definition

- **Respiratory pathology**: Existing risk factors (crowding, nutrition, poor living conditions) predispose to high rates of bacterial upper airway carriage in Aboriginal children. This increases rates of bacterial pneumonia. Recurrent pneumonia (particularly adeno-viral infection) predisposes to (long term) development of bronchiectasis and chronic lung disease.

- **Ear pathology**: Enlarged adenoids/tonsils lead to blocked eustachian tubes.

How is this diagnosis made?

PNEUMONIA:

- **Positive Blood Culture** is diagnostic
- **Positive Sputum Culture** is diagnostic
- **Chest X Ray** with characteristic lobar consolidation is diagnostic (NOT SO for bronchopneumonia)
- **Blood tests consistent with Infectious Illness**
- **Serology studies show elevated specific IgG or IgM antibody titres** (is diagnostic)

OTITIS MEDIA:

- Diagnosed on history of URTI, inflamed tonsils ? tympanocentesis and otoscopy

Management

PNEUMONIA:

- **OXYGEN THERAPY**: use if pulse oxymetry below 95%
- **Pharmacotherapy**: !! MAKE DECISIONS BASED ON CULTURE SENSITIVITIES !!

Non-severe Pneumonia:

- Amoxycillin 500mg tds or Erythromycin 500mg qds orally.
- The combination of both drugs may be appropriate in some cases.

Severe pneumonia:

- 2 or more criteria defining severe pneumonia:
  - Elderly Patient
  - Respiratory rate > 30.
  - Diastolic BP ≤ 60 mmHg.
  - New confusion.
  - Multi-lobar involvement.
  - Plasma urea > 7 mmol/L.
  - Hypoxaemia – Pulse Oxymetry less than 90%

- If organism unknown:
  - Cefuroxime 750mg tds iv & Erythromycin 500mg qds iv (Legionella suspected 1g qds)
  - Review need for iv therapy daily.
  - When able to take oral treatment:
    - Amoxycillin 500mg tds
    - Erythromycin 500mg qds - in penicillin sensitive patients / Mycoplasma pneumoniae.
    - Review clinical response & length of antibiotic course after 5 days therapy.

Unusual pneumonias:

- **M. pneumoniae** Treat as severe pneumonia (follow with oral macrolide antibiotic)
- **Staph aureus** Add Flucloxocillin 2g qds iv (prolonged treatment usually required)
- **Legionella pn.** Treat as severe pneumonia (prolonged treatment ie 3 weeks usually required).
- **Psittacosis** Oral doxycycline 200mg od (with food).
- **Aspiration** Cefuroxime 750mg iv tds plus metronidazole 500mg tds iv.
Hospital acquired:
- Discuss with Microbiology / Infectious Diseases Unit.
- Treatment decision is dependent on a number of factors ie age, medical problems, admission length, etc.
- Sputum cultures are effective in confirming that appropriate antibiotic therapy is being used.
- Mild disease: Consider one of - oral amoxycillin / cefaclor / quinolone.
- Severe disease: Cefuroxime 750mg tds iv + metronidazole 500mg iv 8-hourly.

OTITIS MEDIA:
Discharging ear gently syringed twice daily and antibiotic ear drops instilled following syringing
USE BETA-LACTAMS unless otherwise indicated.

Treatment efficacy:
PLACEBO: 81% of infections resolve within 1 week
Antibiotics: 94% of infections resolve within 1 week

High Risk factors for Treatment Failure
A. Otitis Media within the last month
B. Antibiotic within the last month
C. Day Care attendance
D. Bilateral Otitis Media
E. Age less than 2 years old
F. Age at first Otitis Media less than 6 months old
G. Over 3 episodes Acute Otitis Media in last 6 months

Prognosis
OTITIS MEDIA: With antibiotics 94% of infections resolve within 1 week

Persistence of Middle Ear Effusion
At 2 weeks: 70% have persistent effusion
At 4 weeks: 40%
At 2 months: 20%
At 3 months: 10%

PNEUMONIA:
Most patients will respond to treatment and improve within two weeks.
Elderly or debilitated patients who fail to respond to treatment may die from RESPIRATORY FAILURE
- The overall mortality rate in developed countries is 5 percent.

Factors that influence prognosis = MAINLY COMORBIDITIES
- age extremes, especially younger than 1 year and older than 60 years of age;
- involvement of more than 1 lobe of the lungs;
- leucocytosis (>5000 per ml)
- associated comorbidities eg diabetes, cirrhosis, heart failure, uraemia, etc.
- Meningitis or endocarditis

Epidemiology: Pneumonia
Incidence in US, per 1000 per year:

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5 yrs</td>
<td>30-45</td>
</tr>
<tr>
<td>5-9 yrs</td>
<td>16-20</td>
</tr>
<tr>
<td>10-16 yrs</td>
<td>6-12</td>
</tr>
</tbody>
</table>

Australia: 0-2 yr olds:
Non aboriginal 19
Aboriginal 193 (!)
Epidemiology: Otitis Media

RESPIRATORY INFECTIONS ARE THE COMMONEST IN VERY YOUNG OR VERY OLD

95% of them are Upper respiratory tract infections (max 2-4 y.o)

- Colds (most common infectious illness)
  - Otitis media (2nd most common, max infant/child)
    - **Etiology:** Virus (Resp viruses), Bacteria (Haemophilus influenzae, Strep pneumoniae (pneumococcus) attach to nasopharyngeal epithelia receptors via adhesins on fimbriae, pili etc), co-infection (↑ chance of persistent infectn)
    - [NB Part of norm flora of URT (includes Staph (coag –ve, and aureus), Viridans strep, Neisseria spp, Haemoph spp, Strep. Pneumoniae)]

**Complications:**

- Glue ear/ mild hearing loss:
  - commonest cause of “mild” hearing loss in children (25-50dBHL)
  - (Persistent middle ear effusion → ↓ conductn of sound to cochlea (conductive hearing loss) → mild hearing loss → inattentn/poor performance in school kids)
- Perforation of the tympanic membrane
- Otorrhoea (purulent discharge from the ear)
- Cholesteatoma: chronic otitis media → a mass of keratinizing squamous epithelium and cholesterol in the middle ear, with squamous metaplasia or extension of squamous epithelium inward to line an expanding cystic cavity that may involve the mastoid and erode surrounding bone

Aetiology: PNEUMONIA

**Age-specific pattern of infection: CHILDREN**

Less than 2 yrs old: RESPIRATORY VIRUSES
Over 2 yrs old: VIRUSES LESS IMPORTANT, MYCOPLASMA MORE IMPORTANT

!! PNEUMOCOCCUS 2nd most common !!

6-18 yrs old: MYCOPLASMA + PNEUMOCOCCUS

**ADULT STATISTICS:** !! 42% are Pneumococcal !!

10% mortality from community-acquired P.- 6ths most common cause of death in the US

!! MOST COMMON INFECTIOUS CAUSE !!

**OTHER PATHOGENS:**

Most Common: S.Pneumoniae
  - H. Influenzae
  - M. Pneumoniae
  - Resp. Viruses

Aetiology: OTITIS MEDIA

**USUALLY a consequence of UPPER AIRWAY INFECTION in children**

More so in children because of ANATOMICAL characteristics of their eustachean tube:
- MORE STRAIGHT AND HORIZONTAL than in adults

**HIGH RISK GROUPS:**
- **Children with cleft palate** have abnormal Eustachian tube function and thus a greatly increased risk of otitis media.
- **Immotile Cilia Syndrome**
- **Children who live with smokers (impaired ciliary clearance)**
- **Respiratory viruses (impaired ciliary clearance)**
- **When viruses and bacteria coinfect** the middle ear, children are more likely to develop persistent infection.
- **Early age** of first infection MAY RESULT IN PERSISTANT INFECTIONS
- **Aboriginal children** are thus more prone to O.M. because of HEAVY AND EARLY exposure

Breast-feeding protects against otitis media
Microbiology & Pathology: the MECHANISM

**ATTACHMENT**
By polysaccharides
To epithelial receptors

**PATHOGEN**
= normal URT flora =
Gram +ve coccus

**PREDISPOSING RISK FACTORS**
- Viral infection
- Impaired Immunity
- Unvaccinated
- Young age (immature immunity)
- Crowded living conditions
- Smokers at home

**COLONISATION**
Of upper airways
Particularly NASOPHARYNX

An Odyssey up the eustachean tube

**COLONISATION**
Of upper airways
Particularly NASOPHARYNX

**ATTACHMENT**

**PATHOGEN**

**PREDISPOSING RISK FACTORS**

**Thick Polysaccharide Capsule**
Prevents phagocytosis

**Multiplication in the Alveolus**

**Lipotechoic Acids**
stimulate macrophages

**Macrophages**
Release IL-1, TNF α

**FEVER AND CHILLS**

**DYSPNOEA**

**PLEURITIS**

**MACROPHAGES**
CANNOT DIGEST Lipopolysaccharide
Therefore: LPS released from lysosomes into bloodstream
= HIGHLY IMMUNOGENIC !!
binds antibody, activates macrophages

**GREY HEPATISATION**
(RBCs lyse)

**EXUDATE** coughed up or phagocytosed by macrophages

**FIBRIN** resolves or organises into COLLAGEN

**FIBROTIC CHANGES**
? bronchiectasis ?Pleural adhesion

**IMPAIRED CLEARANCE**
Predisposes to future infection

**Bacteraemia**
As bacteria slip into bloodstream

**Massive TNF and IL-1 release**

**Increased Endothelial Permeability**

**OEDEMA and therefore Decreased Blood Volume**

**SEPTIC SHOCK**

DEATH
Behavioural science

ABORIGINAL HEALTH:

Life expectancy at birth, (overall measure of health status)
56.9 years for Indigenous men
61.7 years for Indigenous women,
compared with 75.2 years and 81.1 years, respectively, for non-Indigenous men and women.

In 1997, fewer than 31% of Indigenous students remained in Year 12, compared with over 72% of non-Indigenous students.

In the 1996 Census, while Indigenous people made up only 2.1% of the Australian population, they accounted for 19% of the adult prison population, and 41% of the inmates of juvenile corrective institutions (and the proportion of young Indigenous people in detention has increased further since the introduction of the mandatory detention laws in Western Australia and the Northern Territory)

The unemployment rate for all Indigenous Australians is likely to increase from 39% to 47% by the year 2006.

Indigenous households are more likely to be overcrowded, but, despite this, have a lower median weekly income. Other measures of social disadvantage also show an over-representation of Indigenous people.

Respiratory tract Infections in Indigenous Children:

- Pattern of infection similar to developing countries (but lower mortality)

In central Australia Aboriginal children have the highest attack rate for invasive pneumococcal disease that has been reported anywhere in the world.

Known risk factors:
- poverty,
- crowding
- poor living conditions
- malnutrition
- early colonisation of the nasopharynx with pathogens such as Streptococcus pneumoniae and Haemophilus influenzae. Acquisition occurs in the first 1-2 months of life in remote areas.

Wasting and stunting - indices of undernutrition

**Wasting** is weight < 3rd centile for age for the reference population.
approximately equivalent to < 80% of standard weight for height (ie the weight on the 50th centile for a child of that height).
= a sign of **acute undernutrition**

**Stunting**, or low height for age ie < 3rd centile for the reference population;
approximately equivalent to < 90% of standard height for age
= a sign of chronic undernutrition. (poor skeletal growth)

Malnutrition amongst Aboriginal Children

...is regularly documented in Aboriginal children since the 1960s.
- approximately 20% of young Aboriginal children in the Northern Territory were malnourished
  - ~12% were wasted,
  - 3% were stunted
  - 5% were both wasted and stunted

Low Birth Weight

Low birth weight is more common among Aboriginal babies than non-Aboriginal babies.
12% of babies born to Aboriginal women are of low birth weight (ie < 2,500g)
compared with ~ 6% of babies born to non-Aboriginal women.

**associated with a number of maternal factors:**
- maternal undernutrition,
- urinary tract infections,
- anaemia,
- diabetes,
- hypertension,
- smoking,
- alcohol consumption
- lack of regular antenatal supervision.
**Pharmacology of ANTIBACTERIAL AGENTS:**

* GRAM STAIN:
Reflects important differences in cell wall structure:
Depending on retention or not of methyl violet after washing with acetone
+ve = peptidoglycan slime
-ve = LPS and double-layered phospholipid wall

ANTIBIOTICS INHIBITING NUCLEIC ACID SYNTHESIS

**SULFONAMIDES:**
- Interfere with FOLIC ACID SYNTHESIS
- Are negated by presence of pus and some local anaesthetics eg. procaine.
- Concentrated in the urine (but may crystallise due to low solubility)
- NOW MAINLY USED TO TREAT Urinary Tract Infections.
- BACTEROSTATIC

**TRIMETHOPRIM:**
- Mimicks FOLIC ACID;
- 50,000 more affinity for inhibiting bacterial dihydrofolate reductase than for the human enzyme.
- Synergistic with sulfonamides (particularly sulphamethoxazole)
- Excreted in the urine
- USED MAINLY vs. RESPIRATORY INFECTIONS and UTI (poor effect on pneumococcus and S.pyogenes)
- BACTEROSTATIC

**QUINOLONES:**
- Inhibit DNA gyrase, thus no supercoiling of bacterial DNA. Eucariotic cells have no DNA gyrase.
- Good penetration into tissues, low toxicity, effective when given orally. BROAD SPECTRUM.
- Concentrated in the urine
- BACTEROSTATIC AND BACTERICIDAL

**5-NITROIMIDAZOLES:**
- Upon entry into bacteria, Reduced into active intermediates which damage DNA and interfere with synthesis
- Effective vs. ANAEROBES and some PROTOZOA. BROAD SPECTRUM
- BACTEROSTATIC AND BACTERICIDAL
**ANTIBIOTICS INHIBITING BACTERIAL CELL WALL SYNTHESIS**

**BETA LACTAM ANTIBIOTICS:**

**PENICILLINS**
- Interfere with synthesis of bacterial wall **PEPTIDOGLYCONS**:
- by preventing cross-linkage between linear peptidoglycan polymers
- **MAINLY USED FOR GRAM-POSITIVE BACTERIA:**
- GRAM NEGATIVE bacteria have an outer phospholipid wall which may hinder penicillin penetration
- Often given with a beta-lactamase inhibitor
- POOR PENETRATION INTO THE BRAIN!
- Mainly excreted in the urine
- **BACTERICIDAL**

**CEPHALOSPORINS:**
Very similar to penicillins in structure and action (i.e beta-lactam ring is primary active component)
- Mainly excreted in the urine
- **BACTERICIDAL**
- **PENETRATE Blood-Brain Barrier** THUS useful in meningitis

**VANCOMYCIN:**
Inhibits the release of building-block peptide from carrier molecule, thus halting the synthesis of peptidoglycans
- **NOT absorbed orally!**
- **BACTERICIDAL**
ANTIBIOTICS INHIBITTING PROTEIN SYNTHESIS

..Are SELECTIVELY TOXIC TO BACTERIA:

Bacterial ribosomes have a 50S subunit and 30S subunit,
while mammal ribosomes have a 60S subunit and a 40S subunit

TETRACYCLINES
- Inhibit protein synthesis by competing with tRNA for the activation site (the 30S subunit) on the ribosome
- Absorbed well into macrophages therefore good for Rickettsia and Chlamydia and other intracellular pathogens
- !! Cause DISCOLOURATION OF NEW TEETH !! therefore not given to under 8 yr. olds
- BROAD SPECTRUM
- BACTERIOSTATIC AND BACTERICIDAL

AMINOGLYCOSIDES
- Interfere with protein synthesis by altering base-pairing properties of bacterial tRNA:
  - THUS misreading of mRNA occurs: NON-FUNCTIONAL PROTEINS PRODUCED, which cause cell death
- ALL AMINOGLYCOSIDES are potentially TOXIC
- BACTERIOSTATIC AND BACTERICIDAL

CHLORAMPHENICOL
- Inhibits transfer of the new amino acid to the growing peptide (transpeptidation) at the 50S subunit
- Penetrates everywhere including the brain, thus VERY GOOD FOR Haemophilus Influenzae MENINGITIS
- SERIOUS SIDE EFFECTS: bone marrow aplasia, RBC + WBC suppression, encephalopathy, optic neuritis.
- \( \Rightarrow \) WILL ALMOST CERTAINLY KILL NEONATES who can't metabolise it ("grey baby syndrome")
- BACTERIOSTATIC AND BACTERICIDAL

MACROLIDES
- Inhibit translocation of the peptide chain from the active peptide-building (A) site to the waiting (P) site (50S)
- THUS: no new peptide is built because the old peptide is stuck at the A-site.
- Mainly Gram-POSITIVE bacteria, like the penicillins.
- POOR PENETRATION OF BLOOD-BRAIN BARRIER
- UNLIKE PENICILLINS the macrolides are effective vs. WEIRD PATHOGENS eg. Mycoplasma and Legionella
- BACTERIOSTATIC AND BACTERICIDAL
**Physiology:**

**Functional Anatomy of the Ear**

Normal range of hearing is from **15Hz to 15,000Hz**

In Summary…

- The outer and middle ears are **air filled spaces**
- The inner ear is **fluid filled**.
- The inner ear is the site of **neural transduction** of sound.
- The eardrum (tympanic membrane) = the boundary between the outer and middle ear.
- The eustachian tube equalises pressure.

The general function of the ear is to transduce acoustic (mechanical) energy into neural signals.
Frequency range of human hearing is matched to the frequency content of sounds of biological interest to humans (eg communication sounds).
The human ear has the largest sensitivity around 1000-4000 Hz, the range for normal speech. As the middle ear is a mechanical system it has a resonant frequency which is around 1000Hz. As a result it transmits the middle range of frequencies to which humans are sensitive more effectively than low and high frequencies.

**Compensation for fluid/air interface at the inner ear:**
Fluid is much less compressible than air: THUS most of the sound energy would be reflected at the air-water interface. The middle ear compensates for this impedance mismatch using three different mechanisms:
- **Lever action** of the middle ear bones,
- **area differences** between the tympanic membrane and the stapes foot plate
- **buckling motion** of the tympanic membrane.

The resonance of a mechanical system is determined by its mass and stiffness. THUS: changes in mass or stiffness of middle ear will influence transmission into the inner ear.
- Increase in stiffness increases the resonance frequency and causes a decrease in the transmission of low frequencies.
- Increase in the mass decreases the resonant frequency and the transmission of high frequencies.
- A combination of the two causes an overall reduction in transmission.

If the Eustachian tube fails to open or becomes blocked then a negative pressure builds up in the middle ear as the mucosa lining the cavity absorbs the trapped oxygen. The negative pressure results in a painful inward distension of the tympanic membrane and an increase in stiffness of the middle ear mechanics. **Prolonged periods of negative pressure can also be accompanied by a build up of fluid in the middle ear** and can result in conductive hearing loss of up to 40-50dB.

**Deafness**
Hearing loss is measured in decibels hearing loss:
- at frequencies from 125Hz, 250Hz, 500Hz, 1kHz, 2kHz, 4kHz, 8kHz
- A whisper reaches 30dBHL;
- normal conversational voice, 70dBHL,
- shouting, 90dBHL.

**3 types:**
- **Conductive** from loss of transmission to cochlea
  - Eg. “glue ear” from otitis media, tympanic drum perforation, otosclerosis
- **Sensory** from loss of sensory structures eg. hair cells
  - (eg. Presbyacusis, noise induced hearing loss, Meniere's disease).
- **Neural** from auditory nerve dysfunction

**SPECTRUM OF SEVERITY:**
**Mild hearing loss** 25-50 dBHL
- causes minimal problems in an adult but may lead to inattention and poor performance in school age children.

**Moderate hearing loss** 50-70 dBHL
- a social inconvenience and requires treatment surgically or using a hearing aid

**Severe hearing loss** 70-90 dBHL
- prevents the acquisition of normal speech communication skills in children and urgently requires amplification using a hearing aid.

**Profound hearing loss** (deafness) 90 dBHL or worse
- often prevents a child from acquiring speech even using the best hearing aids available.
- Early fitting of cochlear implant will improve prognosis
PRESBYACOUSIS: aka. "old age hearing loss"
Is progressive high frequency sensory hearing loss.
!! Affects 33% by age 65 !!
easily managed with hearing aids

**Noise induce hearing loss (NIHL)**
is a non-progressive high frequency sensory loss often peaking at 4kHz.
CAUSED BY:
- Noise levels in excess of 90dBA over 8 hours,
  - 93dBA over 4hours,
  - 96dBA over 2 hours,
  - and so on (every 3 dBA after 90 halves the duration of exposure)

**IMMUNISATION:**
- more than 80% of the world's children are immunised for diphtheria, tetanus, pertussis, measles, poliomyelitis and tuberculosis. It is expected that poliomyelitis will be eliminated globally by the year 2005.
- Deaths from tetanus, diphtheria and polio are now extremely rare in Australia.
- Since the introduction of conjugated Haemophilus influenzae type b (Hib) vaccines in 1993, the number of cases of Hib meningitis and epiglottitis has fallen by over 90%.
- However, measles, rubella and pertussis continue to occur

  **the IDEAL VACCINE:**
  stable,
  safe,
  administered orally in a single dose at birth,
  100% effective,
  reasonably priced
  protective for a lifetime

**ACTIVE IMMUNITY:**
Induction of memory cells

**PASSIVE IMMUNITY:**
Introduction of specific immunoglobulins

**Inactivated vaccines** produce their protective effect by stimulating the production of antibodies
- In general, inactivated vaccines require a series of doses before inducing long-term immunity

**live attenuated vaccines** induce the production of both protective antibody and cell-mediated immunity
- induce long-term immunity in more than 90% of recipients after a single dose.

**infants respond less well** immunologically to vaccines than older children and adults, and therefore require earlier booster doses of vaccines

**Vaccination strategies and schedules**
BENEFITS DEPEND ON:
- the severity of the disease in the population
- the efficacy of the vaccine
- the vaccination rate required to contain, eliminate or eradicate the infection.

Cost benefits of vaccination: COST OF VACCINE vs. MONEY SAVED ON TREATING THE DISEASE
The cost benefits of the vaccines presently included in the routine infant schedule are very high (about $14 saved for every $1 spent in the USA).

**Safety, side effects and adverse events**
No vaccine is 100% safe or 100% effective.
Adverse neurological sequelae are the reactions which are likely to be of most concern.

**Disease surveillance**
Most vaccine-preventable diseases are sufficiently serious to be mandatorily notifiable in Australia.