ADVERSE DRUG REACTIONS & PHARMACOVIGILANCE
Cur’d yesterday of my disease
I died last night of my physician

Matthew Prior (1664-1721): remedy worse than the disease.
ADVERSE DRUG REACTIONS (ADRs)

• Def. : “any harmful or seriously unpleasant effects occurring at doses intended for therapeutic (incl. prophylactic/diagnostic) effect and which requires reduction of dose or withdrawal of drug & /or forecasts hazard from future administration.”
Defn...

• S/E
• TOXICITY
• SECONDARY EFFECTS
• INTOLERANCE
• IDIOSYNCRACY
• ADVERSE EVENT
Table 1. Definition of ADEs and ADRs

**Adverse Drug Event**
- Unfavorable and unintended response to a drug, whether or not considered related to the product (i.e., no causality implied)
- Includes medical errors (miscalculations, misadministrations, difficulty in interpreting handwritten orders, misunderstanding of verbal orders, name confusion of drugs, and packaging or labeling of drugs are thus not included in this definition) and adverse drug reactions

**Adverse Drug Reaction**
- Noxious and unintended response to a medicinal product if a medicine properly prescribed (normal dose, route, etc.) and administered
- Causal relationship between medicinal product and adverse event cannot be ruled out
- Medical errors are not included in this definition

ADEs: adverse drug events; ADRs: adverse drug reactions.
Source: Reference 1.
• Adverse drug reactions caused by immune and nonimmune mechanisms are a major cause of morbidity and mortality worldwide. They are the most common iatrogenic illness, complicating 5 to 15 percent of therapeutic drug courses.
• In the United States, more than 100,000 deaths are attributed annually to serious ADRs.
• Three to 6 percent of all hospital admissions are because of ADRs, and 6 to 15 percent of hospitalized patients (2.2 million persons in the United States in 1994) experience a serious adverse drug reaction.
Classification of ADRs

- Type A: Augmented eg S/E
- Type B: Bizzare eg drug allergy, idiosyncracy
- Type C: Continuous: d/t long term use
- Type D: Delayed: duration or critical time exposure eg teratogenesis
- Type E: End of use eg acute adrenal insuff d/t abrupt steroid cessation
Causes

- **PATIENT:** age, gender, genetic predisposition, allergic diathesis, disease, personality,
- **DRUG:** e.g., anticancer drugs are cytotoxic; digoxin has steep DRC-type A rxn, AMAs – type B rxns
- **PREScriBER:** ADR may occur if drug used for inappropriately long time (Type C), at a critical phase in gestation (Type D) or is abruptly d/c (Type E) or given with other drugs (Drug-drug interactions)
Patient Risk Factors for Adverse Drug Reactions

- Female gender
- Serious illness
- Renal insufficiency
- Liver disease
- Polypharmacy
- HIV infection
- Herpes infection
- Alcoholism
- Genetics (P'genetics)
Allergy in response to drugs:
Gell and Coombs Classification of Drug Hypersensitivity Reactions

1. Immune reaction
2. Mechanism
3. Clinical manifestations
4. Timing of reaction

Type I (IgE-mediated)
- Drug-IgE complex binding to mast cells with release of histamine, inflammatory mediators
- Urticaria, angioedema, bronchospasm, pruritus, vomiting, diarrhea, anaphylaxis
- Minutes to hours after drug exposure

Type II (cytotoxic)
- Specific IgG or IgM antibodies directed at drug-hapten coated cells
- Hemolytic anemia, neutropenia, thrombocytopenia
- Variable
Allergy in response to drugs....

- **Type III (immune complex)**
  - Tissue deposition of drug-antibody complexes with complement activation and inflammation
  - Serum sickness, fever, rash, arthralgias, lymphadenopathy, urticaria, glomerulonephritis, vasculitis
  - 1 to 3 weeks after drug exposure

- **Type IV (delayed, cell-mediated)**
  - MHC presentation of drug molecules to T cells with cytokine and inflammatory mediator release
  - Allergic contact dermatitis, maculopapular drug rash*
  - 2 to 7 days after cutaneous drug exposure
  - MHC = major histocompatibility complex.
  - *—Suspected Type IV reaction, mechanism not fully elucidated
Cutaneous symptoms of Drug Hypersensitivity Reactions (M. common)

• Exanthematous or morbilliform eruption originating on trunk
• Urticaria
• Purpura
• Maculopapular lesions with distribution on the fingers, toes, or soles
• Blistering lesions with mucous membrane involvement
• Eczematous rash in sun-exposed areas
• Solitary circumscribed erythematous raised lesion
• Papulovesicular, scaly lesion
## Diagnostic Testing and Therapy for Drug Hypersensitivity

<table>
<thead>
<tr>
<th>Immune reaction</th>
<th>Laboratory tests</th>
<th>Therapeutic considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I (IgE-mediated)</td>
<td>Skin testing</td>
<td>Discontinue drug.</td>
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<tr>
<td></td>
<td>RAST</td>
<td>Consider epinephrine, antihistamines, systemic corticosteroids, bronchodilators.</td>
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<td></td>
<td>Serum tryptase</td>
<td>Inpatient monitoring, if severe</td>
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<tr>
<td>Type II (cytotoxic)</td>
<td>Direct or indirect Coombs' test</td>
<td>Discontinue drug.</td>
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<td></td>
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<td>Consider systemic corticosteroids.</td>
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<td></td>
<td>Transfusion in severe cases</td>
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<tr>
<td>Type III (immune complex)</td>
<td>ESR</td>
<td>Discontinue drug.</td>
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<tr>
<td></td>
<td>C-reactive protein</td>
<td>Consider NSAIDs, antihistamines, or systemic corticosteroids or plasmapheresis if severe.</td>
</tr>
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<td>Immune complexes</td>
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<td>Complement studies</td>
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<td></td>
<td>Antinuclear antibody, antihistone antibody</td>
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<td></td>
<td>Tissue biopsy for immunofluorescence studies</td>
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<td>Immune reaction</td>
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<td>Therapeutic considerations</td>
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</tr>
<tr>
<td><strong>Type IV (delayed, cell-mediated)</strong></td>
<td>Patch testing</td>
<td>Discontinue drug.</td>
</tr>
<tr>
<td></td>
<td>Lymphocyte proliferation assay*</td>
<td>Consider topical corticosteroids, antihistamines, or systemic corticosteroids if severe.</td>
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</tbody>
</table>
• Distinctive features of allergic rxns
• Diagnosis and treatment of allergic drug reactions
• Adrenaline 0.3-0.5 ml of 1:1000 IM, rpted 3-5 min if reqd----life saving ,
• Others Antihisaminics-CPM , Corticosteroids,
Pseudoallergic rxns

• Mimic allergic rxns BUT have no immunological basis, are largely genetically determined. Are d/t release of endogenous mediators like histamine, LTs. PAR mimicking Type 1 rxn- anaphylactoid rxn eg aspirin, nsaid

• PAR mimicking type 2 rxn eg hemolysis d/t antimalarials, sulphones in G6PD def pt.
ADRs on prolonged use – Type C, D

- **EYE**- cataract d/t: chloro, corticosteroids,
- Corneal opacities : phenothiazines
- Retinal injury : thioridazine, chloro, indo
- **CNS**: Tardive dyskinesia- neuroleptics,
- Polyneuritis- metronidazole
- Optic neuritis- ETM
- **LUNG**: pulm fibrosis- amiodarone, busulphan,
- **KIDNEYS**: nephropathy-gold salts, NSAIDs
- **LIVER**: fibrosis, failure-MTX, alcohol, PZA
Carcinogenesis

• Takes months to years 3-5 yrs
• Mech: 1. Alteration of DNA (mutagenicity)-chemicals/metabolites-
• 2. Immunosuppression:
• 3. Hormonal- long term use of ERT — endometrial Ca, DES exp in-utero —vaginal adenoCa in females
Adverse effect on reproduction

• Drugs may act on embryo & fetus-directly eg teratogens ; indirectly eg on uterus – vasoconstrictors; on mother’s hormonal balance.

• Early pregnancy: m.vulnerable pd- 2-8 weeks (10-56 days) of IU life –organogenesis

• Teratogenesis ( teratos-monster)

• Teratogens: thalidomide, cytotoxics, warfarin, alcohol, lithium, valproate, phenytoin, methotrexate,isotretinoin, ACE inhbg...... ...

...... ......
Phocomelia due to Thalidomide
Teratogenic drugs...

• Definitive list not practical- depends on dose taken, and at what stage of pregnancy. VV cautious use of drugs during pregnancy

• **Late pregnancy**: eg I and antithyroid drugs- fetal goitre, tetracyclines -, Ace inhib. -, NSAIDs,

• **During labour**: opioid anagesics, diazepam--
Adverse effects on Male reproductive system

• **Impotence**: ANS drugs eg beta blockers, thiazides

• **Decreased spermatogenesis**: sulfasalazine, cytotoxic anticancer drugs, nitrofurantoin

• Iatrogenic diseases
General Criteria for Drug Hypersensitivity Reactions

• The patient's symptomatology is consistent with an immunologic drug reaction.
• The patient was administered a drug known to cause such symptoms.
• The temporal sequence of drug administration and appearance of symptoms is consistent with a drug reaction.
• Other causes of the symptomatology are effectively excluded.
• Laboratory data are supportive of an immunologic mechanism to explain the drug reaction (not present or available in all cases).
Evaluation and Management of Drug Reaction

- Medical history: symptoms, detailed medication list, temporal sequence physical examination, clinical laboratory data

  - Is a drug reaction likely?
    - Yes
      - Is there a suspicion of drug-induced hypersensitivity/immunologic reaction?
        - Yes
          - Immune mechanism
            - IgE-mediated
            - Cytotoxic
            - Immune complex
            - Delayed, cell-mediated
            - Other immune mechanism
          - Evaluate with appropriate confirmatory tests.
          - Are tests supportive of immune drug reaction?
            - Yes
              - Diagnosis of drug hypersensitivity/immunologic reaction confirmed
            - No
        - Nonimmune mechanism
          - Pharmacologic side effect
          - Drug toxicity
          - Drug-drug interactions
          - Drug overdose
          - Pseudallergic
          - Idiosyncratic
          - Intolerance
      - Management
        - Modify dose.
        - Try drug substitution.
        - Treat side effects.
        - Consider graded challenges.
        - Implement patient education.
        - Does test have high negative predictive value?
          - Yes
            - Administer drug with observation.
          - No
            - Consider desensitization (IgE) or graded challenge (non-IgE) before administration, as appropriate.
            - Anaphylactic reactions require prompt emergency treatment.
            - Avoid drug if possible.
            - Consider prophylactic regimen before administration (if shown to be effective).
            - Prudent use of drugs in future
            - Patient education
        - Evaluate and treat other causes of symptoms.
Pharmacovigilance

• Refers to the process of continuous monitoring for unwanted effects and other safety related aspects of marketed drugs. It is the science and application of detection, assessment, understanding and prevention of adverse drug reactions.

• Post marketing surveillance/phase 4 trials

• PSURs

• Severe ADRs:
Naranjo ADR probability scale
Score >9=definite, 5-8=probable,1-4=possible,0=doubtful

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>Do not know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are there previous conclusive reports on this reaction?</td>
<td>+1</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Did the adverse event appear after the suspected drug was administered?</td>
<td>+2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Did the adverse reaction improve when the drug was discontinued or a specific antagonist was administered?</td>
<td>+1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Did the adverse reaction reappear when the drug was readministered?</td>
<td>+2</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>Are there alternative causes (other than the drug) that could on their own have caused the reaction?</td>
<td>-1</td>
<td>+2</td>
<td>0</td>
</tr>
<tr>
<td>Did the reaction reappear when a placebo was given?</td>
<td>-1</td>
<td>+1</td>
<td>0</td>
</tr>
<tr>
<td>Was the drug detected in the blood (or other fluids) in concentrations known to be toxic?</td>
<td>+1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Was the reaction more severe when the dose was increased, or less severe when the dose was decreased?</td>
<td>+1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Did the patient have a similar reaction to the same or similar drugs in any previous exposure?</td>
<td>+1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Was the adverse event confirmed by any objective evidence?</td>
<td>+1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total score</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WHO – Uppsala Causality term</td>
<td>Assessment criteria (all points should be reasonably complied)</td>
<td></td>
<td></td>
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<td>-----------------------------</td>
<td>---------------------------------------------------------------</td>
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</tbody>
</table>
| Certain                    | • Event or laboratory test abnormality, with plausible time relationship to drug intake  
|                            | • Cannot be explained by disease or other drugs               |
|                            | • Response to withdrawal plausible (pharmacologically, pathologically) |
|                            | • Event definitive pharmacologically or phenomenologically (ie, an objective and specific medical disorder or a recognized pharmacologic phenomenon)  
|                            | • Rechallenge satisfactory, if necessary                      |
| Probable/likely            | • Event or laboratory test abnormality, with reasonable time relationship to drug intake  
|                            | • Unlikely to be attributed to disease or other drugs         |
|                            | • Response to withdrawal clinically reasonable                |
|                            | • Rechallenge not required                                   |
| Possible                   | • Event or laboratory test abnormality, with reasonable time relationship to drug intake  
|                            | • Could also be explained by disease or other drugs           |
|                            | • Information on drug withdrawal may be lacking or unclear    |
| Unlikely                   | • Event or laboratory test abnormality, with a time to drug intake that makes a relationship improbable (but not impossible)  
|                            | • Disease or other drugs provide plausible explanation        |
| Conditional/unclassified   | • Event or laboratory test abnormality                        |
|                            | • More data for proper assessment needed, or                  |
|                            | • Additional data under examination                          |
| Unassessable/unclassifiable| • Report suggesting an adverse reaction                      |
|                            | • Cannot be judged because information is insufficient or contradictory  
|                            | • Data cannot be supplemented or verified                    |
Pharmacovigilance Programme of India (PvPI)

- **Objectives**
  - To monitor Adverse Drug Reactions (ADRs) in Indian population
  - To create awareness amongst health care professionals about the importance of ADR reporting in India
  - To monitor benefit-risk profile of medicines
  - Generate independent, evidence based recommendations on the safety of medicines
  - Support the CDSCO for formulating safety related regulatory decisions for medicines
  - Communicate findings with all key stakeholders
  - Create a national centre of excellence at par with global drug safety monitoring standards
TARGETS FOR THE FIVE PHASES OF PHARMACOVIGILANCE PROGRAMME OF INDIA

**FY 2010-11**
- Developing systems & procedures
- Enroll 40 Medical Colleges
- Start Data Collection from AEFI (Adverse Event Following Immunization)
- Development & establishment of training centers
- Training of Pharmacovigilance human resource
- Linkage with Uppsala Monitoring Center, Sweden, WHO
- Initiate software development for National Drug Safety database
- Zonal workshop for Public awareness of drug safety
- Publication of Drug Safety Newsletter

**FY 2011-12**
- Enroll additional 60 Medical Colleges
- Training of Pharmacovigilance Human Resource
- Identify gaps & address through appropriate training
- Training in Pharmacovigilance software provided by Uppsala Monitoring Center Sweden, WHO (Vigilflow)
- Software Development and Validation
- Zonal Workshop for Public awareness of drug safety
- Publication of Drug safety newsletter

**FY 2012-13**
- Enroll additional 100 medical colleges
- Training of Pharmacovigilance Human Resource
- Zonal Workshop for Public awareness of drug safety
- Publication of drug safety newsletter

**FY 2013-14**
- Enroll additional 100 medical colleges
- Interaction with international Pharmacovigilance bodies
- Training of Pharmacovigilance Human Resource
- Publication of drug safety newsletter

**FY 2014-15**
- Create Center of excellence for Pharmacovigilance in Asia Pacific

Publication of Drug safety newsletter