Information models as a basis for Interoperability
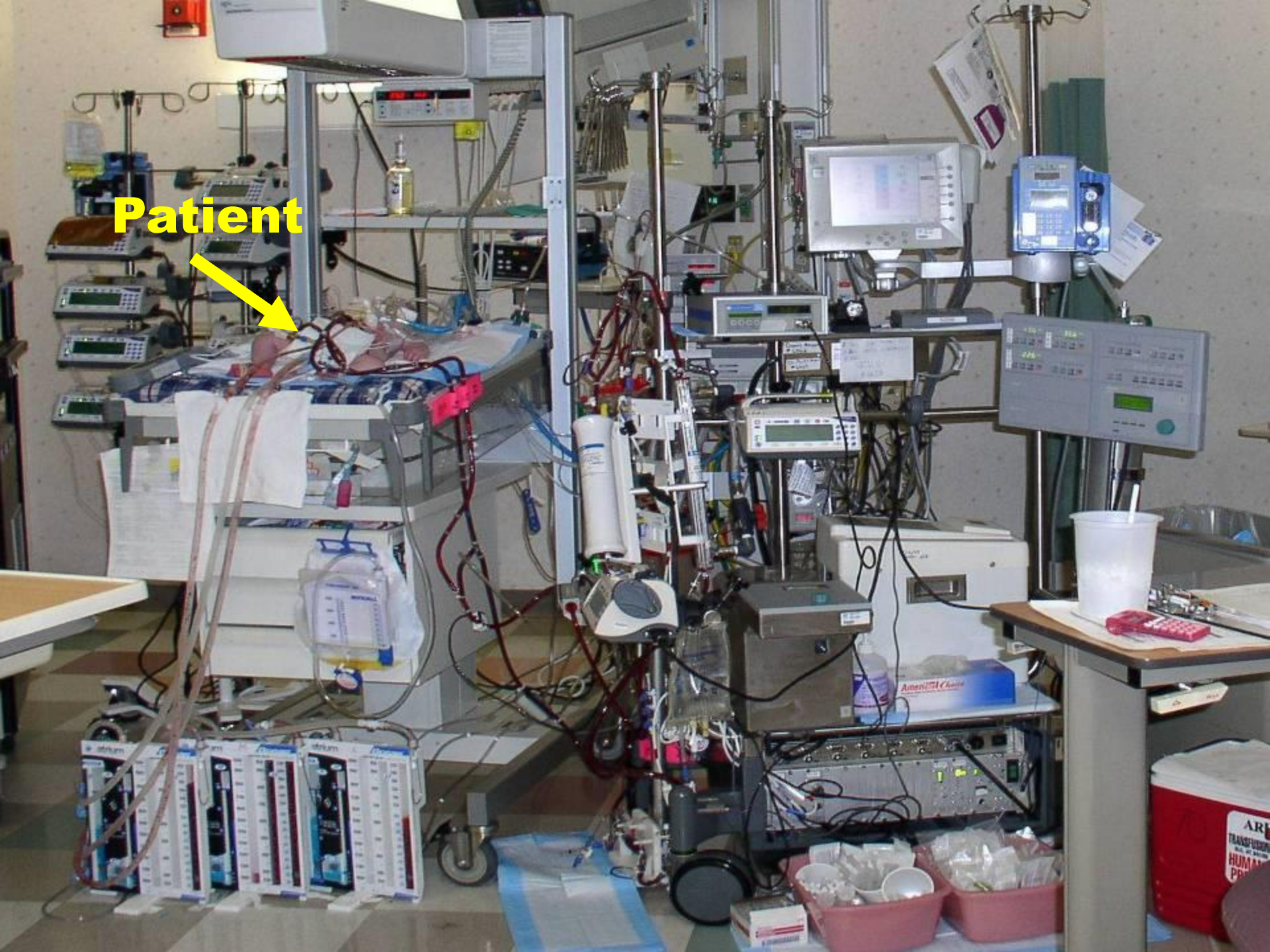
SemTechBiz
June 3-5, 2013

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Chief Medical Informatics Officer

Intermountain Healthcare
Healing for life

Patient

Core Assumptions

'The complexity of modern medicine exceeds the inherent limitations of the unaided human mind.'

~ David M. Eddy, MD, Ph.D.

'... man is not perfectible. There are limits to man's capabilities as an information processor that assure the occurrence of random errors in his activities.'

~ Clement J. McDonald, MD

Intermountain can only provide the highest quality, lowest cost health care with the use of advanced clinical decision support systems integrated into frontline workflow
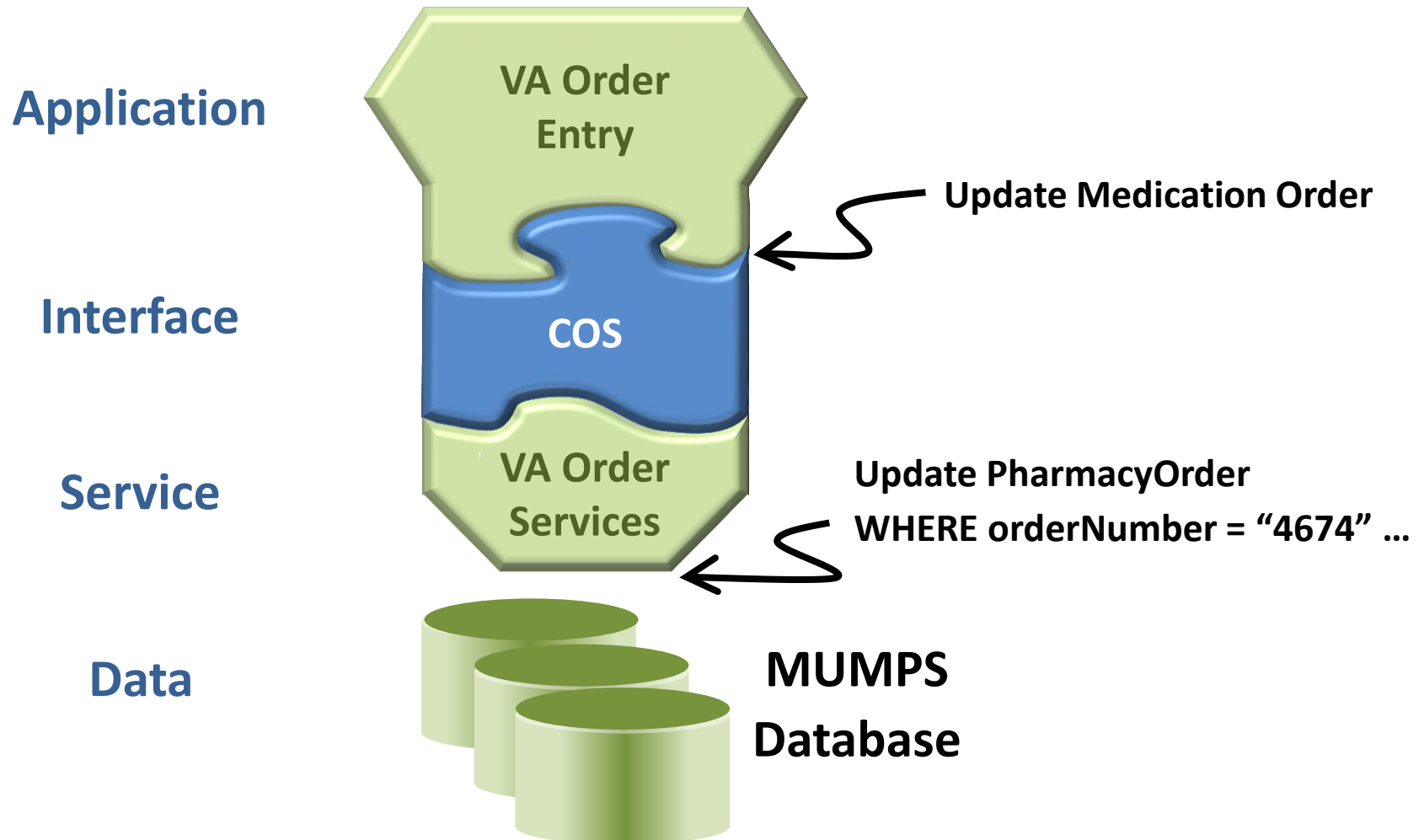
Decision Support Modules

- Antibiotic Assistant
- Ventilator weaning
- ARDS protocols
- Nosocomial infection monitoring
- MRSA monitoring and control
- Prevention of Deep Venous Thrombosis
- Infectious disease reporting to public health

- Diabetic care
- Pre-op antibiotics
- ICU glucose protocols
- Ventilator disconnect
- Infusion pump errors
- Lab alerts
- Blood ordering
- Order sets
- Patient worksheets
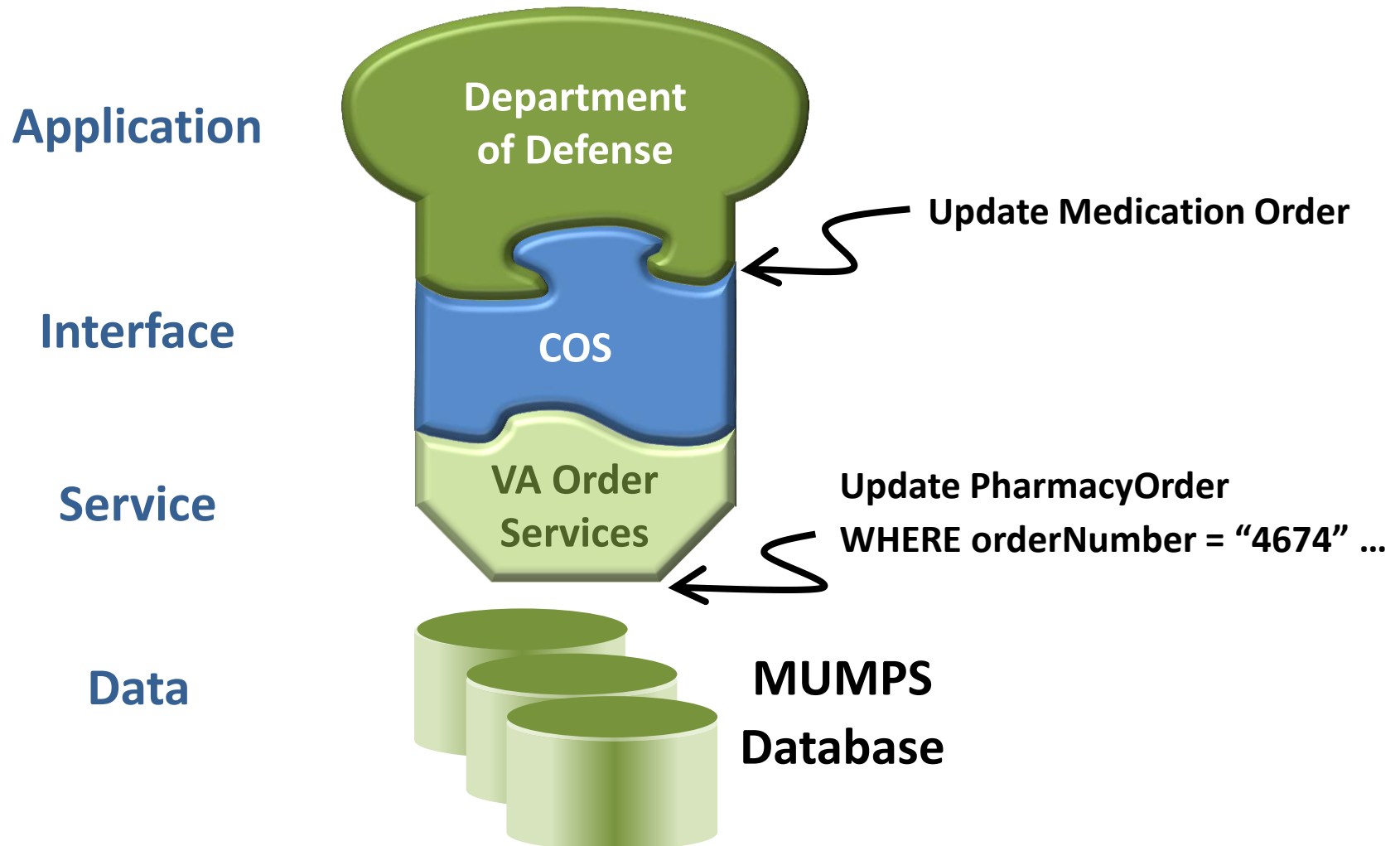- Post MI discharge meds

Strategic Goals

- Minimum goal: Be able to share applications, reports, alerts, protocols, and decision support with ALL customers of our same vendor

- Maximum goal: Be able to share applications, reports, alerts, protocols, and decision support with anyone in the WORLD
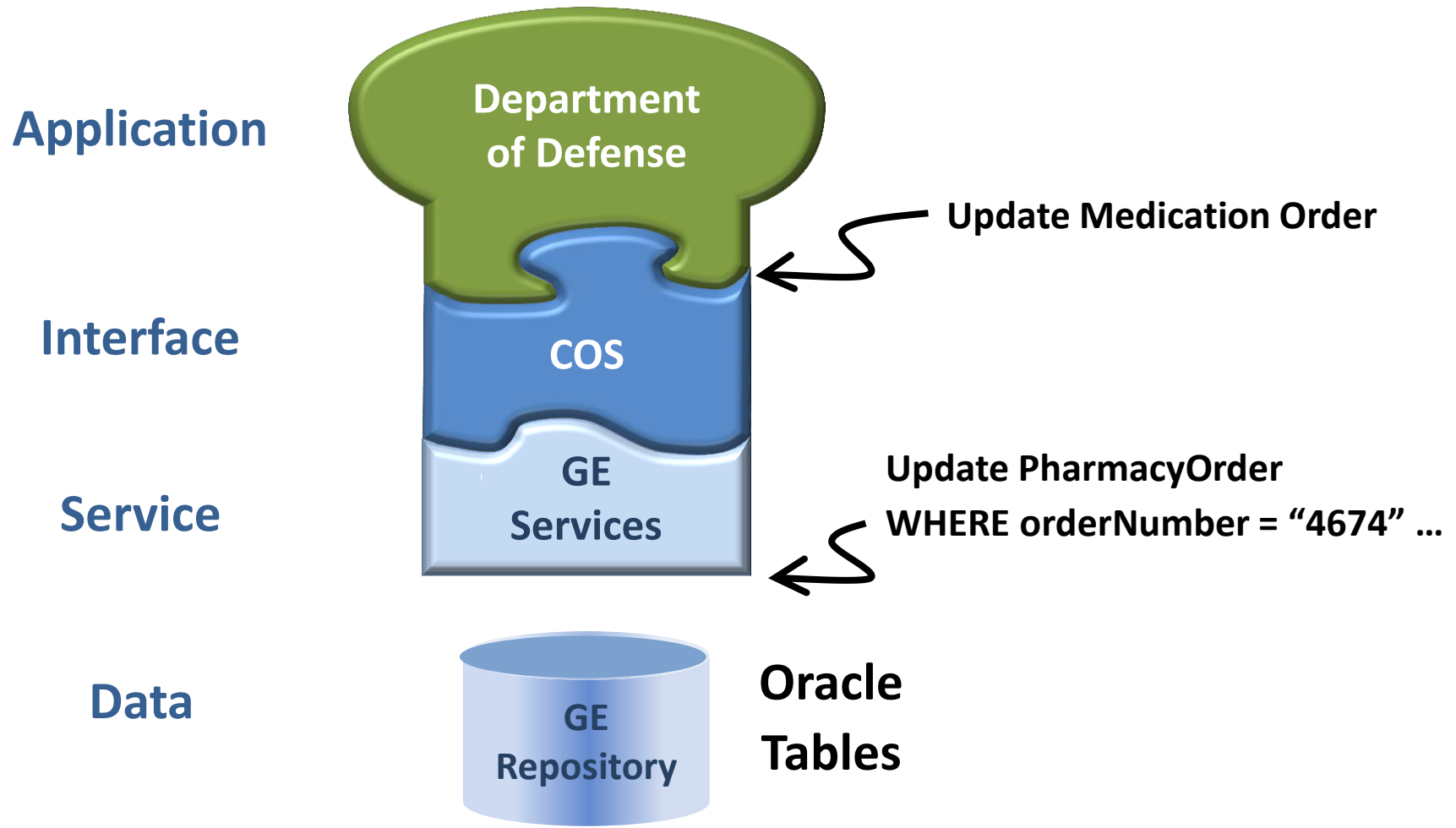
Order Entry API (adapted from Harold Solbrig)

Application — VA Order Entry

Interface — COS

Update Medication Order

Service — VA Order Services

Update PharmacyOrder
WHERE orderNumber = "4674" …

Data — MUMPS Database

Order Entry API:
Different Client, Same Service (adapted from Harold Solbrig)

Application

Department of Defense

Interface

COS

← Update Medication Order

Service

VA Order Services

Update PharmacyOrder
WHERE orderNumber = "4674" …

Data

MUMPS Database

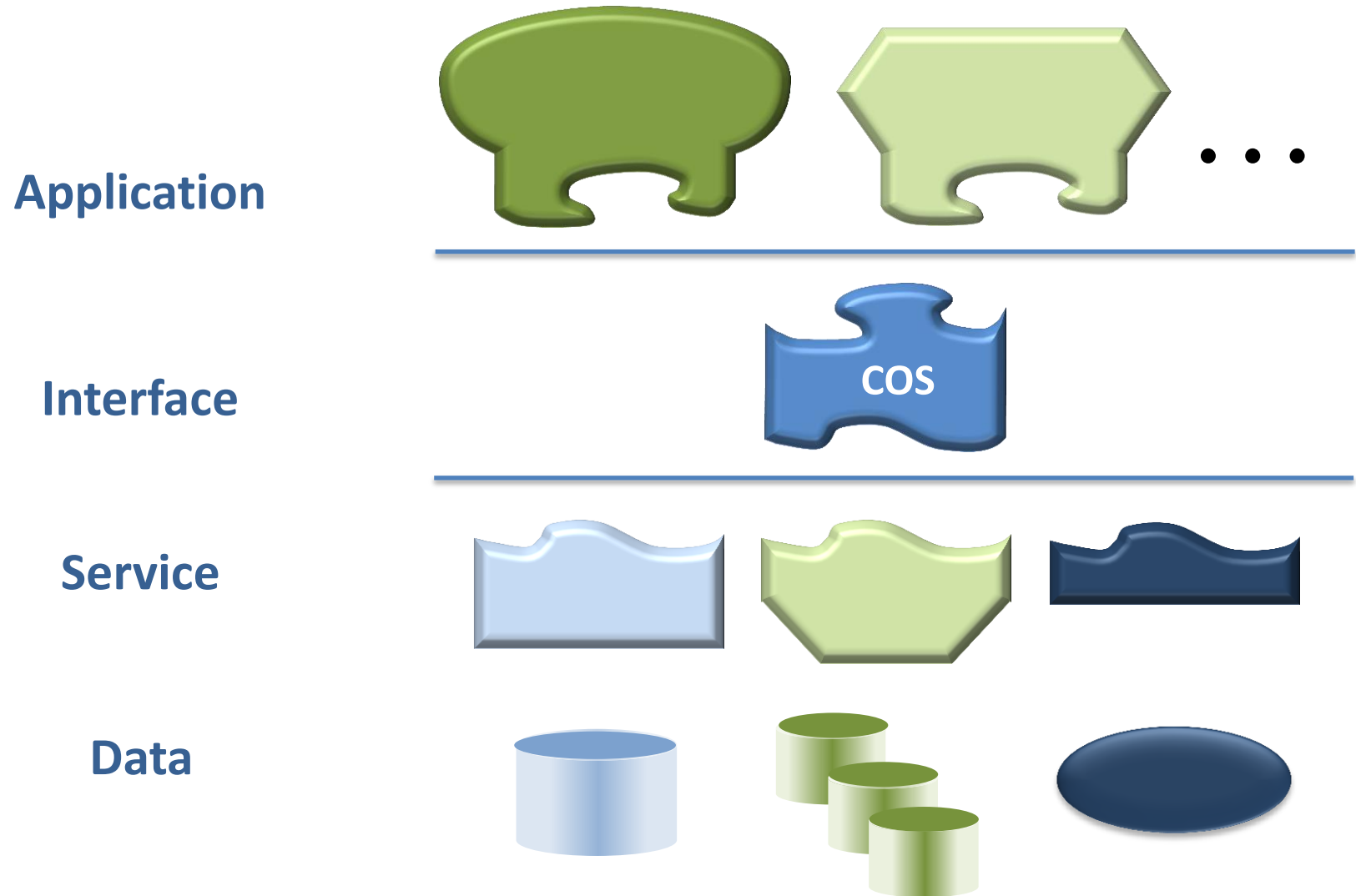# Order Entry API:
Different Server, Same Client (adapted from Harold Solbrig)

Order Entry API (adapted from Harold Solbrig)

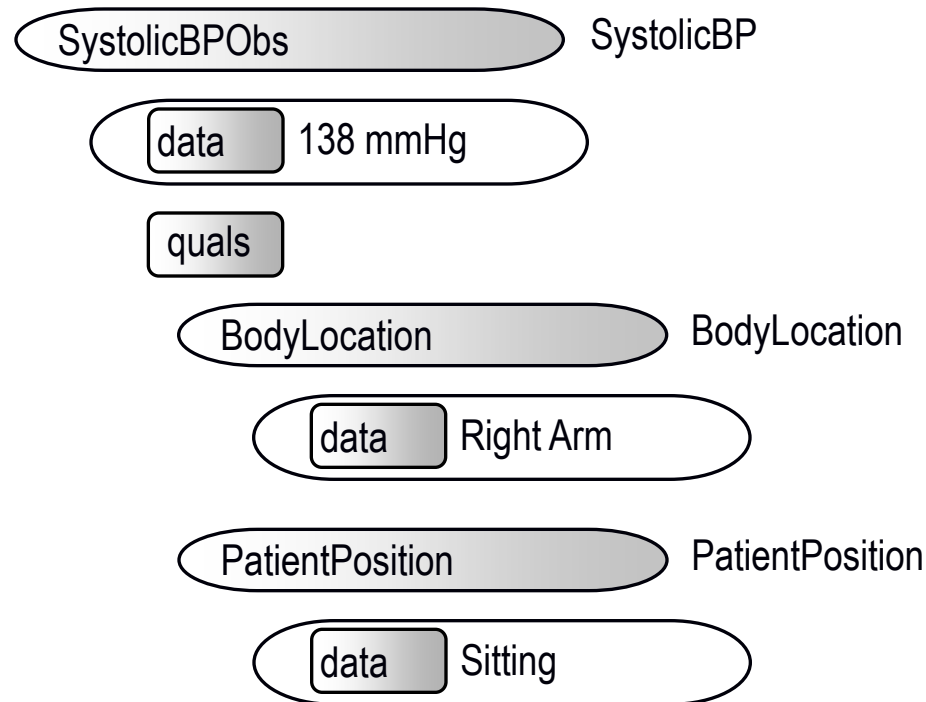**Application**

Interface

COS

Service

Data

What Is Needed to Create a New Paradigm?

- Standard set of detailed clinical data models coupled with…

- Standard coded terminology

- Standard API's (Application Programmer Interfaces) for healthcare related services

- Open sharing of models, coded terms, and API's

- Sharing of decision logic and applications

Why do we need detailed clinical models?

A diagram of a simple clinical model

Clinical Element Model for Systolic Blood Pressure

SystolicBPObs   SystolicBP

data   138 mmHg

quals

BodyLocation   BodyLocation

data   Right Arm

PatientPosition   PatientPosition

data   Sitting

Need for a standard model

- A stack of coded items is ambiguous (SNOMED CT)
  - Numbness of right arm and left leg
    - Numbness (44077006)
    - Right (24028007)
    - Arm (40983000)
    - Left (7771000)
    - Leg (30021000)
  - Numbness of left arm and right leg
    - Numbness (44077006)
    - Left (7771000)
    - Arm (40983000)
    - Right (24028007)
    - Leg (30021000)

What if there is no model?

Site #1
    Dry Weight: 70 kg

Site #2
    Weight: 70 kg   ● Dry
                     ○ Wet
                     ○ Ideal

Too many ways to say the same thing

- A single name/code and value
  - *Dry Weight* is 70 kg
- Combination of two names/codes and values
  - *Weight* is 70 kg
    - *Weight type* is dry

Model fragment in XML

Pre-coordinated representation

```
<observation>
  <cd>Dry weight  (LOINC 8340-2) </cd>
  <value>70 kg</value>
</observation>
```

Post-coordinated (compositional) representation

```
<observation>
  <cd>Weight (LOINC 3141-9) </cd>
    <qualifier>
      <cd> Weight type (LOINC 8337-8) </cd>
      <value> Dry (SNOMED CT 13880007) </value>
    <qualifier>
  <value>70 kg</value>
</observation>
```

Relational database implications

Patient Identifier	Date and Time	Observation Type	Observation Value	Units
123456789	7/4/2005	Dry Weight	70	kg
123456789	7/19/2005	Current Weight	73	kg

Patient Identifier	Date and Time	Observation Type	Weight type	Observation Value	Units
123456789	7/4/2005	Weight	Dry	70	kg
123456789	7/19/2005	Weight	Current	73	kg

How would you calculate the desired weight loss during the hospital stay?

More complicated items:

- Signs, symptoms

- Diagnoses

- Problem list

- Family History

- Use of negation – "No Family Hx of Cancer"

- Description of a heart murmur

- Description of breath sounds
  - "Rales in right and left upper lobes"
  - "Rales, rhonchi, and egophony in right lower lobe"

What do we model?

- All data in the patient's EMR, including:
  - Allergies
  - Problem lists
  - Laboratory results
  - Medication and diagnostic orders
  - Medication administration
  - Physical exam and clinical measurements
  - Signs, symptoms, diagnoses
  - Clinical documents
  - Procedures
  - Family history, medical history and review of symptoms

How are the models used in an EMR?

- Data entry screens, flow sheets, reports, ad hoc queries
    - Basis for application access to clinical data
- Computer-to-Computer Interfaces
    - Creation of maps from departmental/external system models to the standard database model
- Core data storage services
    - Validation of data as it is stored in the database
- Decision logic
    - Basis for referencing data in decision support logic
- Does ***NOT*** dictate physical storage strategy

Detailed clinical models and terminology

Model & terminology must be done together

- Terminology models and information models
  - models made by data modelers (message standards)
  - models made by terminology groups (maintenance of terms)
- "Impedance mismatch" arises when one group is making terms and another group is making the model
- Post coordination in a single field in the model is just another style of modeling – it is important to make the semantics explicit

Model Centered Data Representation
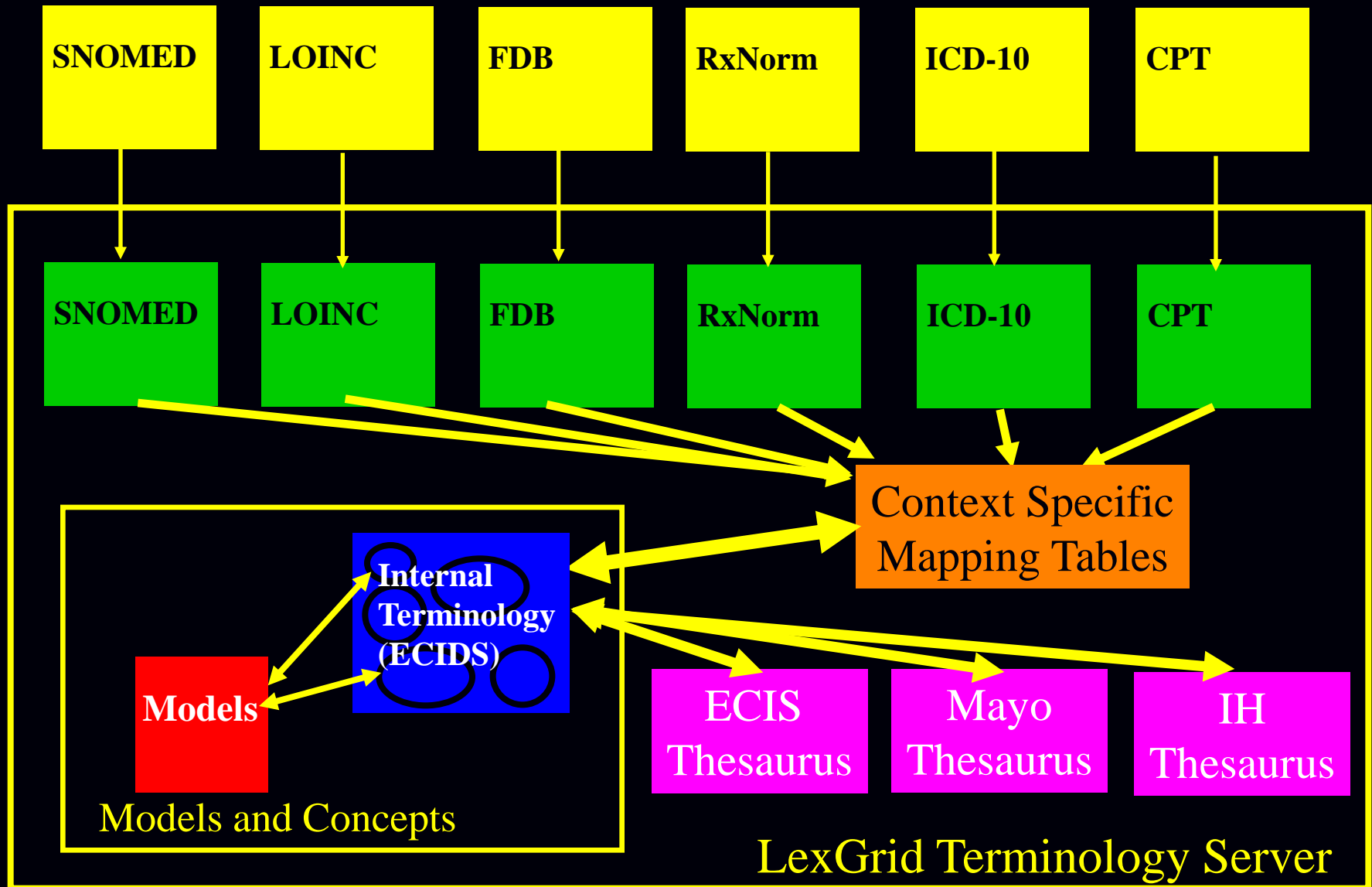
We assume that the model is used in association with a terminology server.

Model and Terminology

Model

Instance data

```
MedicationOrder ::= SET {
        drug            Drug,
        dose            Decimal,
        route           DrugRoute,
        frequency       DrugFrequency,
        startTime       DateTime,
        endTime         DateTime,
        orderedBy       Clinician,
        orderNumber OrderNumber}
```
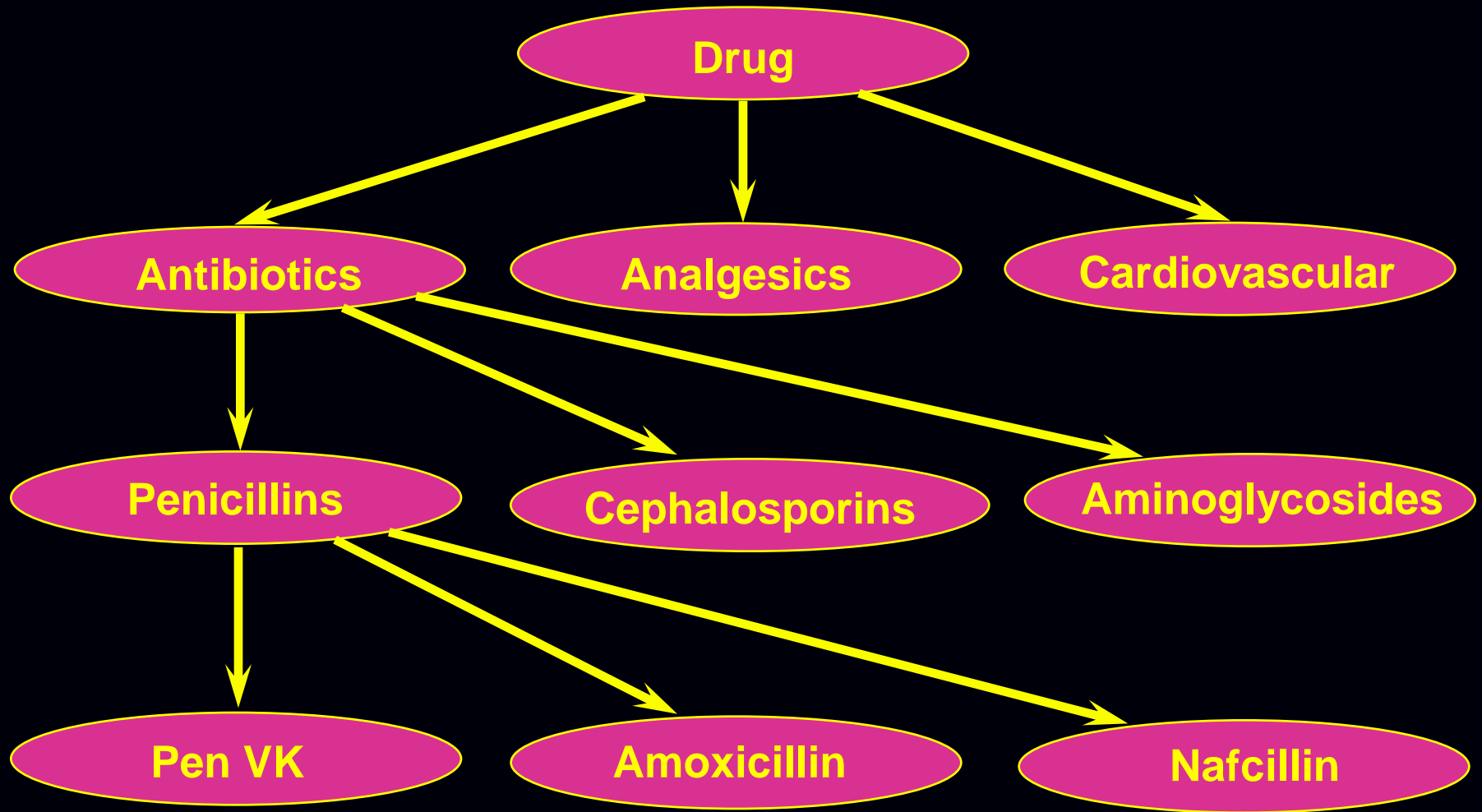
```
MedicationOrder {
        drug            PenVK,
        dose            250,
        route           Oral,
        frequency       Q6H,
        startTime       09/01/95 10:01,
        endTime         09/11/95 23:59,
        orderedBy       Don Jones, M.D.,
        orderNumber  A234567 }
```

If the medicationOrder.drug is_a "antibiotic"
then notify the infection control officer.

Concept Semantic Network

Denormalized Semantic Network

Drugs	**has-child**	**Antibiotics**
Drugs	**has-child**	**Analgesics**
Drugs	**has-child**	**Cardiovascular**
Antibiotics	**has-child**	**Penicillins**
Antibiotics	**has-child**	**Cephalosporins**
Antibiotics	**has-child**	**Aminoglycosides**
Penicillins	**has-child**	**Pen VK**
Penicillins	**has-child**	**Amoxicillin**
Penicillins	**has-child**	**Nafcillin**
Drugs	**has-member**	**Antibiotics**
Drugs	**has-member**	**Penicillins**
Drugs	**has-member**	**Pen VK**
Drugs	**has-member**	**Amoxicillin**
Drugs	**has-member**	**Nafcillin**