World Health Organization

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# Implementation and Use of ICPS in Health Information Systems (HIS)

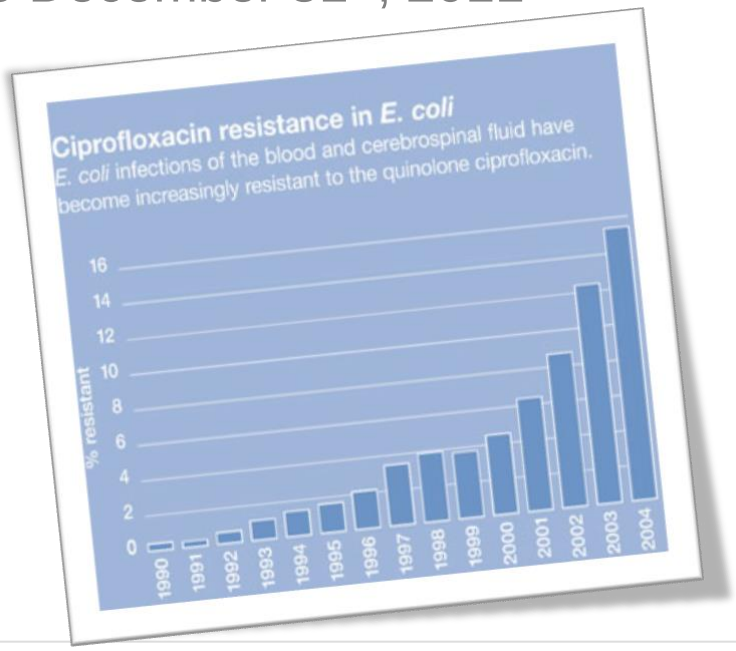
Stefan Schulz

Freiburg University Medical Center, Germany

# Context: the DebugIT project

- DebugIT (Detecting and Eliminating *Bacteria* UsinG Information Technology)
  - Patient Safety project
  - Funded by the European Community's Seventh Framework Program under grant agreement n° FP7–217139 (7M€)
  - Project period: from Jan 1st, 2008 to December 31st, 2011
  - 11 Partners

- Background:
  - 50% of antimicrobial drug use is inappropriate
  - Increasing resistance – new antibiotics can not keep up

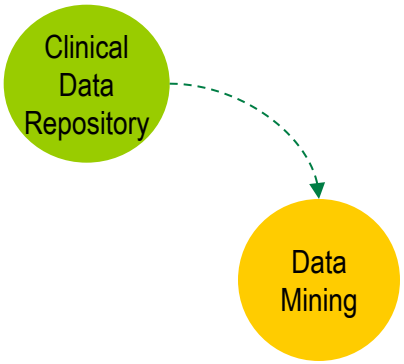


# Collect Data

- Routine clinical data
  - different hospitals in different countries
  - in different coding schemes, data and information models
  - Including free text documents in different languages
- map them to commonly agreed information models rooted in common ontologies
- organized in a virtualized clinical data repository (CDR).

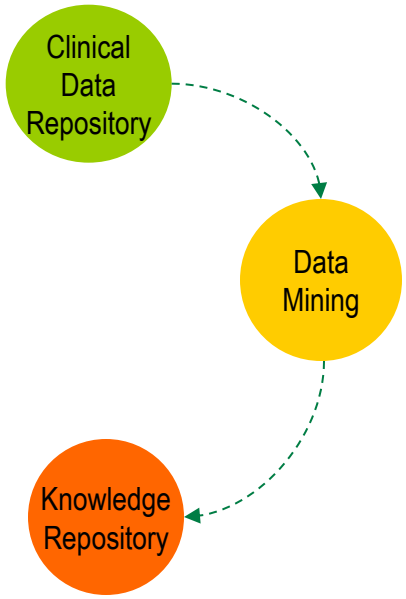
# Learn

- debugIT learns by detecting PS relevant patterns for the better treatment of infectious diseases
- Information extraction, knowledge discovery
  - structured data mining
  - text mining (from clinical narratives)



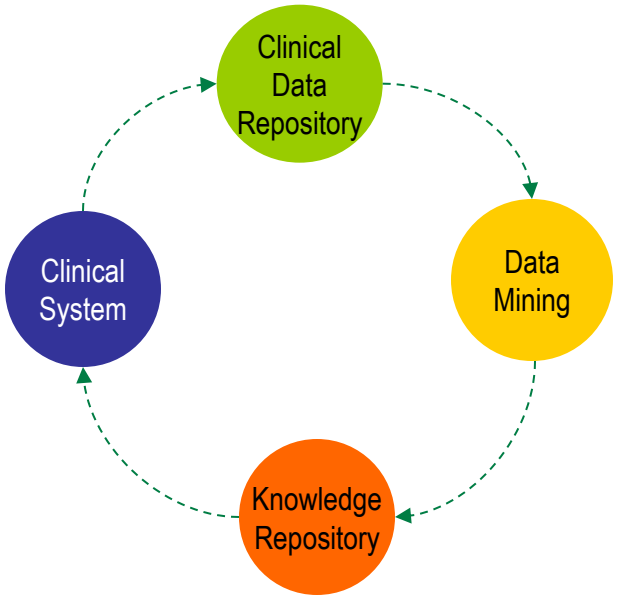
# Store and Author Clinical Knowledge

- debugIT learns by detecting PS relevant patterns for the better treatment of infectious diseases
- Information extraction, knowledge discovery
  - structured data mining
  - text mining (from clinical narratives)
- Merged with authoritative knowledge (e.g. clinical practice guidelines)
- Stored and aggregated in a distributed repository
- Feeds a translational framework



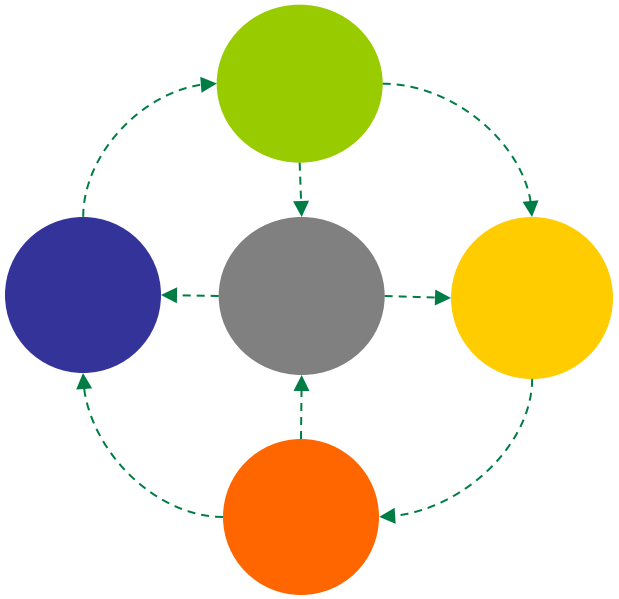
# DebugIT's Translational Framework

- Decision support for improvement of clinical care (choice, dose and administration of antibiotics)
- Monitoring to analyze ongoing care activities and outcomes
- Predicting future outcomes to give additional support to treatment decision
- Integration in existing clinical information systems enable its self-learning from existing data

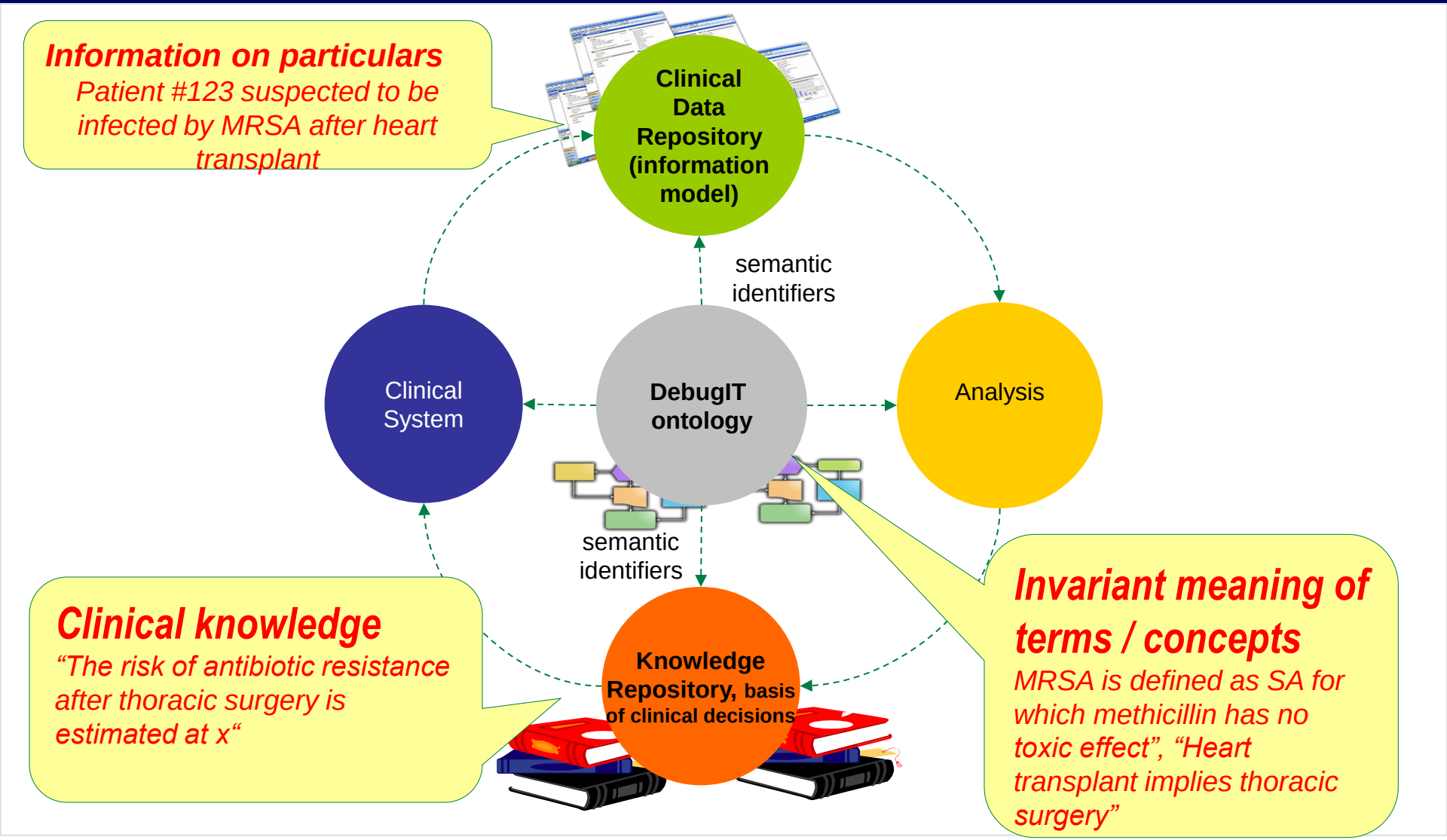


# Expected Outcome

- “living” knowledge base for supporting clinical information systems of participating hospitals
- virtualization of clinical data repository information relevant for patient safety
- advanced multimodal data mining techniques on text image and distributed storage
- use of machine reasoning related to real, point of care patient data to reduce harm to patients



# Semantic framework



# Can ICPS be used in the DebugIT framework?

- DebugIT ‘s analysis of the state of ICPS in march 2009
- We expected:
  - an ontology / classification to be re-used / linked to the DebugIT ontology
- We found:
  - a list of accurately defined concepts (ICPS 48 “key concepts”), but not represented in an ontology format
  - a hierarchical reporting template (ICPS “concepts by class”)
- We missed:
  - compliance with basic requirements for clinical vocabularies, e.g. no unique names, no IDs
  - enough detail for e.g. pathogens, chemicals etc.
- Analysis published at MIE 2009

# Is the "International Classification for Patient Safety" a Classification?

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[b] *Department of Medical Informatics, University of Linköping, Sweden,*
[c] *INSERM, UMR_S 872, eq.20 Paris, France; Université Paris Descartes, France,*
[d] *AGFA Healthcare, Gent, Belgium,* [e] *University Hospitals of Geneva, Switzerland*

**Abstract.** The WHO has developed and is currently testing a classification for patient safety (ICPS). Analyzing the ICPS in the light of classificatory and ontology principles as well as international standards we conclude that its qualification as a classification or taxonomy is misleading. Acknowledging its merits as a standard reporting instrument for change management and process improvements we propose formal improvements.
**Keywords.** WHO classification, Ontologies, Information Models

- "Classification" in the "traditional" sense

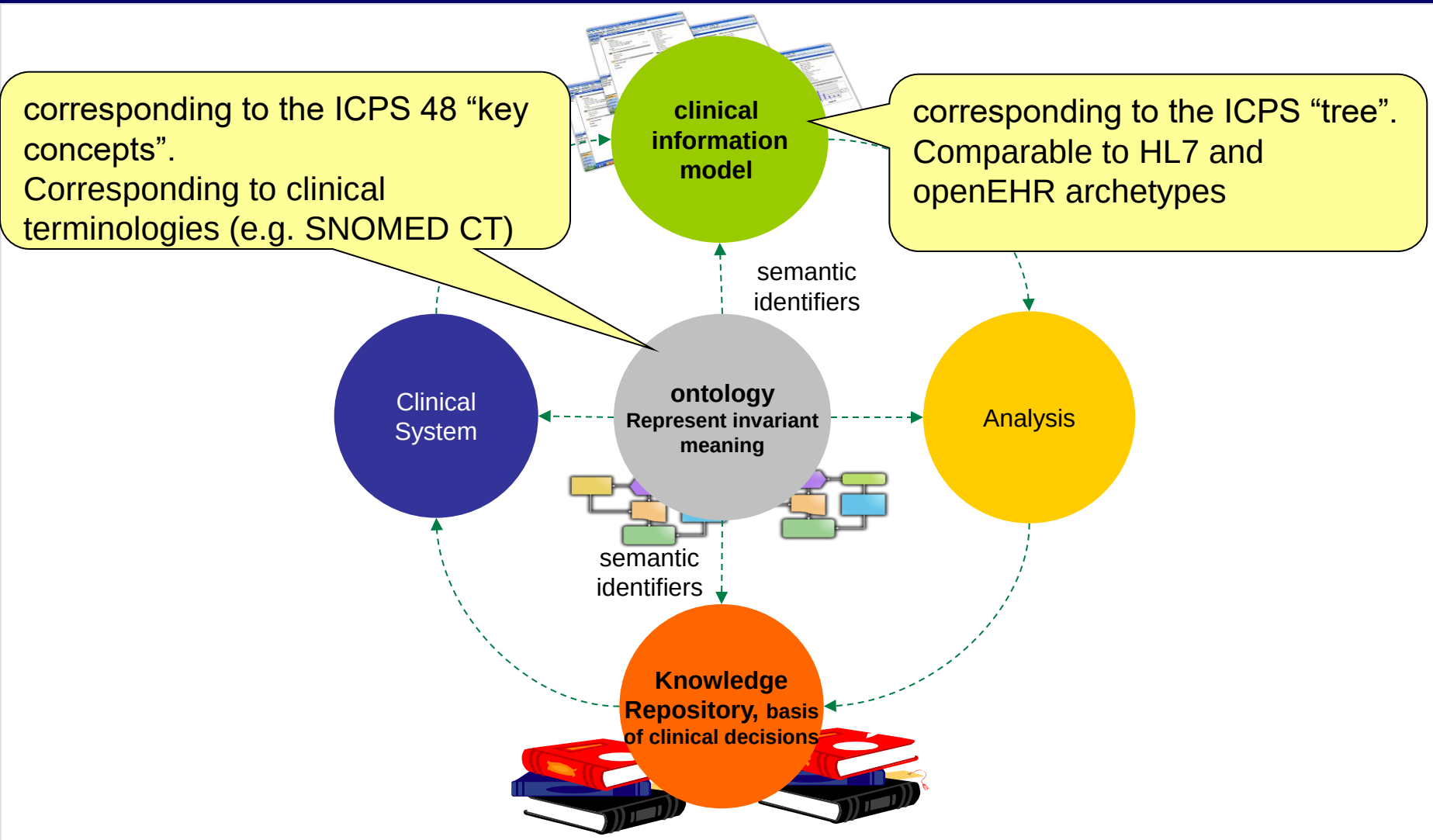
"ICPS's name and its closeness to the WHO-FIC [9] are misleading. ICPS is neither a classification nor a taxonomy. Its hierarchical tree could be described as an information model or reporting template. As such it is well-thought and may be suited for the purpose being devised for"

*Stud Health Technol Inform. 2009;150:502-6; PMID: 19745362*

# Decision for DebugIT

- In the initial phase ICPS not used (to be re-assessed later)
- Construction of an ontology-based clinical information model, to be filled by heterogeneous clinical data
- Necessary steps
  - ontology binding (in DebugIT: mix of existing and new ontologies)
  - formal descriptions (using OWL)
  - mappings from individual information models (complicated if logically consistent)
  - using text mining to extract information into pre-defined information model
- Interesting for ICPS: all these steps would also be necessary when implementing ICPS into HIS
- DebugIT experience: blueprint for implementing ICPS…

# DebugIT Semantic framework adapted to ICPS



# HIS aspects and two ICPS use cases

- ICPS is used for the standardized and comprehensive reporting of patient safety relevant events:
  - the initiative comes from the user
  - the user fills the information template
  - ideally the system could automatically extract as many information as possible from the HIS (using mapping rules and information extration / text mining): the user has to verify and complete
- ICPS is used as a semantic basis for the automated detection of PS relevant events
  - system takes the initiative and proposes PS candidates
  - user identifies true positives and performs the steps as explained above

# Desiderata from an implementation perspective

- Short term
  - Reconsider what ICPS really is: (novel) classification, information model or reporting template or sth in between?
  - Use one of the standards for clinical information models (openEHR archetypes, HL7 V3) for representing the ICPS “tree”. Enhance compatibility with existing models (e.g. ICSR and the HL7 Public Health Reporting Domain Information Model)
- Long term:
  - formally describe the meaning of the ICPS data elements in terms of a clinical ontology drawing upon the ICPS “48 key concepts”
  - feeding the ICPS “48 key concepts” into a terminological / ontological standard (e.g. SNOMED CT)

# Ontologies, Classifications and Information Models

## Ontologies

Formal descriptions
- MRSA *subtype-of* SA
- SA *subtype-of* Staphylococcus
- SA *implies* bearer-of *some* MR quality

Textual descriptions
- "MRSA is defined as SA for which methicillin has no toxic effect"

- theories th… ttempt to give precise mathemati… ormulations of the properties … relations of certain

**Future Classifications ??**

## Information M…

*Methicillin resistance*
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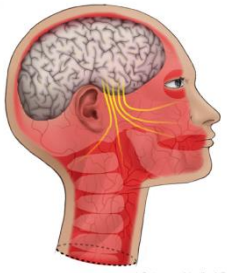

- artifacts … hich information is record…

*A. Recto… manticHealth D6.1*

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**Patient safety**

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WHO > Programmes and projects > Patient safety > Taxonomy

## Taxonomy

International Classification for Patient Safety (ICPS)

The key action areas of WHO Patient Safety aim to improve specific aspects of patient safety. A common element of each action area is that it serves as a source of learning within countries and across the world to help make health care safer. In order to accomplish this, a standardized internationally accepted classification for key patient safety concepts must be developed.

Taxonomy for Patient Safety aims to define, harmonize and group patient safety concepts into an internationally agreed classification. This will help elicit, capture and analyse factors relevant to patient safety in a manner conducive to learning and system improvement. The classification aims to be adaptable yet consistent across the entire spectrum of health care and across cultures and languages.

The International Classification for Patient Safety (ICPS) is not yet a classification. It is a conceptual framework for an international classification represents a consensus of international experts on a reasonable understanding of the world of patient safety. **The Final Technical Report for The Conceptual Framework for the International Classification for Patient Safety 2009 (v1.1) and accompanying Technical Annexes** provide a detailed overview of the conceptual framework and the

# The ICPS: A taxonomy, a classification, an ontology or an information model?

**Stefan SCHULZ**

IMBI, University Medical Center,

Freiburg, Germany

# Representation Artifacts

## Ontology

- theory of reality

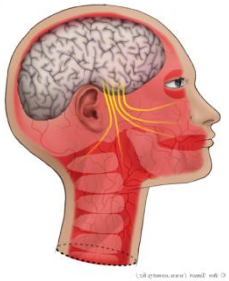
## Ontologies

•theories that attempt to give precise mathematical formulations of the properties and relations of certain entities.
*(Stanford Encyclopedia of Philosophy)*

## Epistemology

- theory of knowledge

## Information Models



- artifacts in which information is recorded
  *A. Rector, SemanticHealth D6.1*

# Representation Artifacts

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Textual descriptions
- "MRSA is defined as SA for which methicillin has no toxic effect"

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## Information Models

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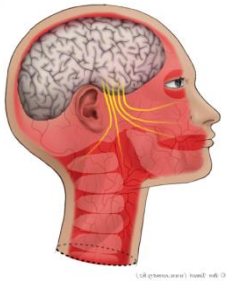

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Textual descriptions
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## Taxonomies

Backbone of Ontologies

*SubClass* or is-a relation:
a class *B* is a subclass
of a class *A*
if and only if
all members of *B* are
also members of *A*
(ENV 12264:2005, Horrocks 2003)

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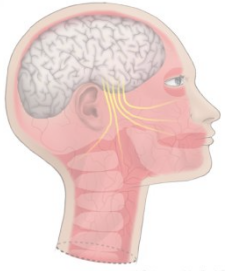

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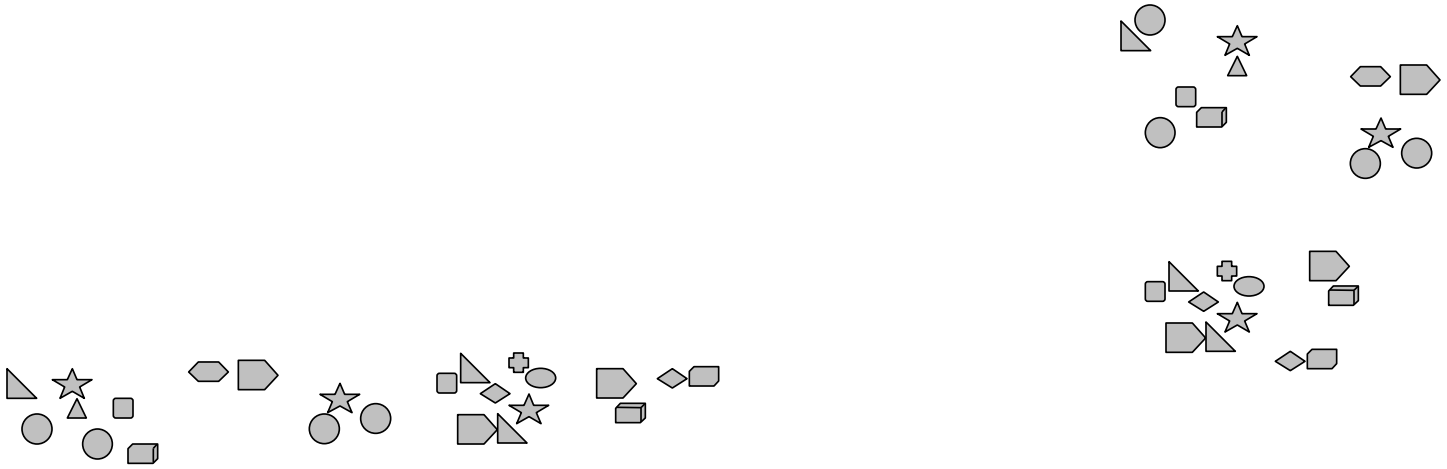
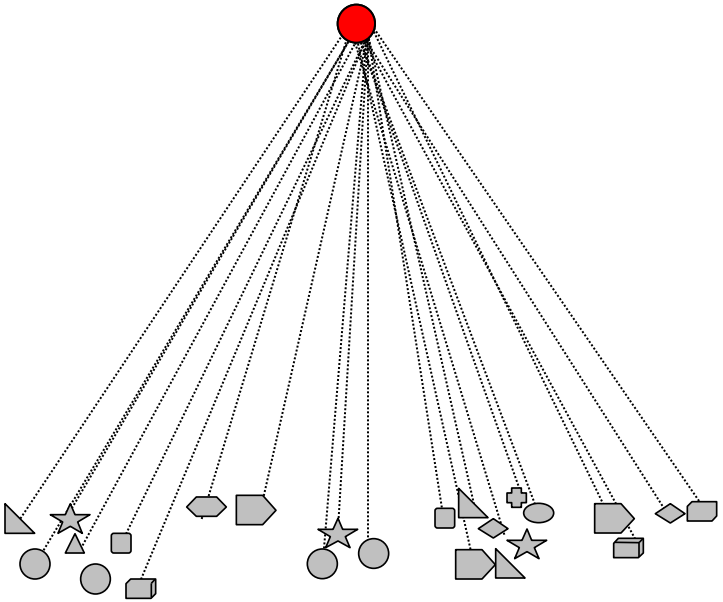
# Taxonomy building principles

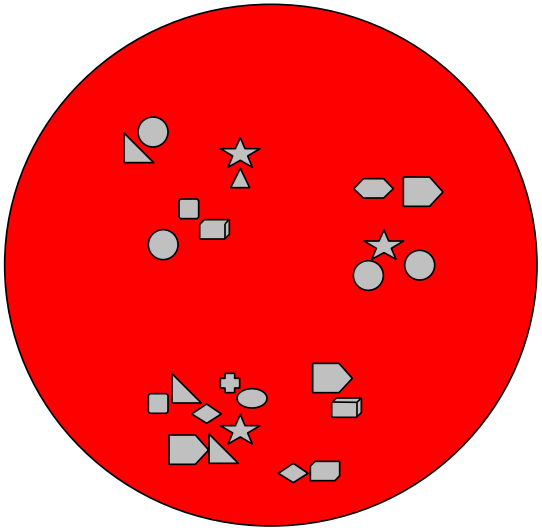


Individuals (particulars, instances)

# Taxonomy building principles

Class



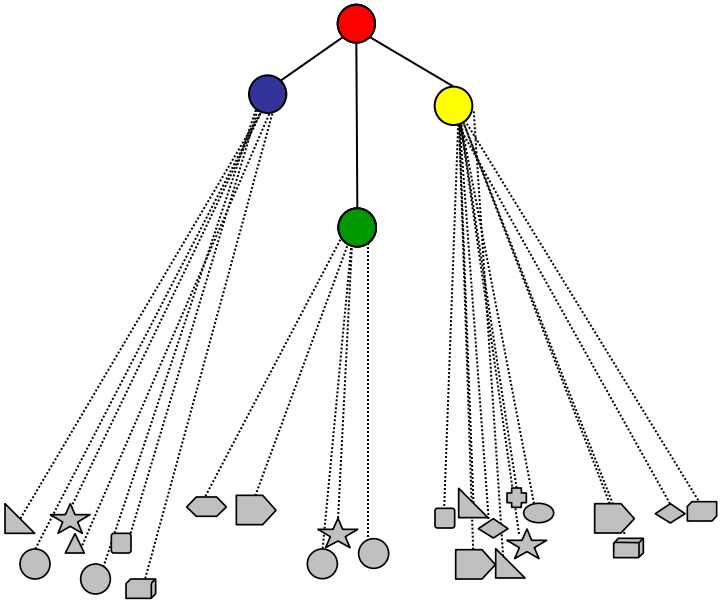


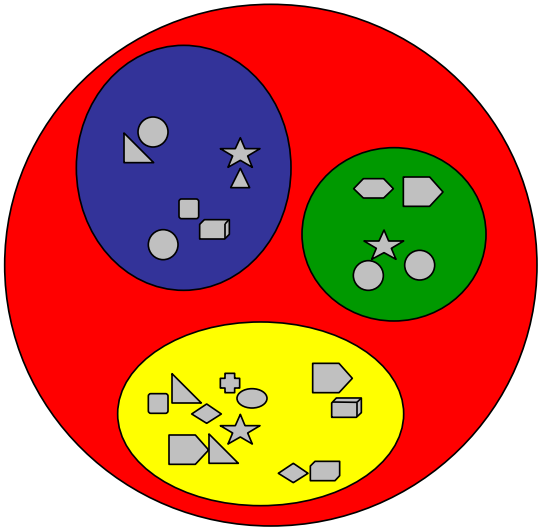
Individuals (particulars, instances)

# Taxonomy building principles

Class

Subclasses





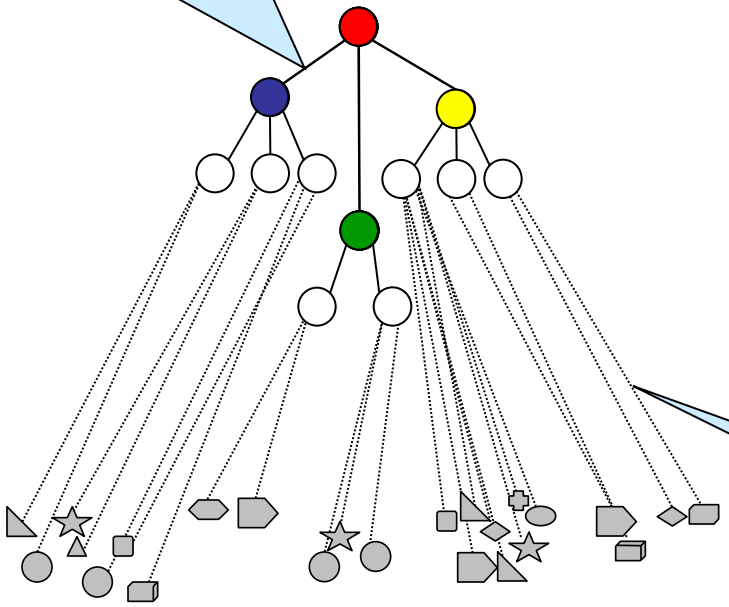
Individuals (particulars, instances)

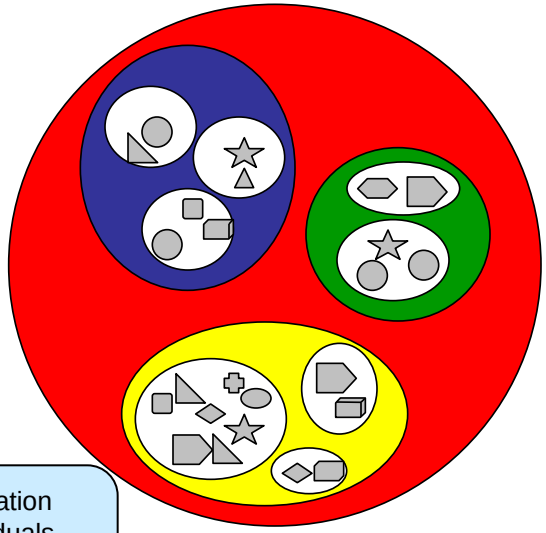
# Taxonomy building principles

is-a or
subclass relation
(relating classes with
classes):
corresponds to subset relation

Class

Subclasses





instance-of relation
(relating individuals
with classes)
corresponds to set
membership relation

Individuals (particulars, instances)

# Representation Artifacts

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Textual descriptions
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## Classifications

Taxonomies with additional building principles:
- exhaustiveness
- disjointness

## Information Models

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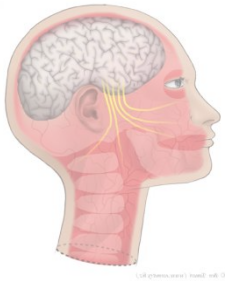
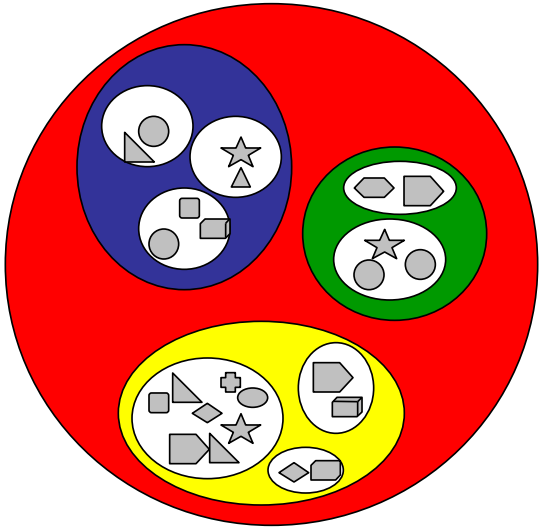
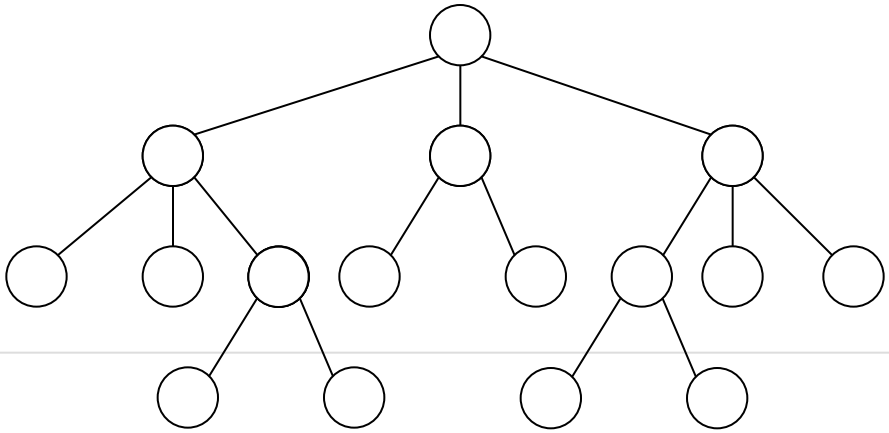


- artifacts in which information is recorded
  *A. Rector, SemanticHealth D6.1*

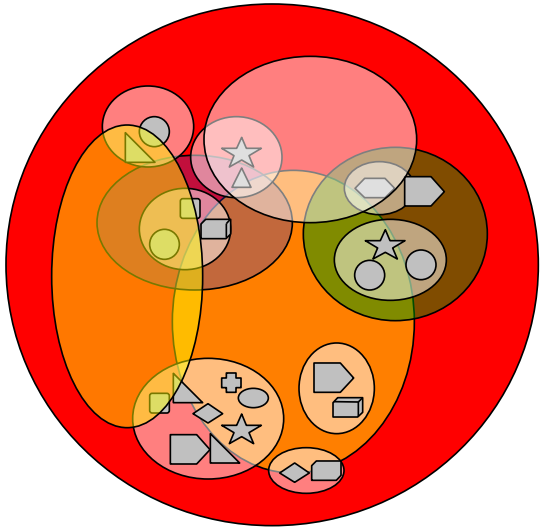
# Classifications: Disjointness principle

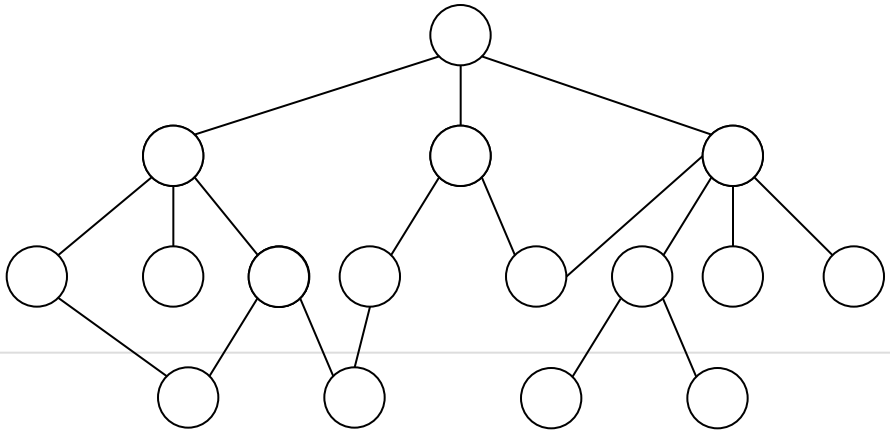
Classifications, e.g. ICD





Other Terminologies, e.g. SNOMED CT





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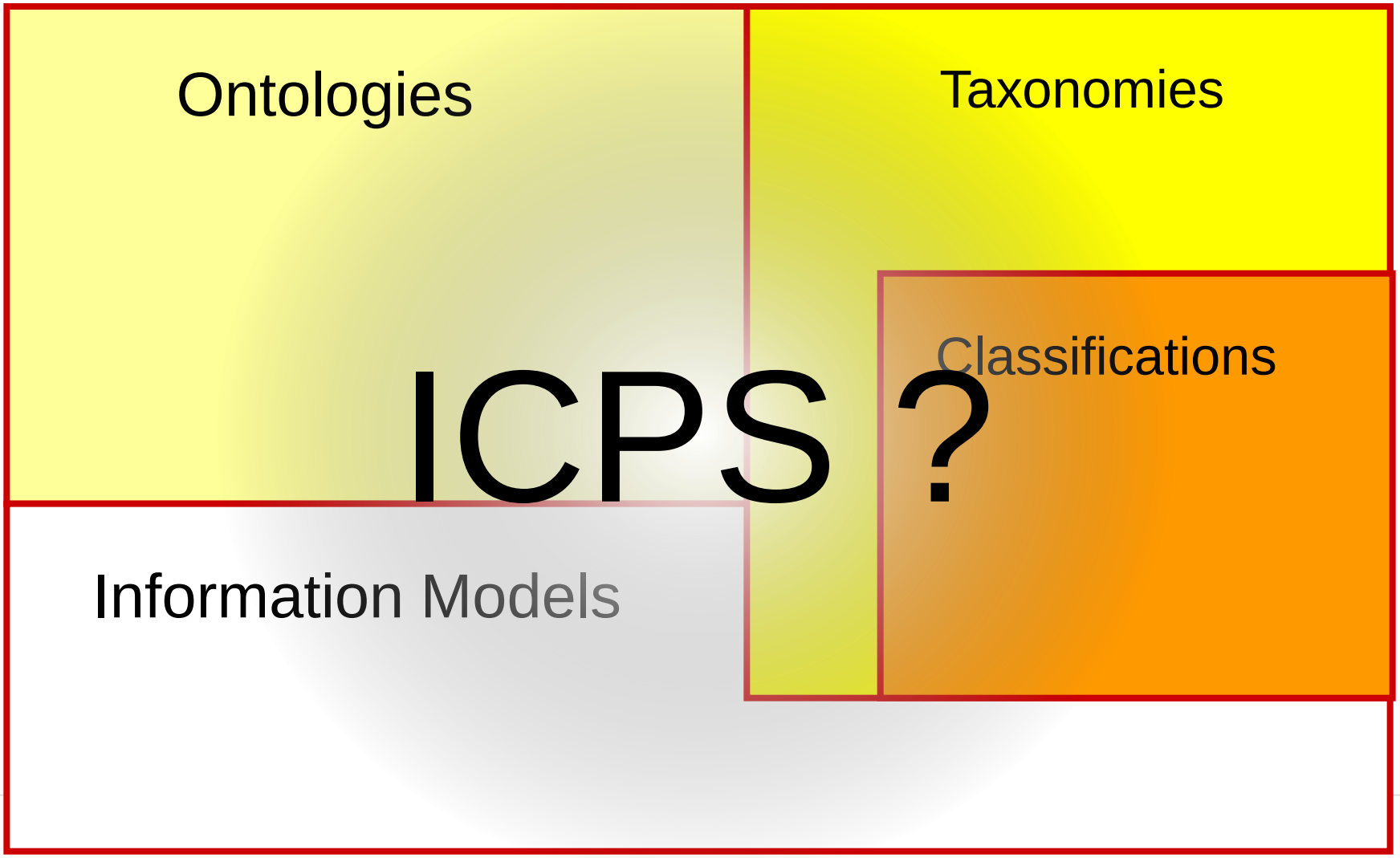
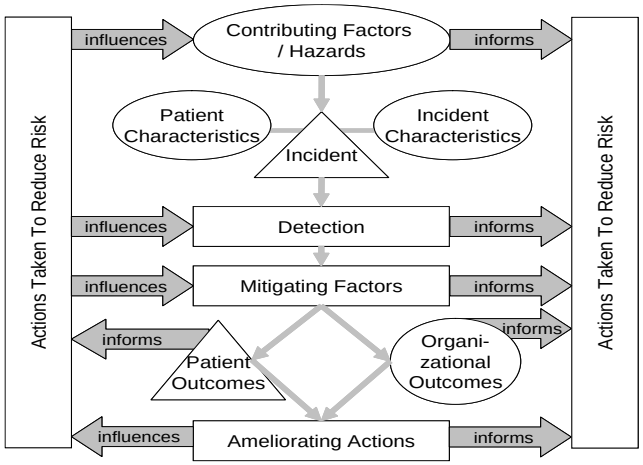


# Three components of ICPS

## "Conceptual Framework"




## "Key Concepts"

9. Hazard: a circumstance, agent or action with the potential to cause harm.
10. Circumstance: a situation or factor that may influence an event, agent or person(s).
11. Event: something that happens to or involves a patient.
12. Agent: a substance, object or system which acts to produce change.
13. Patient Safety: the reduction of risk of unnecessary harm associated with healthcare to an acceptable minimum.
14. Healthcare-associated harm: harm arising from or associated with plans or actions taken during the provision of healthcare, rather than an underlying disease or injury.
15. Patient safety incident: an event or circumstance which could

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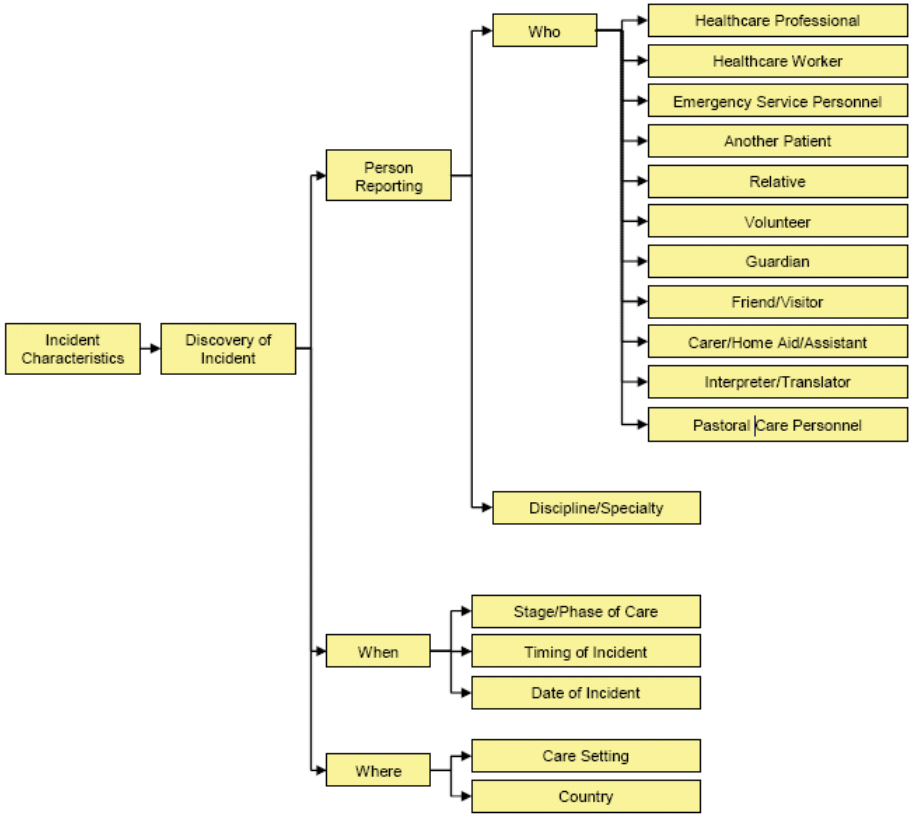

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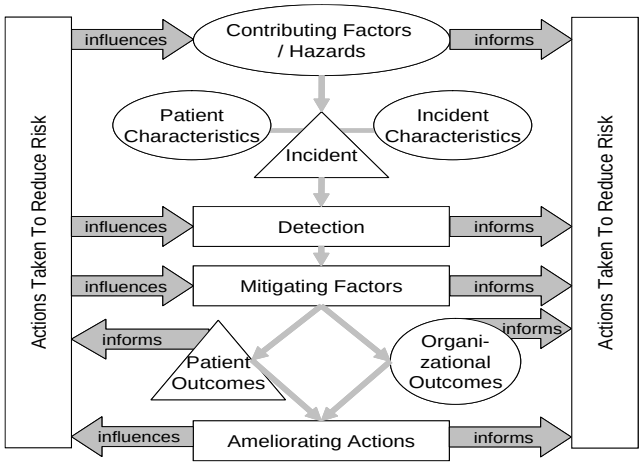


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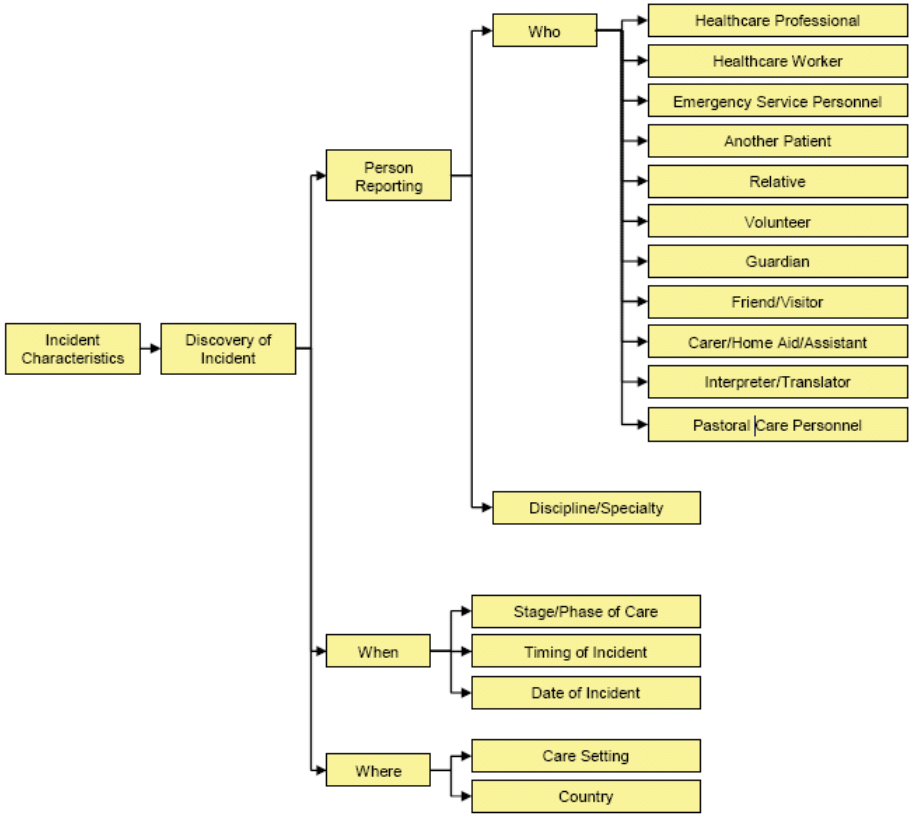

# ICPS Components

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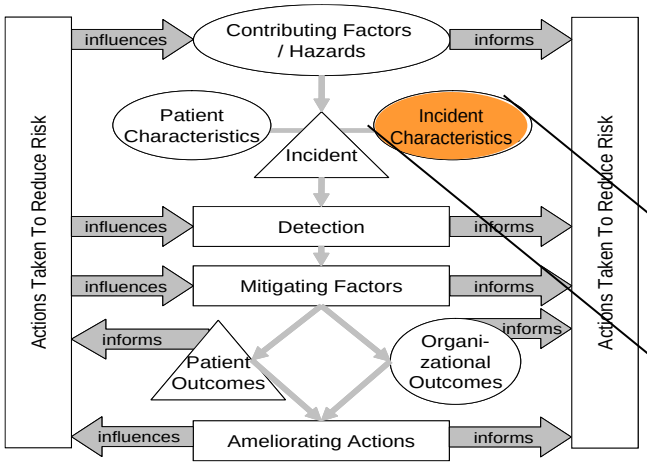


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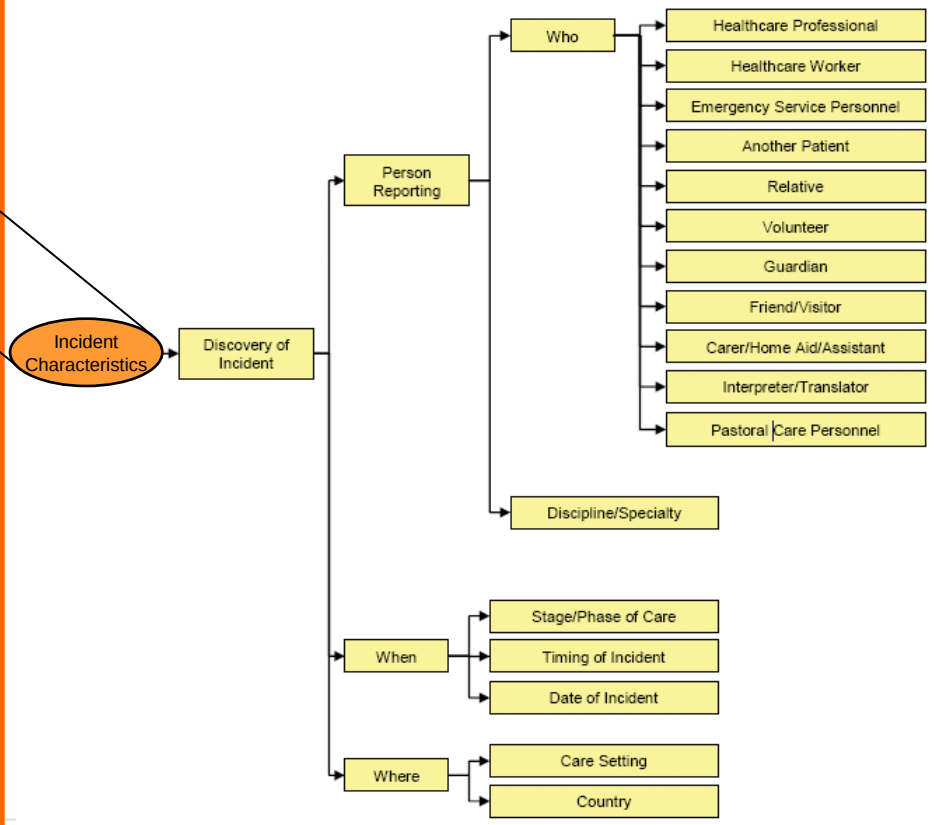

# ICPS Conceptual Framework

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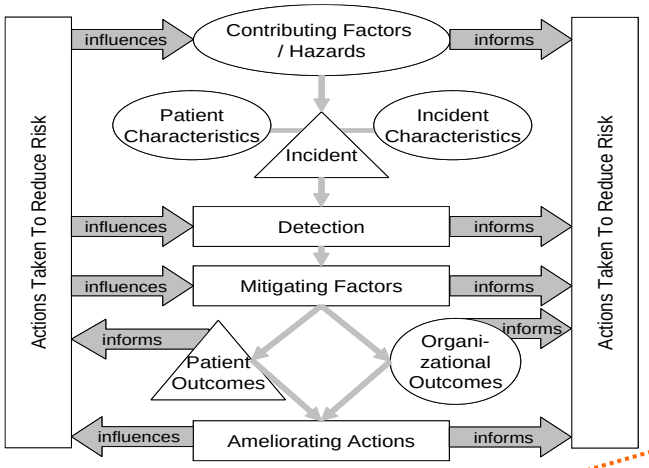


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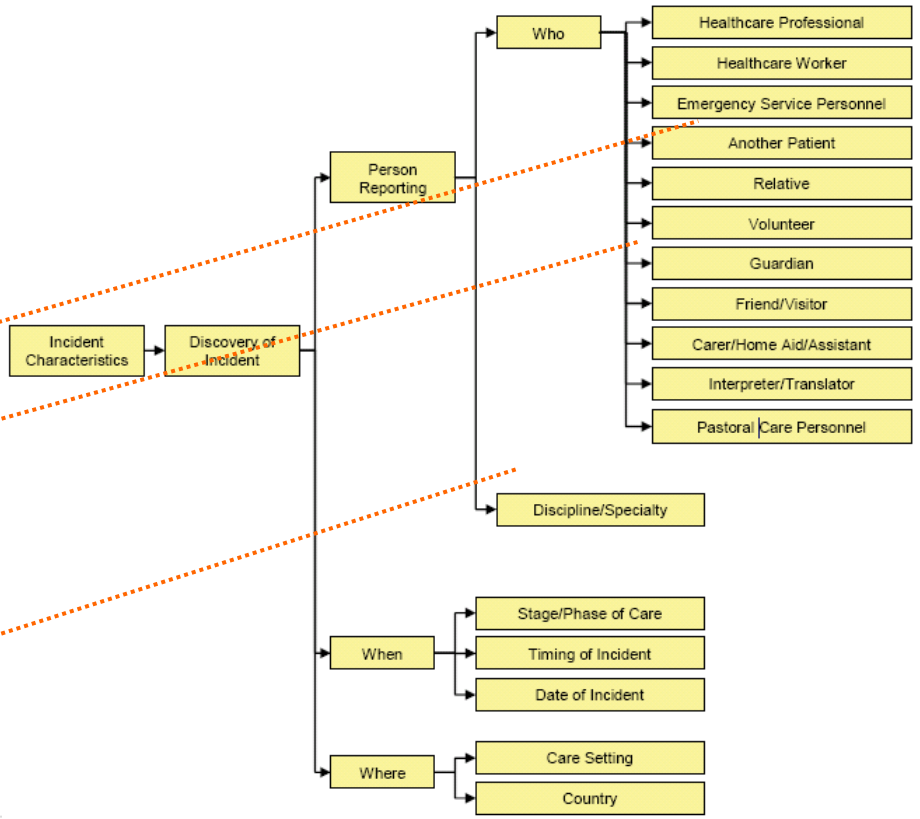
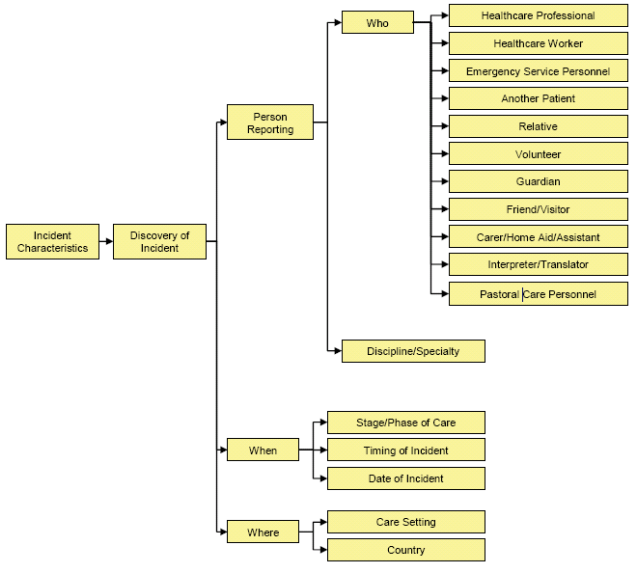
15. Patient safety incident: an event or circumstance which could have resulted, or did result, in unnecessary harm to a patient.

## ICPS "taxonomy"



# Analyzing ICPS

- target of analysis: the ICPS tree…
  - graph structure: resemblance with WHO-FIC classifications (4 – 5 levels, single parents)
  - artifact meant to be used by coders




- key concepts and conceptual framework: meta information from user's point of view

9. Hazard: a circumstance, agent or action with the potential to cause harm.
10. Circumstance: a situation or factor that may influence an event, agent or person(s).
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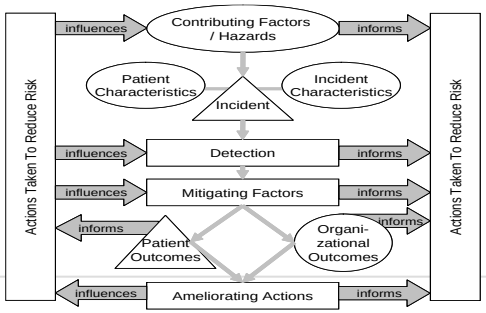


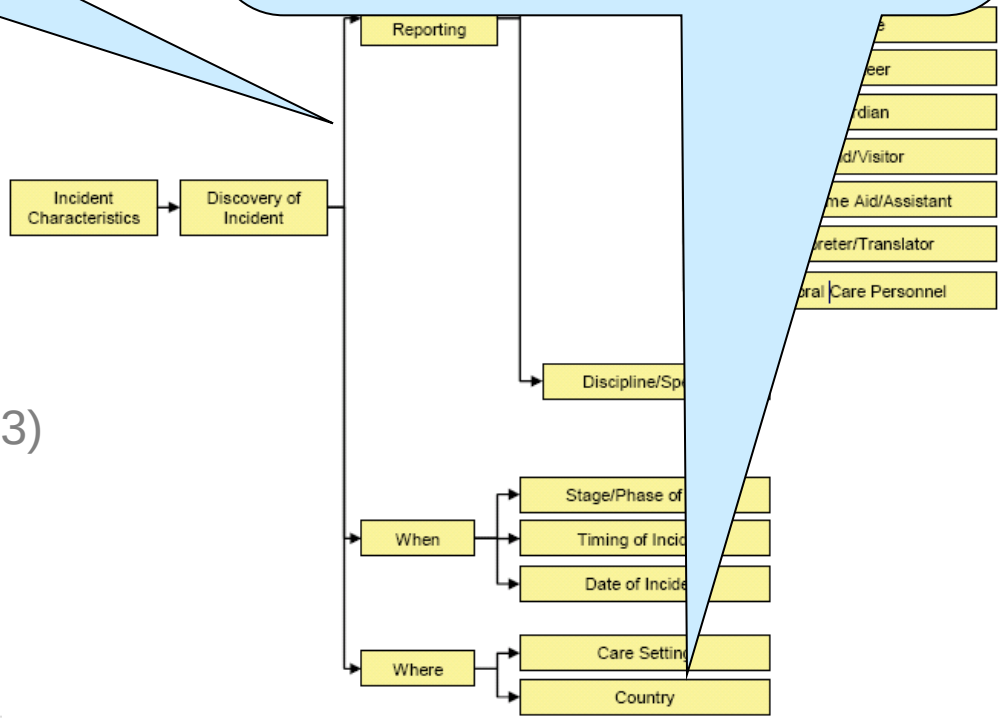
# ICPS is in a strict sense not…

A member of the class *Person Reporting* is not a member of the class *Discovery of Incident*: No taxonomic link!
But
For every member of the class *Discovery of Incident*" there is some member of the class *Person Reporting* as a participant: non-taxonomic, ontological relation

A member of the class *Country* is not a member of the class *Where* and no member of Discovery of Incident. No taxonomic link!
But: for every member of the class *Discovery of Incident*" there is some member of the class *Country* as a location: non-taxonomic, ontological relation

… 005,

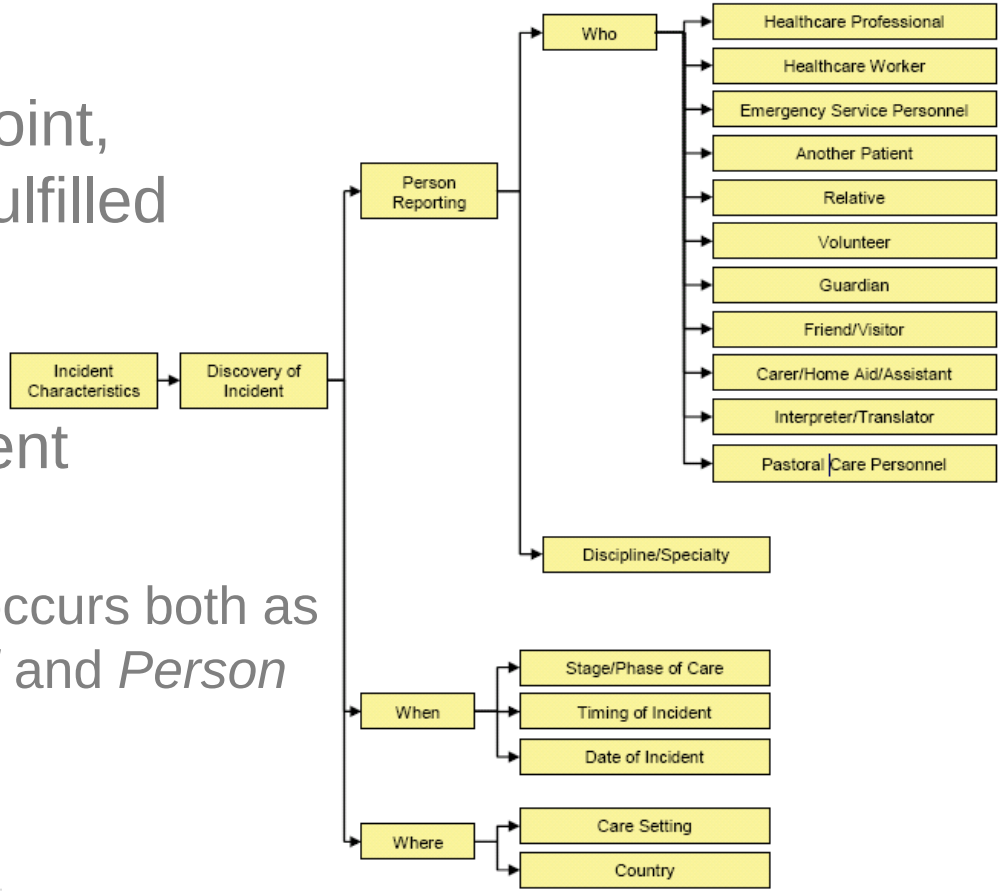
- Semantic nature of hier… links are not specified
- *Subclass* or is-a relation: a class *B* is a subclass of a class *A* if and only if all members of *B* are also members of *A* (ENV 12264:2005, Horrocks 2003)



# ICPS is not yet…

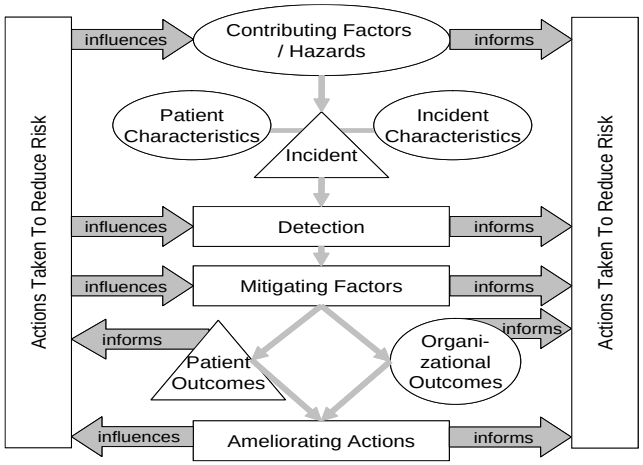
… a **classification** (ISO 17115:2007, Ingenerf MIM 1998, Madden [WHO-FIC] 2007)

- Criterion of mutually disjoint, exhaustive classes not fulfilled
- more than hundred ICPS concepts occur more than once in different hierarchies
  - *Healthcare Professional* occurs both as a child of *People Involved* and *Person Reporting*



# ICPS: What it is now

## "Conceptual Framework"




## "Key Concepts"

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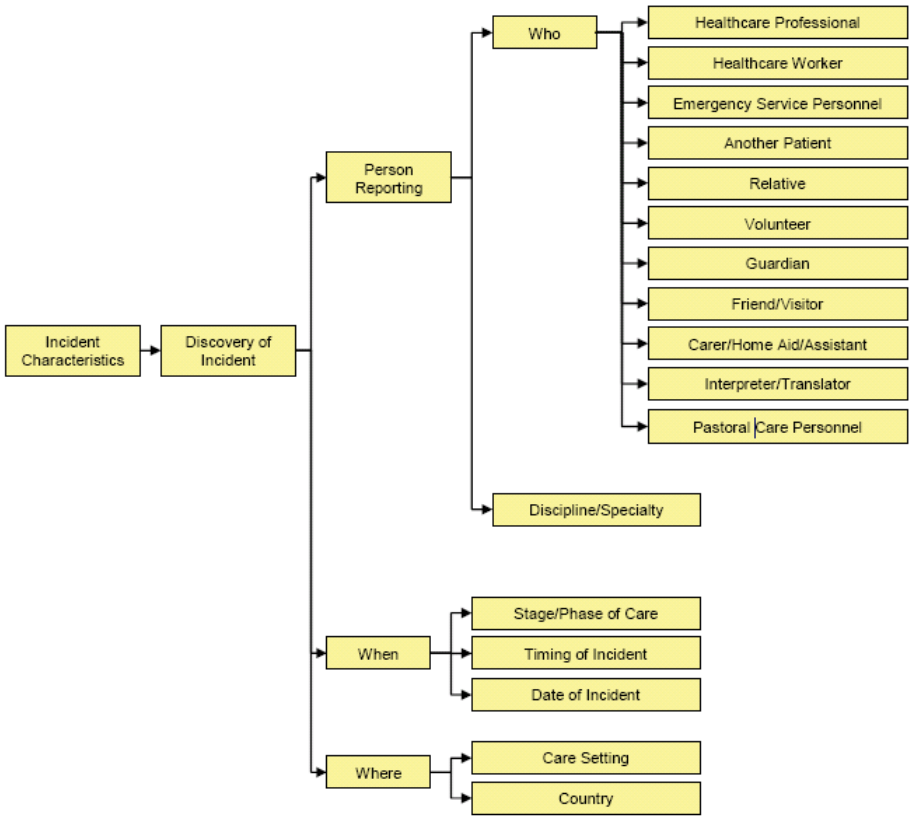
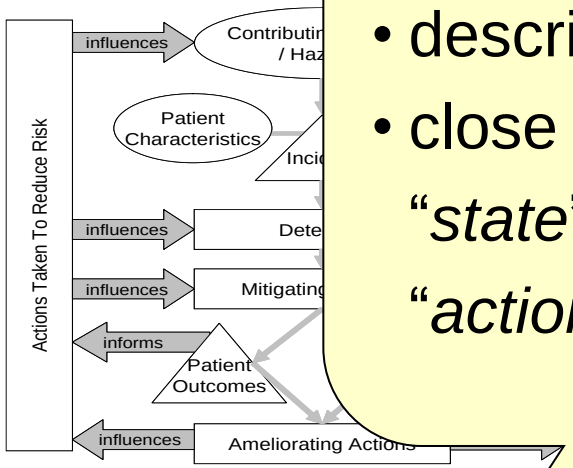
15. Patient safety incident: an event or circumstance which could

## ICPS "taxonomy"



# ICPS: What it is now

## "Conceptual




This is a **rudimentary, informal ontology**

- describes terms by their generic properties
- close to upper-level ontologies (e.g. BioTop): "*state*", "*substance*", "*event*", "*agent*", "*object*", "*action*", "*quality*".

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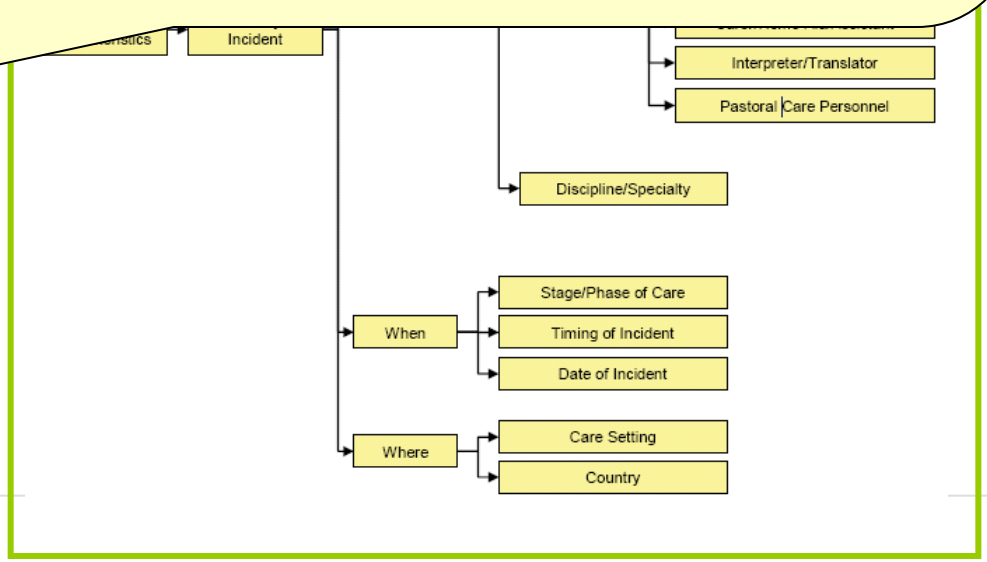
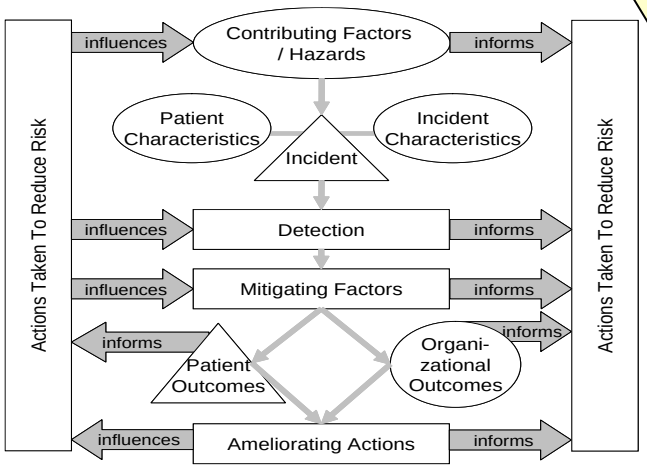


# ICPS: What it is now

## "Conceptual Framework"

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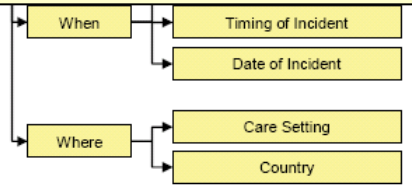
## ICPS "taxonomy"

This is a **complex patient safety model**

- Similarity with
  - workflows
  - business models
- Ontologically:
  - complex event type



# ICPS: What it is now

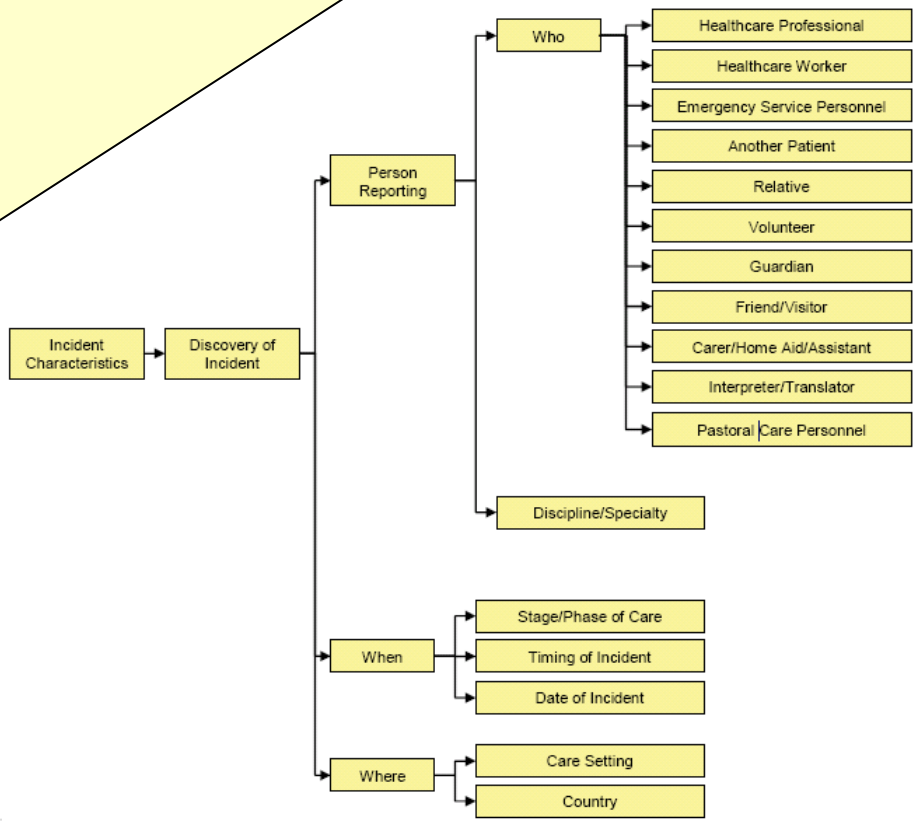
This is a structured **data acquisition template** consisting of (mostly) binary fields

Can be described as information model

Hierarchical parents provide context information for fields (but are not superclasses)

It is not meant to arrange classes of entities by their inherent properties (ontology), but gives a framework for acquiring what a reporting person knows (information model)

## ICPS "taxonomy"




than an underlying disease or injury.

15. Patient safety incident: an event or circumstance which could

# Representation Artifacts

## Ontologies

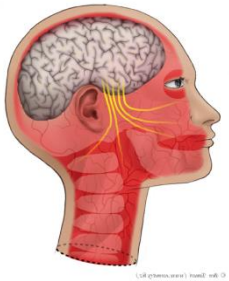
Formal descriptions
- MRSA *subtype-of* SA
- SA *subtype-of* Staphylococcus
- SA *implies* bearer-of *some* MR quality

Textual descriptions
- "MRSA is defined as SA for which methicillin has no toxic effect"

- theories that attempt to give precise mathematical formulations of the properties and relations of certain entities. *(Stanford Encyclopedia of Philosophy)*

## Information Models

*Methicillin resistance*
- ☐ Clinically confirmed
- ☐ Confirmed by antibiogram
- ☑ Suspected
- ☐ None
- ☐ Unknown



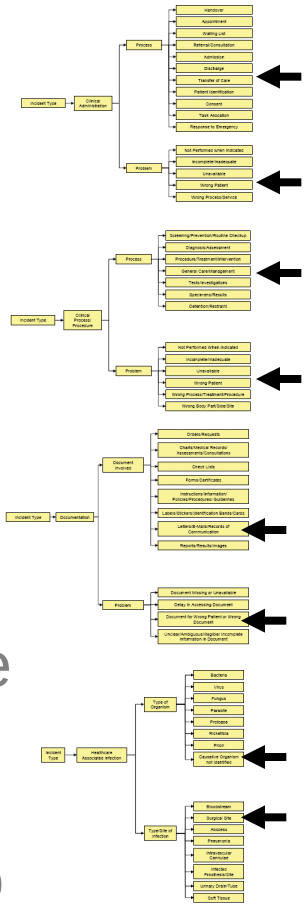
- artifacts in which information is recorded
  *A. Rector, SemanticHealth D6.1*

# Structure of the Talk

- ICPS: How does it look like?
- ICPS: What it isn’t
- ICPS: What it is now
- **ICPS: What it may be in the future**

# What ICPS may be in the future

- After finishing, ICPS has the potential to be universally accepted as a reporting standard
- The ICPS “key concepts” may become a fully-fledged formal ontology rooted in existing upper-level ontologies and using Semantic Web standards (OWL) and being linked to ontological / terminological standards like SNOMED CT
- The ICPS “conceptual framework” can be enhanced by formal descriptions
- The ICPS reporting template ("taxonomy") may then be fully described in terms of ICPS’s ontological core
- but…

# Open issues

- The needs for semantically interoperable patient-safety relevant event reporting is essentially different from the reporting of diseases
- For the latter, the format of a statistical classification is adequate (ICD-10)
- Is the format of a reporting template adequate for the purpose ICPS is devised for?
- Is it necessary to transform the ICPS tree into a real taxonomy or classification structure?