Medicine In The Age of Informatics

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THE COMPLEXITY OF MODERN MEDICINE EXCEEDS THE INHERENT LIMITATIONS OF THE UNAIDED HUMAN MIND.

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Major Issues in Health Informatics

◆ **Computer-based records**

◆ **Medical database management**

◆ **Medical language representation and processing, and medical data and terminology**

◆ **The clinical process and decision-making**

◆ **Hospital information systems**

◆ **Clinical information systems (diagnostic imaging, lab, pharmacy, cardio-pulmonary, etc.)**

◆ **Medical imaging, image processing, and telemedicine**

◆ **Modeling and simulation of healthcare systems for process improvement**

◆ **Medical data security and legal issues affecting medical informatics**

Source: D Covvey, 1999.

Standards for Establishing Unambiguous Clinical Communications

Health Level 7

Its mission is to provide HL7 standards for the exchange and integration of data that support clinical management of patients and the evaluation of healthcare services.

Logical Observation Identifier Names and Codes

LOINC is a set of universal names and codes for identifying clinical observations and laboratory results. It is the basis of the ICD-10-PCS codes.

Snowmed International

Snowmed provides a systemized nomenclature of human and veterinary medicine - a hierarchical terminology coding system organized in different axes and chapters. The chapters include laboratory and imaging procedures.
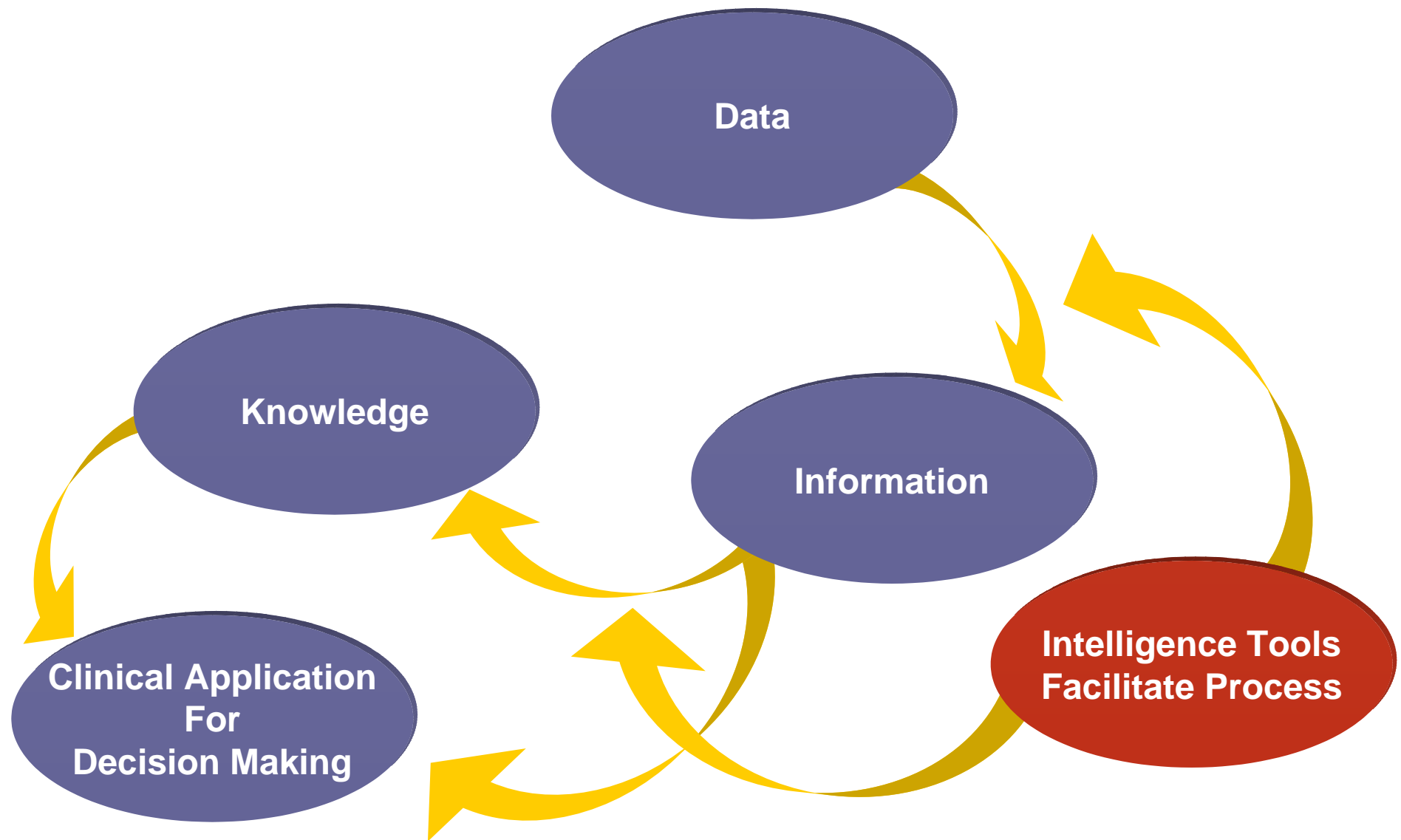
Snowmed RT

This upcoming release provides clinical reference terminology for storing, receiving, and analyzing clinical information.

The future lies in the merger of LOINC and Snowmed to cover all detailed laboratory terms and their classification.
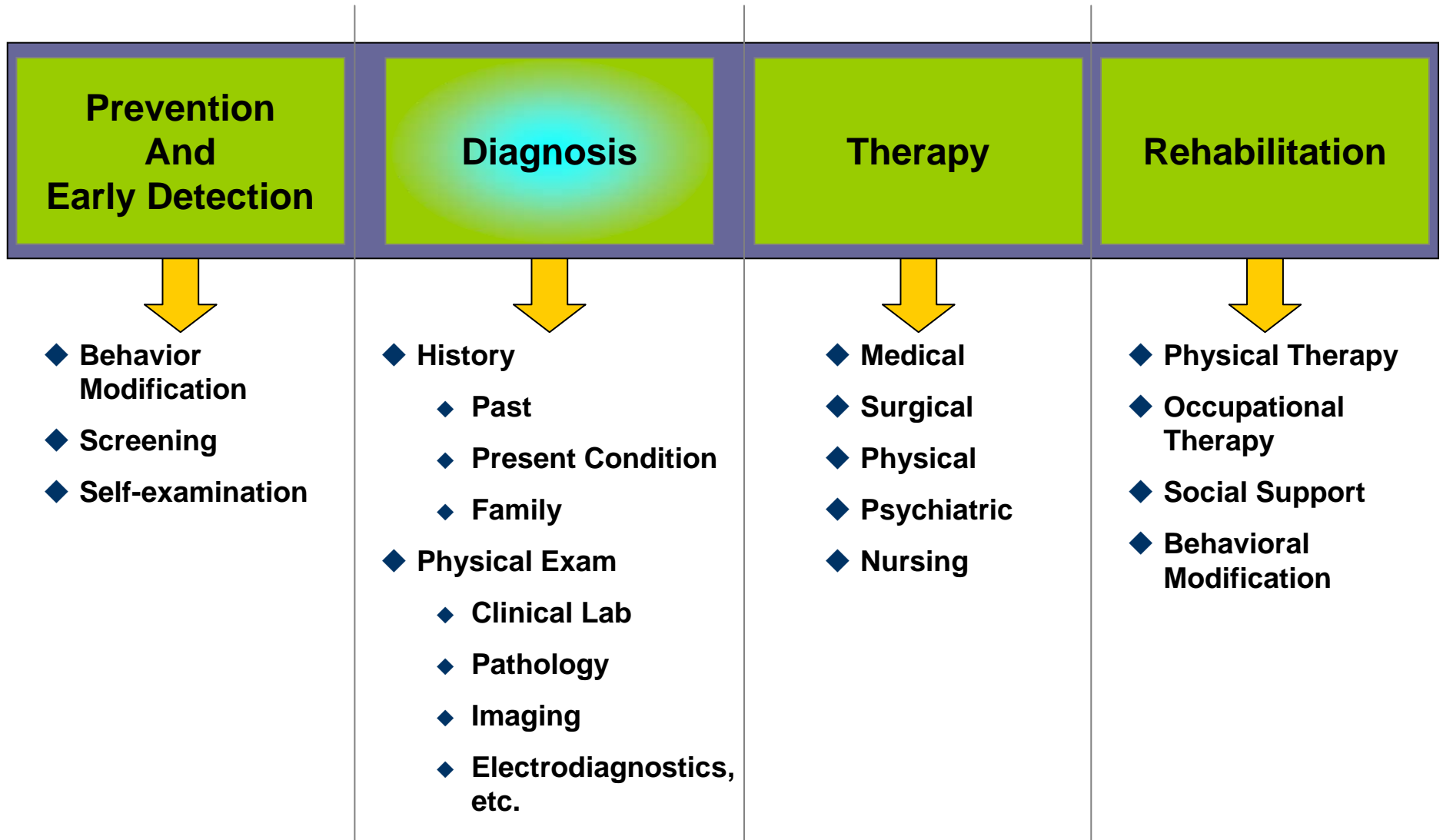
Extensible Markup Language

XML serves to format material for presentation to a browser and via HTML (hypertext marking language) to navigate among pages and sites of the WWW. Next generation of Netscape and Microsoft will support the display and manipulation of XML documents using HL7, LOINC, and Snowmed standards.
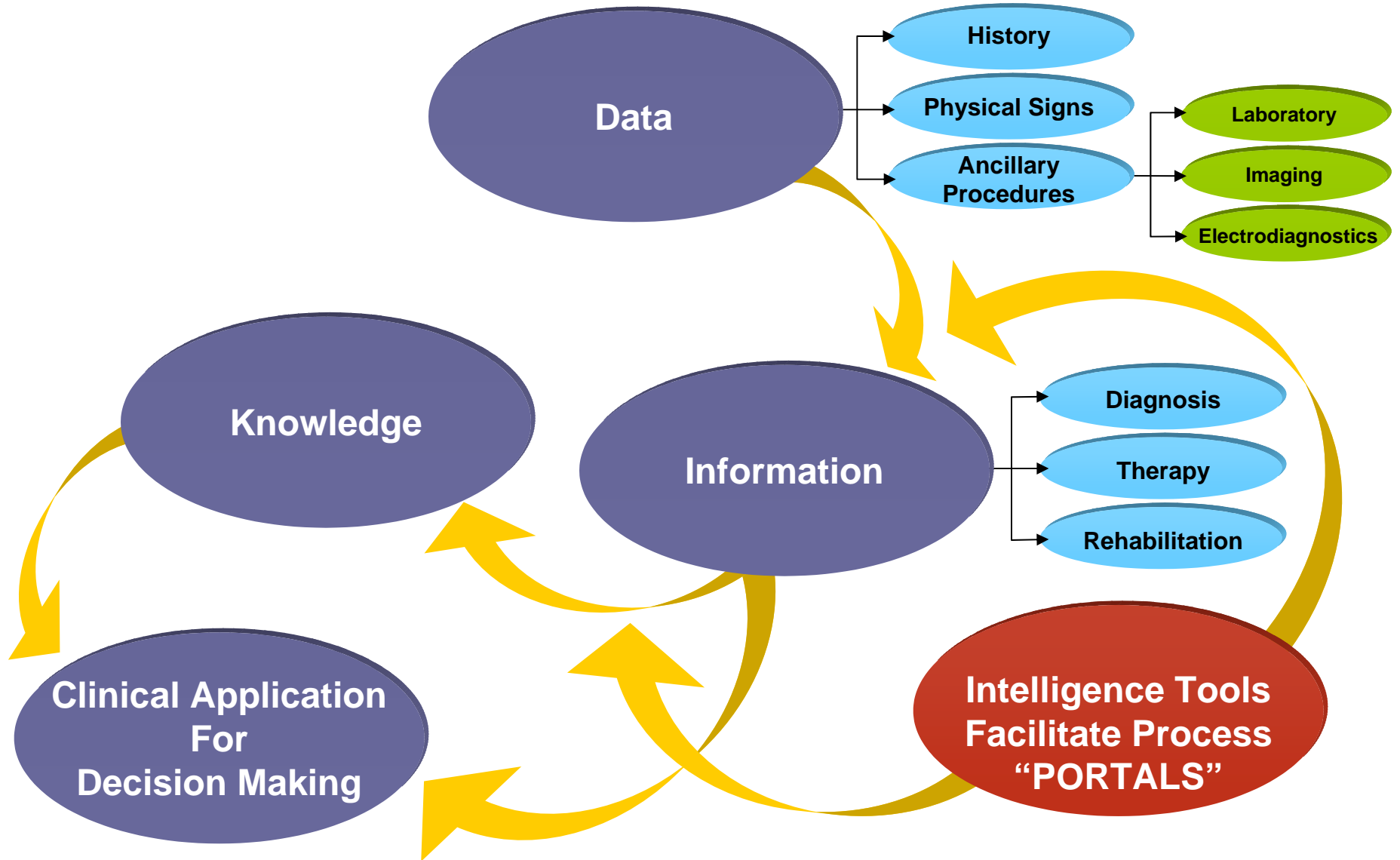
Basic Medical Informatics Theory

The Disease Management System

Prevention And Early Detection	Diagnosis	Therapy	Rehabilitation

Prevention And Early Detection
- Behavior Modification
- Screening
- Self-examination

Diagnosis
- History
  - Past
  - Present Condition
  - Family
- Physical Exam
  - Clinical Lab
  - Pathology
  - Imaging
  - Electrodiagnostics, etc.

Therapy
- Medical
- Surgical
- Physical
- Psychiatric
- Nursing

Rehabilitation
- Physical Therapy
- Occupational Therapy
- Social Support
- Behavioral Modification

Basic Medical Informatics Theory

Data

- History
- Physical Signs
- Ancillary Procedures
  - Laboratory
  - Imaging
  - Electrodiagnostics

Knowledge

Information

- Diagnosis
- Therapy
- Rehabilitation

Clinical Application
For
Decision Making

Intelligence Tools
Facilitate Process
"PORTALS"

The Process of Medical Care

◆ **The physician depends on**

- History taking

- Physical examination

- Knowledge of disease processes

- Consideration of experience

◆ **Ancillary information is critical in**

- Confirming or ruling out or suggesting diagnoses

- Optimizing the choice and application of therapy

  - Integration of ancillary data into the clinical workflow constitutes the basis for cost-effective use of clinical data and information

◆ **The burden**

- Educate the physician in the appropriate use of constantly changing technologies and methodologies in an environment of privacy and confidentiality - i.e., the best practices solution to achieve the optimal outcome.

Diagnostic Process

◆ **The capstone of the disease management process**

◆ **Failure to make correct diagnosis mars the entire subsequent management process**

Process

◆ **Process similar to finding cause of crime**

◆ **Requires identification of many data points and connecting the dots**

◆ **Increasing array of tools for identifying data**

   ◆ Tests expand from 1,500 to 5,000

   ◆ New Imaging Techniques

◆ **Increasing problem to connect the dots**

◆ **Process:**

   ◆ Create list of potential diagnoses "Differential Diagnosis"

   ◆ Select most likely culprit

   ◆ Confirm "Definitive Diagnosis"

Emphasis on Medical Errors Omits Mention of the Cardinal Error
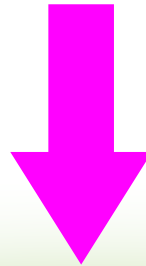
False Diagnosis of Disease

The Molecular Diagnostic Challenge

◆ Routine genomic and proteomic testing will overwhelm clinicians; need IT tools and laboratory consultation to manage patients

◆ Current information systems cannot manage deluge of data that will be presented to them for both volume and complexity perspectives

◆ Consumer sensitivity to consequences of genetic testing; may balk at results integration into hospital databases

◆ Testing may not lend itself to one-shot reporting; reporting lab may need to create lifelong "alerts" relationship with patient

◆ Payors will balk at costs of testing and these lifelong reporting relationships; direct pay customers will demand more service

Critical Changes in Health Environment

Compound Diagnostic Difficulties

◆ **Increasing risk of disease in general**

- ◆ Environmental factors
- ◆ Behavioral factors - drugs, tobacco, excess food intake
- ◆ Sexually transmitted and infectious diseases

◆ **Aging population**

- ◆ Increasing incidence of chronic diseases

◆ **Large uninsured population**

- ◆ Delay in seeking medical advice
- ◆ Erroneous self-medication
- ◆ Avoiding preventative care - Immunization, PAP Smears, dietary deficiency

◆ **World-wide travel immunization**

- ◆ Pandemics - SARS, AIDS, Influenza
- ◆ Emergence of new disease - Ebola, Avian Tuberculosis, Spongiform Encephalopathy (Mad Cow Disease), Avian Flu

**All Contribute to Increasing Complexity
of Diagnostic Process (Data Acquisition and Analysis)**

Clinicians Face Increasing Time Pressure

◆ **Increasingly complex clinical environment**

◆ **More and faster communications channels**

◆ **Care process interruptions by external overseers**

◆ **Intrusive para-clinical documentation demands**

◆ **Demands for higher clinical productivity**

Physician Challenge and Response to Web-Based Innovation

◆ Seeing more patients per hour without allowing quality to suffer and while maintaining their respect and confidence

◆ Laboring under increasing regulatory and payor documentation burden; distracting from time spent with patients

◆ Malpractice and insurance crisis, driving MDs increasingly out of private practice and increasing their estrangement from the system

◆ Increasing capital and training costs to enhance the IT capabilities of office practice

◆ Patients surfing the web and increasingly IT savvy; higher expectations about office information-access capabilities

◆ Physicians often cyberphobic

Basic Assumptions

Generally, physicians do not know:

❶ **What tests to order**

❷ **How to appropriately sequence testing**

❸ **How to interpret large sets of data points**

❹ **How to aggregate data from other sources with lab data (e.g., imaging, electrodiagnostics, etc.) to form integrated information**

Best Practices (in Relation to Ancillary Informatics)

> **Assist physicians to identify necessary tests and procedures to eliminate redundant testing which defies medical logic**

> **Develop regional clinical data repositories to achieve continuity of care–data compatibility and cradle to grave data coordination through data mining technology**

> **Re-educate physicians to order only:**

◆ **Tests which are medically necessary**

◆ **Tests which meet federal necessity guidelines**

◆ **Tests which are less costly (do not order esoteric tests if routine test will provide answer)**

Health Care Professionals

◆ **Generally above average IQ**
◆ **Dedication to TLC**

Therefore

Rather Than

Artificial Intelligence	Information Augmentation
AI	**IA**

CAI | **Computer Assisted Instruction**
In Primary Care Setting
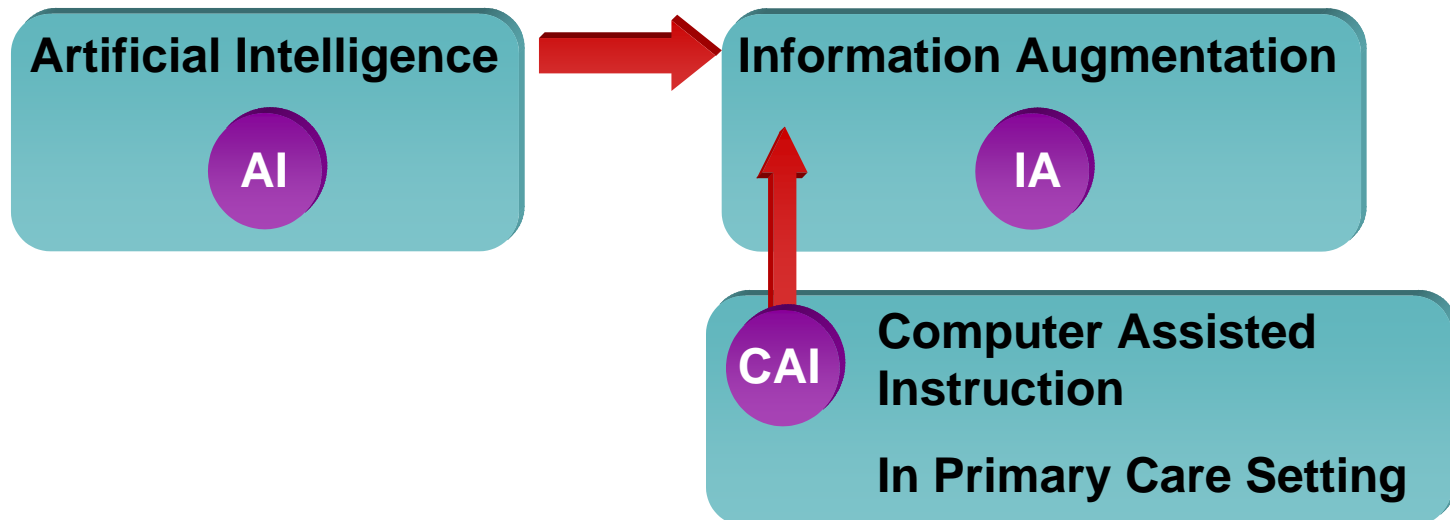
Create a Virtual Team Environment in the Primary Care Setting

Customary Diagnostic Process

◆ **Primary Care Physician**

 ◆ Establishes probable diagnosis

◆ **Refers to Specialist**

 ◆ Identifies of most likely diagnosis

◆ **Refers to Hospital**

 ◆ Arrives at definite diagnosis

Each Referral Augments Cost of Care

Algorithms (Decision Trees)

◆ **Assist in ensuring the correct selection of diagnostic procedures and their sequencing**

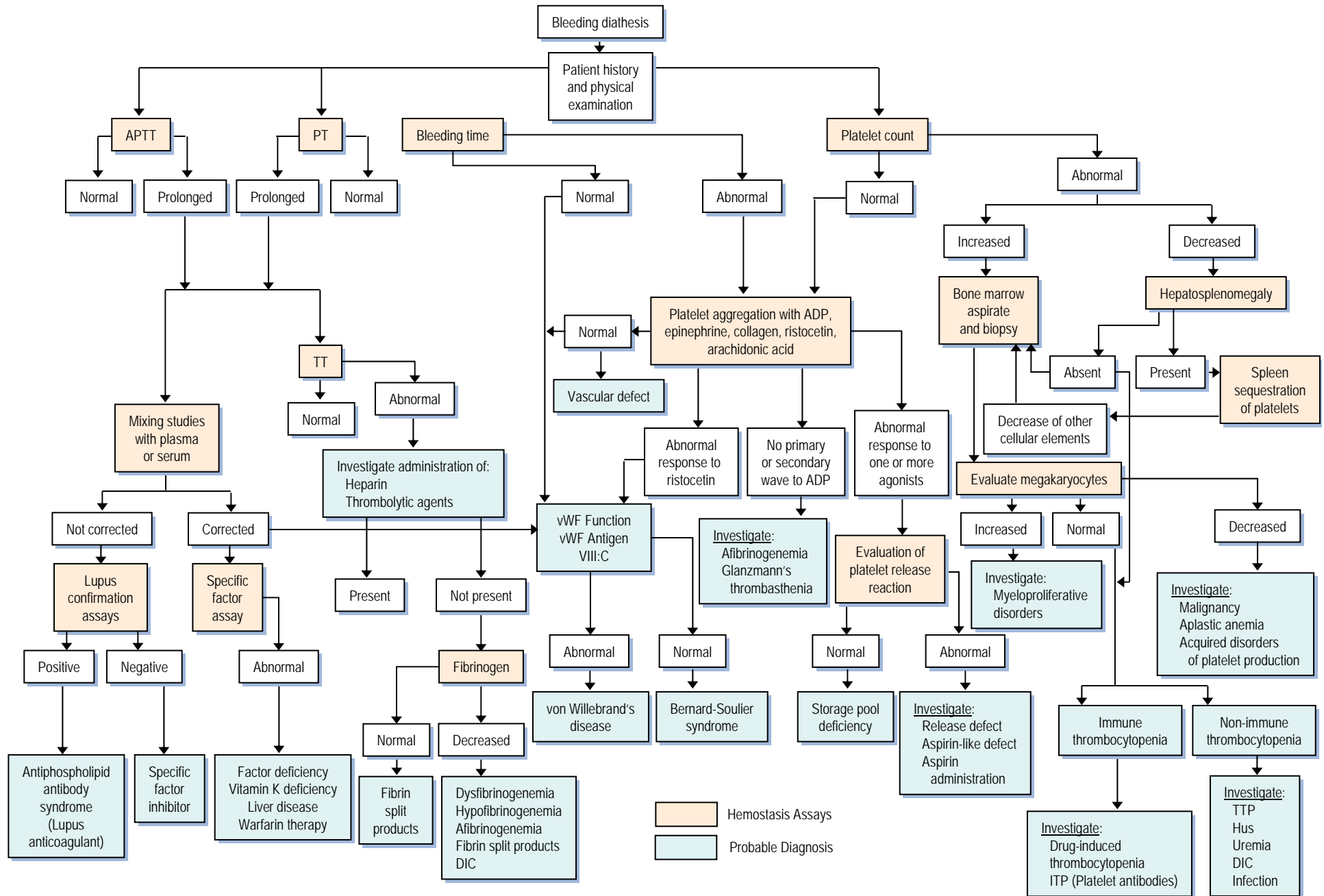◆ **Providing the diagnostician a guide to best practices to ensure:**

   ◆ Fastest solution to conversion of data to information (= diagnosis)

   ◆ Ipso facto - least costly solutions to diagnostic enigmas

Algorithms for Differential Diagnoses of Coagulopathies

Bleeding diathesis

Patient history and physical examination

APTT — Normal | Prolonged
PT — Prolonged | Normal
Bleeding time — Normal | Abnormal
Platelet count — Normal | Abnormal

Prolonged (APTT/PT) → Mixing studies with plasma or serum
- Not corrected → Lupus confirmation assays → Positive → Antiphospholipid antibody syndrome (Lupus anticoagulant) / Negative → Specific factor inhibitor
- Corrected → Specific factor assay → Abnormal → Factor deficiency, Vitamin K deficiency, Liver disease, Warfarin therapy

TT — Normal | Abnormal → Investigate administration of: Heparin, Thrombolytic agents
- Present
- Not present → **Fibrinogen** — Normal → Fibrin split products / Decreased → Dysfibrinogenemia, Hypofibrinogenemia, Afibrinogenemia, Fibrin split products, DIC

Bleeding time Normal / Abnormal

Platelet aggregation with ADP, epinephrine, collagen, ristocetin, arachidonic acid
- Normal → Vascular defect
- Abnormal response to ristocetin → vWF Function, vWF Antigen, VIII:C → Abnormal → von Willebrand's disease / Normal → Bernard-Soulier syndrome
- No primary or secondary wave to ADP → Investigate: Afibrinogenemia, Glanzmann's thrombasthenia
- Abnormal response to one or more agonists → Evaluation of platelet release reaction → Normal → Storage pool deficiency / Abnormal → Investigate: Release defect, Aspirin-like defect, Aspirin administration

Platelet count Abnormal → Increased | Decreased

Increased → **Bone marrow aspirate and biopsy**
Decreased → **Hepatosplenomegaly** — Absent | Present → Spleen sequestration of platelets

Decrease of other cellular elements

Evaluate megakaryocytes
- Increased → Investigate: Myeloproliferative disorders
- Normal
- Decreased → Investigate: Malignancy, Aplastic anemia, Acquired disorders of platelet production

Immune thrombocytopenia → Investigate: Drug-induced thrombocytopenia, ITP (Platelet antibodies)

Non-immune thrombocytopenia → Investigate: TTP, Hus, Uremia, DIC, Infection

Legend:
- Hemostasis Assays
- Probable Diagnosis

Diagnostic approach to bleeding diathesis. Abbreviations: APPT, activated partial thromboplastin time; PT, prothrombin time; TT, thrombin time; ADP, adenosine diphosphate; vWF, von Willebrand's factor; DIC, disseminated intravascular coagulation; ITP, immune thrombocytopenia; TTP, thrombotic thrombocytopenic purpura.

The Effects of Media Hype

◆ **Patients want genetic assessment and medical care based on it - "Personalized Medicine"**

◆ **Patients browse internet:**

    ◆ "I want to have a "Breast Cancer Test"

    ◆ "I want Drug X because it is optimal for my type of person or disease"

Jumping the Gun

◆ **Pharmacogenomics is in its infancy**

◆ **Tools being developed**

◆ **Requires computational models and applications to perform gene analyses**

◆ **Require sharing of data on results of clinical trials of drugs worldwide**

◆ **Disparate databases make info sharing difficult**

◆ **Most medical data are still on paper**

◆ **Data mining increasingly complex and data sharing confounded by HIPAA rules**

Future Plans

◆ **Providing primary care physicians with a virtual hospital environment for Diagnostic (Dx) and Therapeutic (Rx) decision-making.**

◆ **Priorities**

Expand Dx Portal

- ◆ From order entry and report distribution processes

- ◆ To include imaging and electrodiagnostics

- ◆ To Provide linkage to patients

  - ❖ For remote pre-registration

  - ❖ For participation in the diagnostic process and education

- ◆ To provide online consultative services for test selection and sequencing for all ancillary services

Future Plans

Develop Rx Portal

- Diagnostic data on Rx activity

    - Microbiology–antibiotics

    - Pharmacogenomics–therapeutics

    - Clinical trials information

- Maintaining Optimal Disease Management Records

Recommended Actions

A. Medical practitioners who want to deliver high-quality care must obtain an **Electronic Health Record** (EHR) with a **decision support tool** (DST) which is instantly accessible.

The EHR/DST system will enable MDs to:

- ◆ Comply better with clinical practice guidelines,
- ◆ Receive help with interpretation of difficult laboratory and imaging results, and
- ◆ Obtain electronic clinical reminders.

B. **Improve Doctor/Patient Interactions**

- ◆ Use secure email to communicate with patients:
    - ❖ Share certain test reports
    - ❖ Monitor chronic conditions, e.g., asthma, diabetes
    - ❖ Book or cancel appointments
    - ❖ Arrange non-urgent consultations
    - ❖ Request prescription refills

    (Major concerns: confidentiality and potential errors.)
- ◆ Use group office visits for patients with chronic diseases
- ◆ Expand enhanced, supervised self-care by patients
- ◆ Submit selected test reports