MEDICAL UNIVERSITY OF VIENNA

medexter
clinical decision support

Arden-Syntax-Server – Serviceorientierte Architektur für die klinische Entscheidungsunterstützung

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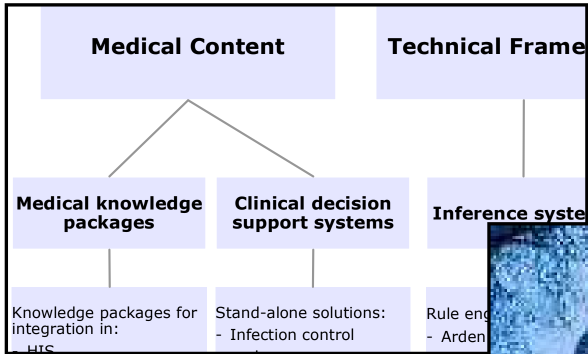
A-1090 Wien



GMDS-Arbeitsgruppe „Wissensbasierte Systeme in der Medizin“, conhIT-Satellitenveranstaltung, 23. April 2012, Berlin

Clinical decision support systems

patients' structured medical data

diagnostic support	therapy advice
• clinical alerts, reminders, calculations • data interpretation, (tele)monitoring • differential diagnostic consultation – rare diseases, rare syndromes – further or redundant investigations – pathological signs accounted for • consensus-criteria-based evaluation – definitions – classification criteria	• drug alerts, reminders, calculations – indication, contraindications, redundant medications, substitutions – adverse drug events, interactions, dosage calculations, consequent orders • management of antimicrobial therapies • (open-loop) control systems
prognostic prediction	**patient management guidelines**
• illness severity scores, prediction rules • trend detection and visualization	• guideline-based reminders • computerized clinical guidelines, protocols, SOPs • high-level patient and hospital analytics

Arden Syntax and Health Level Seven (HL7)

- A standard language for writing situation-action rules that can trigger alerts based on abnormal clinical events detected by a clinical information system.

  van Bemmel, J.H., Musen, M.A. (eds.) (1997)
  Handbook of Medical Informatics, Springer-Verlag, Heidelberg, Glossary, p. 559.

- Each module, referred to as a Medical Logic Module (MLM), contains sufficient knowledge to make a single decision.

  extended by packages of MLMs for complex clinical decision support

- Contraindication alerts, management suggestions, data interpretations, treatment protocols, and diagnosis scores are examples of the health knowledge that can be represented using MLMs.

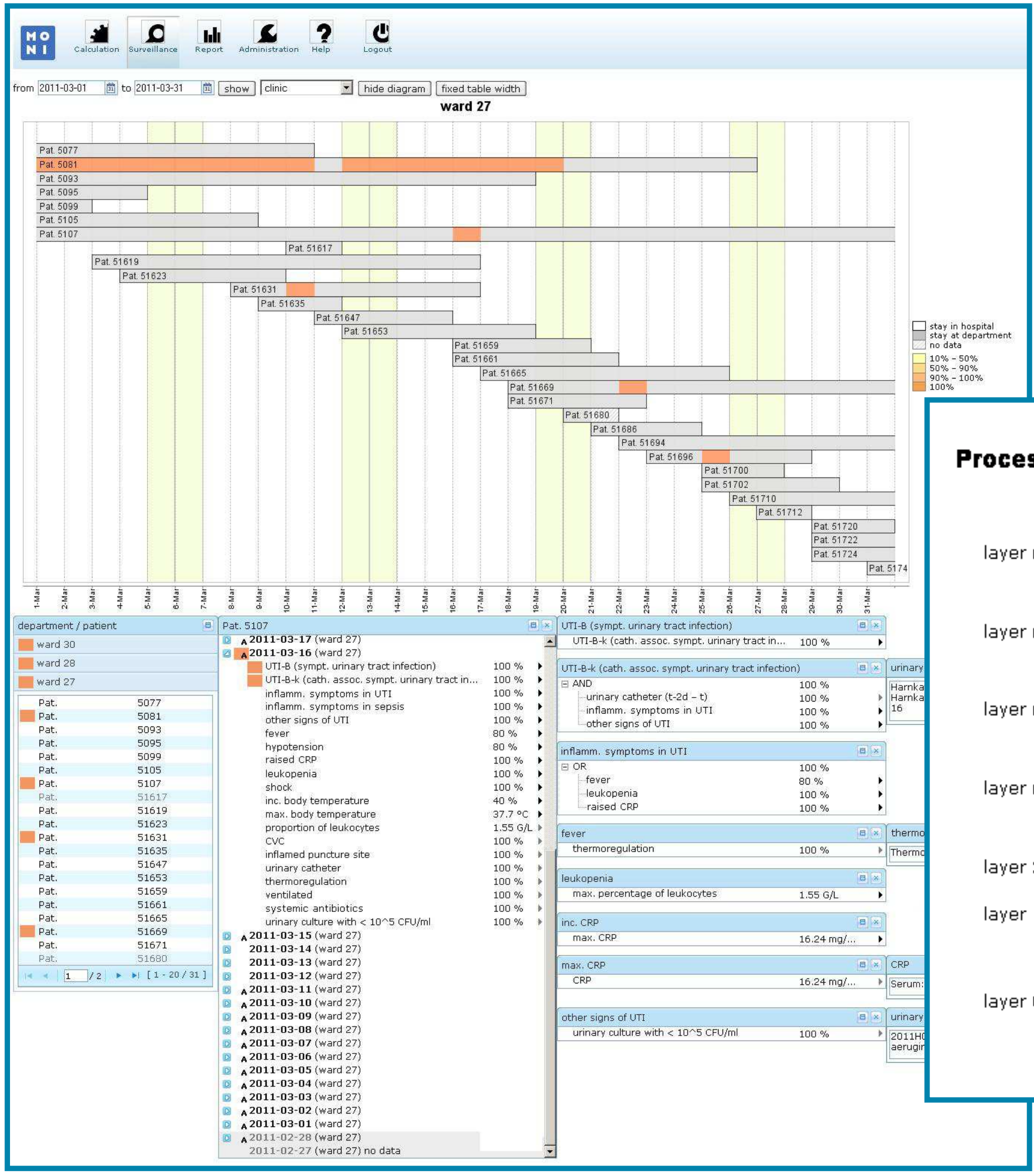
  extended by single and differential diagnostic support, temporal monitoring, control systems, computerized processing of clinical pathways and management guidelines

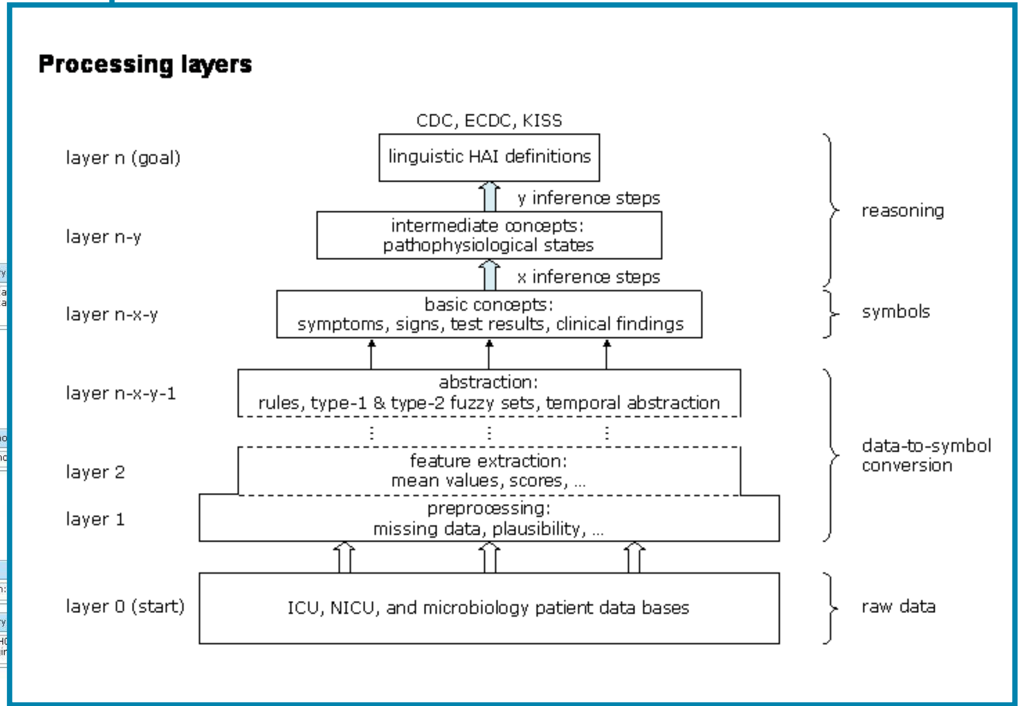
- The first draft of the Arden Syntax was prepared at the Arden Homestead, New York, in 1989.

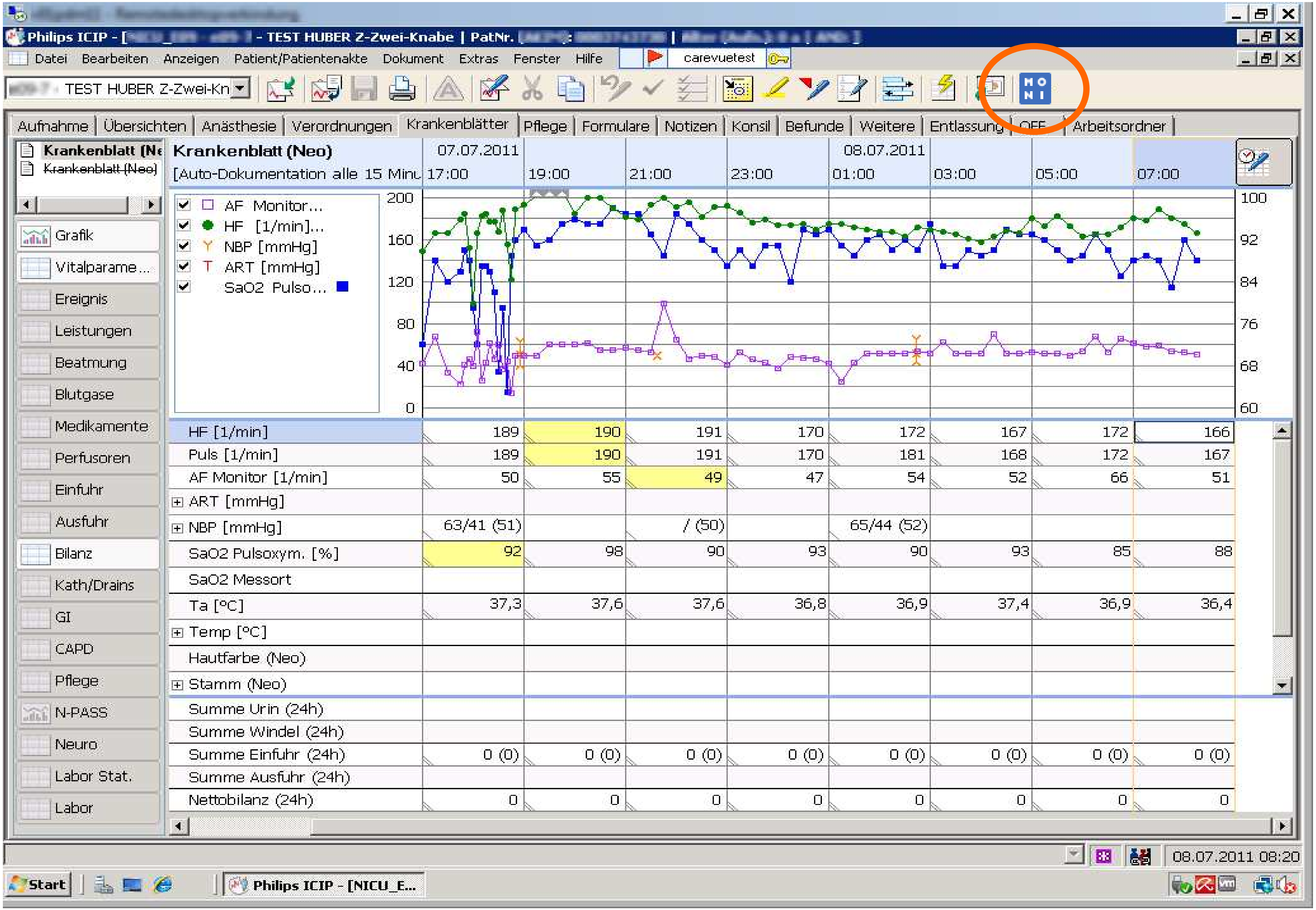
- The Health Level Seven Arden Syntax for Medical Logic Systems, Version 2.8, was approved by the American National Standards Institute (ANSI) and by Health Level Seven International (HL7) on 13 March 2012.

Arden-Syntax-based, service-oriented clinical decision support

Monitoring of healthcare-associated infections



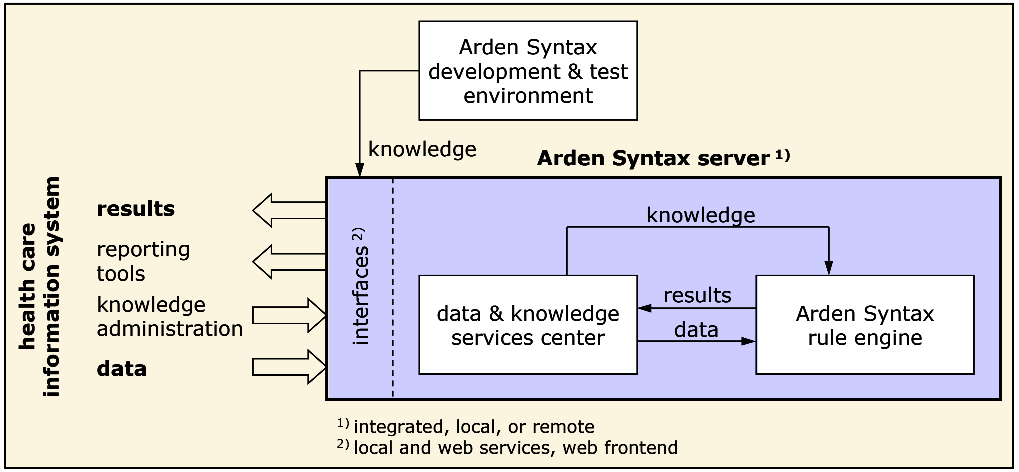




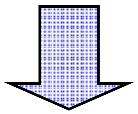
Philips ICIP - [redacted] - TEST HUBER Z-Zwei-Knabe | PatNr. [redacted]
Datei Bearbeiten Anzeigen Patient/Patientenakte Dokument Extras Fenster Hilfe
carevuetest
TEST HUBER Z-Zwei-Kn
MONI
Aufnahme Übersichten Anästhesie Verordnungen Krankenblätter Pflege Formulare Notizen Konsil Befunde Weitere Entlassung OFF Arbeitsordner
Krankenblatt (Ne
Krankenblatt (Neo)
Grafik
Vitalparame...
Ereignis
Leistungen
Beatmung
Blutgase
Medikamente
Perfusoren
Einfuhr
Ausfuhr
Bilanz
Kath/Drains
GI
CAPD
Pflege
N-PASS
Neuro
Labor Stat.
Labor
Krankenblatt (Neo)
[Auto-Dokumentation alle 15 Minu
07.07.2011
08.07.2011
17:00 19:00 21:00 23:00 01:00 03:00 05:00 07:00
AF Monitor...
HF [1/min]...
NBP [mmHg]
ART [mmHg]
SaO2 Pulso...
200 160 120 80 40 0
100 92 84 76 68 60
HF [1/min] 189 190 191 170 172 167 172 166
Puls [1/min] 189 190 191 170 181 168 172 167
AF Monitor [1/min] 50 55 49 47 54 52 66 51
ART [mmHg]
NBP [mmHg] 63/41 (51) / (50) 65/44 (52)
SaO2 Pulsoxym. [%] 92 98 90 93 90 93 85 88
SaO2 Messort
Ta [°C] 37,3 37,6 37,6 36,8 36,9 37,4 36,9 36,4
Temp [°C]
Hautfarbe (Neo)
Stamm (Neo)
Summe Urin (24h)
Summe Windel (24h)
Summe Einfuhr (24h) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0)
Summe Ausfuhr (24h)
Nettobilanz (24h) 0 0 0 0 0 0 0 0
08.07.2011 08:20
Start
Philips ICIP - [NICU_E...

Arden Syntax server and software components

- Arden Syntax integrated development and test environment (IDE) including
  - Medical logic module (MLM) editor and authoring tool
  - Arden Syntax compiler (syntax versions 2.1, 2.5, 2.6, 2.7, and 2.8)
  - Arden Syntax engine
  - MLM test environment
  - MLM export component
- command-line Arden Syntax compiler



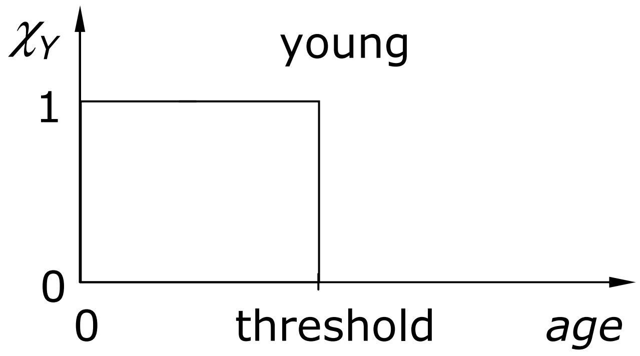
- web-services-based Arden Syntax server including
  - Arden Syntax engine
  - MLM manager
  - XML-protocol-based interfaces, e.g., SOAP, REST, and HL7
  - a project-specific data and knowledge services center may be hosted
- Java libraries
  - Arden Syntax compiler
  - Arden Syntax engine



Fuzzy Arden Syntax

- extension to fuzzy sets, operators, statements, and parallel execution

Crisp sets vs. fuzzy sets



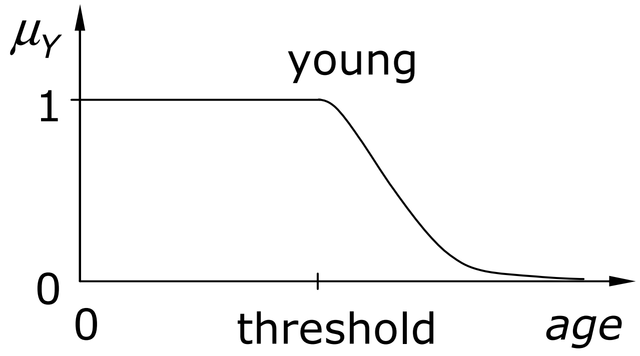
yes/no decision

$U = [0, 120]$

$Y \subseteq U$ with $Y = \{(\chi_Y(x)/\ x) \mid x \in U\}$

$\chi_Y\colon U \rightarrow \{0, 1\}$

$$\chi_Y(x) = \begin{cases} 0 & x > \text{threshold} \\ 1 & x \leq \text{threshold} \end{cases} \qquad \forall\ x \in U$$



gradual transition

$U = [0, 120]$

$Y \subseteq U$ with $Y = \{(\mu_Y(x)/\ x) \mid x \in U\}$

$\mu_Y\colon U \rightarrow [0, 1]$

$$\mu_Y(x) = \begin{cases} \dfrac{1}{1 + (0.04\ x)^2} & x > \text{threshold} \\ 1 & x \leq \text{threshold} \end{cases} \qquad \forall\ x \in U$$

MEDIZINISCHE UNIVERSITÄT WIEN

Regel zur Interpretation von klinisch relevanten Befunden (Regelprämissen bilden Äquivalenzklassen)

REGEL 103:

WENN eine der folgenden 100 Kombinationen zutrifft

HBsAg	anti-HBs	anti-HBc	IgM-anti-HBc	HBeAg	anti-HBe
+ •	+	− ±	− ± •	+	− ± •
+ •	+	+ •	+ − ± •	+	+ − ± •

DANN

Das gleichzeitige Auftreten von HBe-Antigen und Anti-HBs-Antikörpern ist im natürlichen Verlauf einer Hepatitis-B-Virusinfektion ein seltenes Ereignis. Diese Befundkonstellation ist entweder auf (a) zirkulierende HBsAg-anti-HBs-Immunkomplexe, (b) auf eine Koinzidenz einer Hepatitis-B-Virusinfektion mit einer Hepatitis-B-Impfung oder Injektion von HB-Hyperimmunglobulin oder (c) eine Reinfektion mit einem Hepatitis-B-Virus mit unterschiedlichem HBsAg-Subtypus zurückzuführen. Blut und Sekrete (Speichel, Sperma, Muttermilch) solcher Patienten sind als infektiös anzusehen.

teleiatros®

Hepaxpert/Interpretation
Knowledge-based interpretation of hepatitis A, B, and C serology

Interpretation

Benutzer: mxt Logout

Hepatitis-A-Serologie

Anti-HAV	IgM-anti-HAV	HAV-RNA
positiv	nicht untersucht	nicht untersucht

Antikörper gegen das Hepatitis-A-Virus finden sich in drei unterschiedlichen Situationen: (a) bei rezenter Hepatitis-A-Virusinfektion (akute ikterische oder anikterische Hepatitis, stille Feiung oder Rekonvaleszenzstadium einer Hepatitis), (b) bei Immunität nach früherer Hepatitis-A-Virusinfektion oder (c) nach aktiver Impfung oder passiver Immunisierung mit Gammaglobulin.

Hepatitis-B-Serologie

HBsAg	Anti-HBs	Anti-HBc	IgM-anti-HBc
positiv	positiv	positiv	positiv
HBeAg	**Anti-HBe**	**Anti-HBs Titer**	
positiv	positiv	- - - U/l	

Das gleichzeitige Auftreten von HBe-Antigen und Anti-HBs-Antikörpern ist im natürlichen Verlauf einer Hepatitis-B-Virusinfektion ein seltenes Ereignis. Diese Befundkonstellation ist entweder auf (a) zirkulierende HBsAg-Anti-HBs-Immunkomplexe, (b) auf eine Koinzidenz einer Hepatitis-B-Virusinfektion mit einer Hepatitis-B-Impfung oder Injektion von HB-Hyperimmunglobulin oder (c) eine Reinfektion mit einem Hepatitis-B-Virus mit unterschiedlichem HBsAg-Subtypus zurückzuführen. Blut und Sekrete (Speichel, Sperma, Muttermilch) solcher Patienten sind als infektiös anzusehen.

Hepatitis-C-Serologie

Anti-HCV	HCV-RNA
positiv	negativ

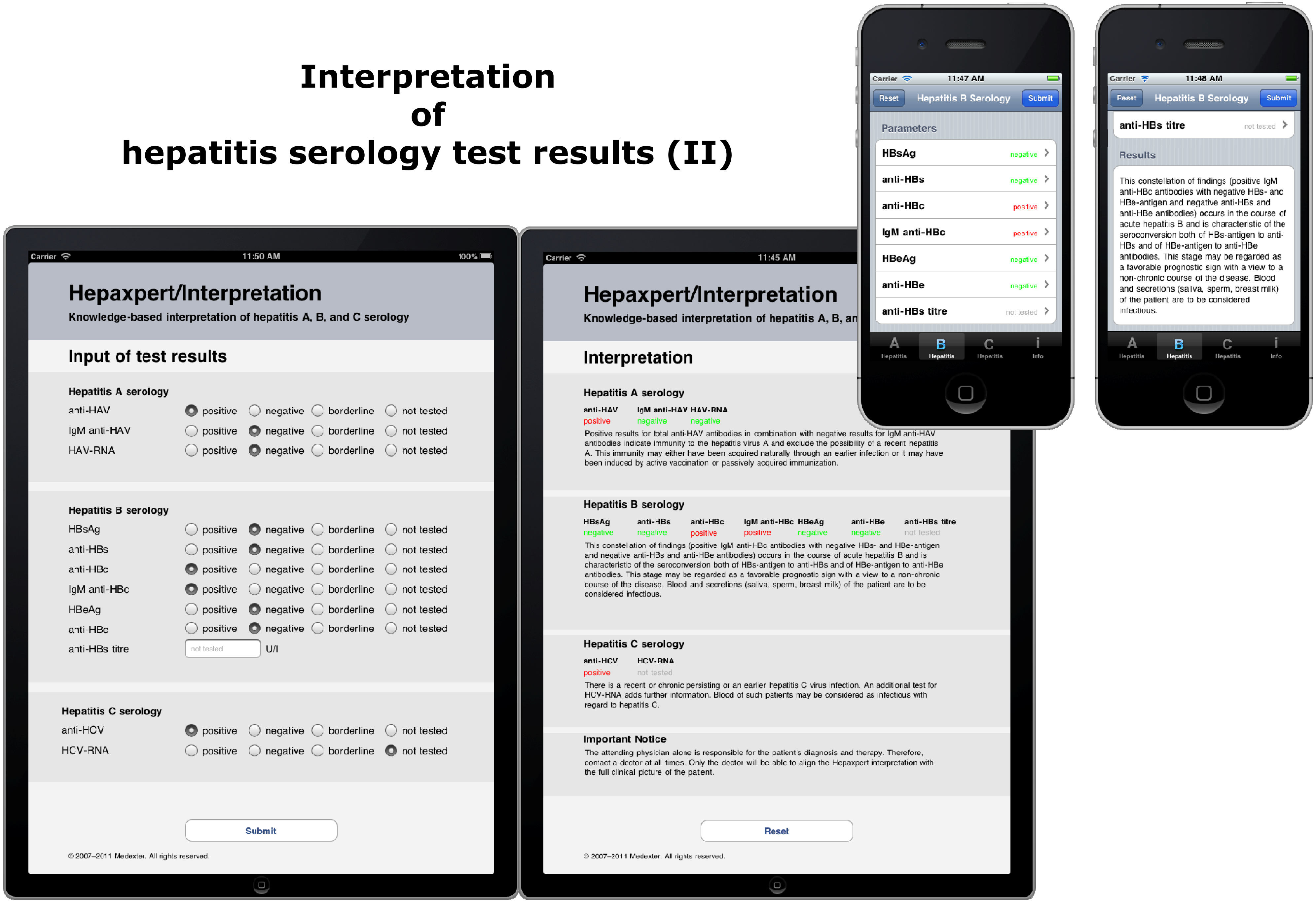
Der erhobene Befund spricht für eine früher abgelaufene HCV-Infektion oder für eine Remission einer bestehenden HCV-Infektion. Bei klinischem Verdacht auf Hepatitis C sind Verlaufskontrollen indiziert. Das Blut solcher Personen ist hinsichtlich Hepatitis C als infektiös anzusehen.

Wichtiger Hinweis

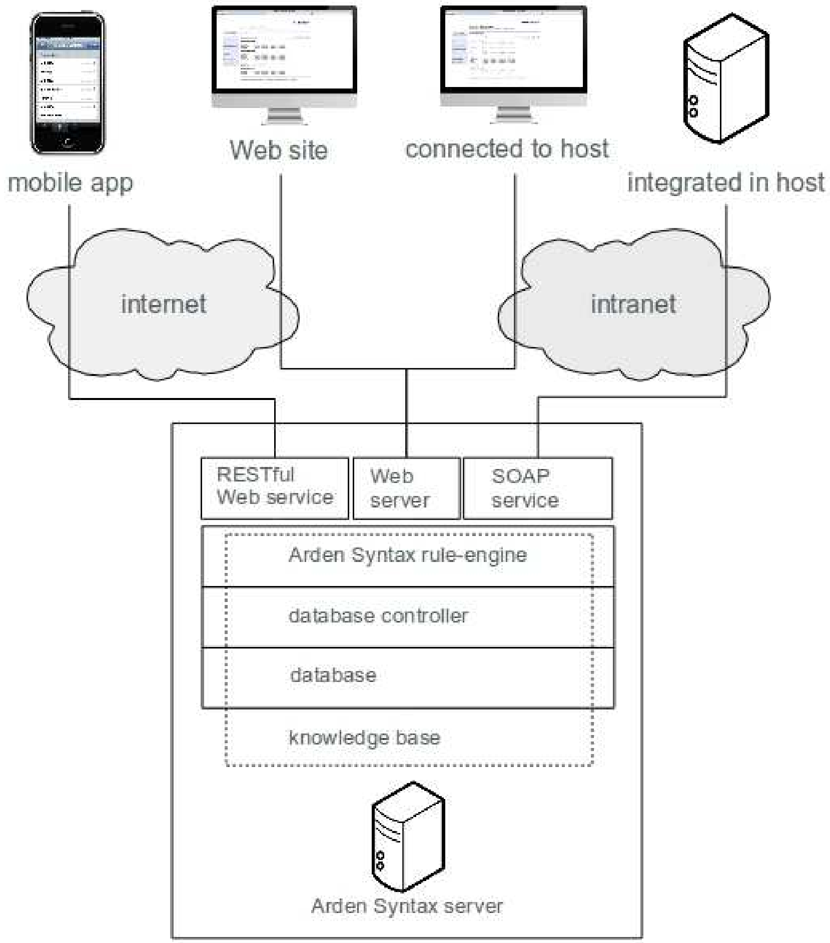
Die Verantwortung für Diagnose und Therapie eines Patienten trägt ausschließlich der behandelnde Arzt. Konsultieren Sie daher immer einen Arzt. Nur dieser kann die Hepaxpert-Interpretation in Einklang mit dem gesamten klinischen Bild des Patienten bringen.

Interpretation von Hepatitis-Serologie-Befunden (I)

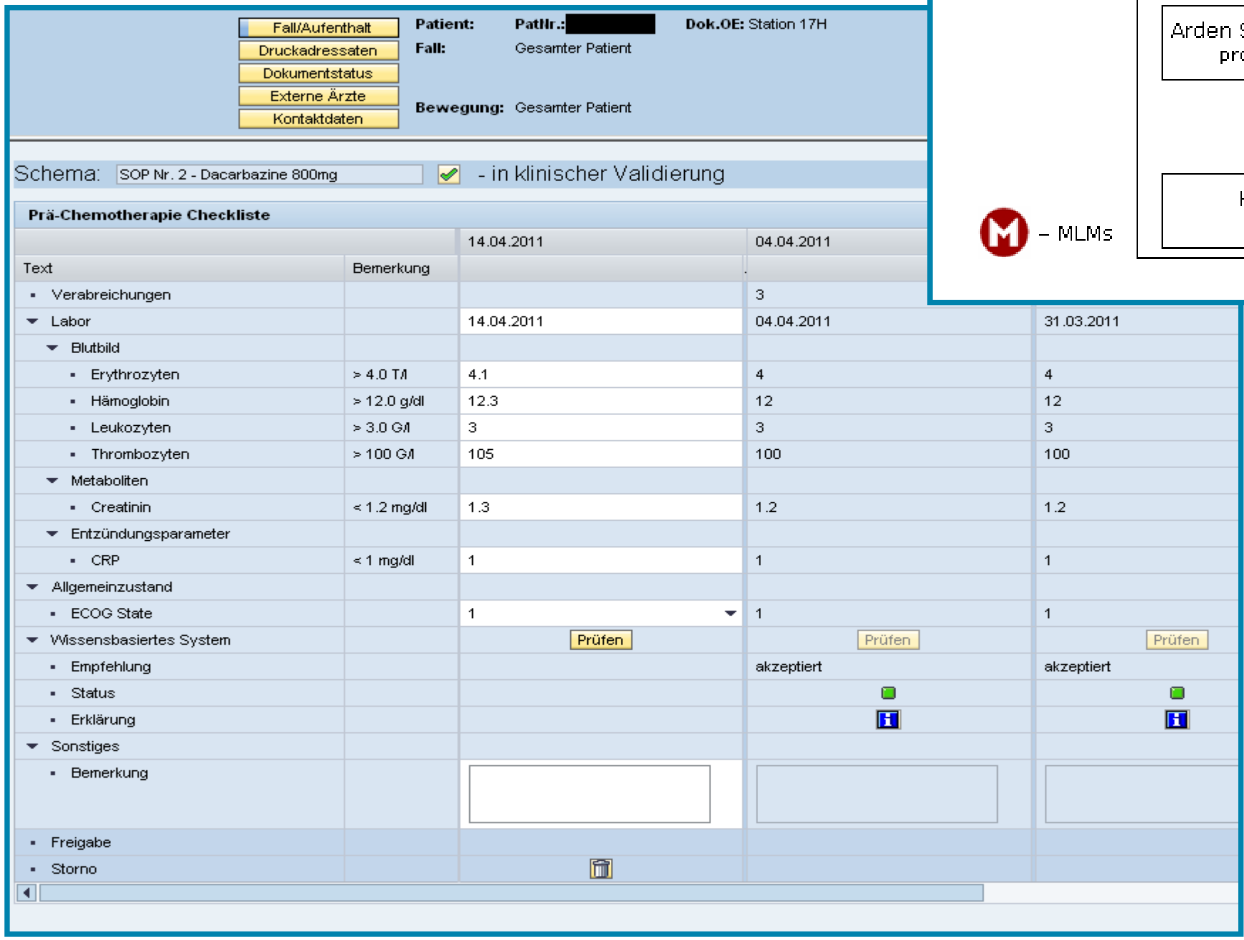
Interpretation
of
hepatitis serology test results (II)

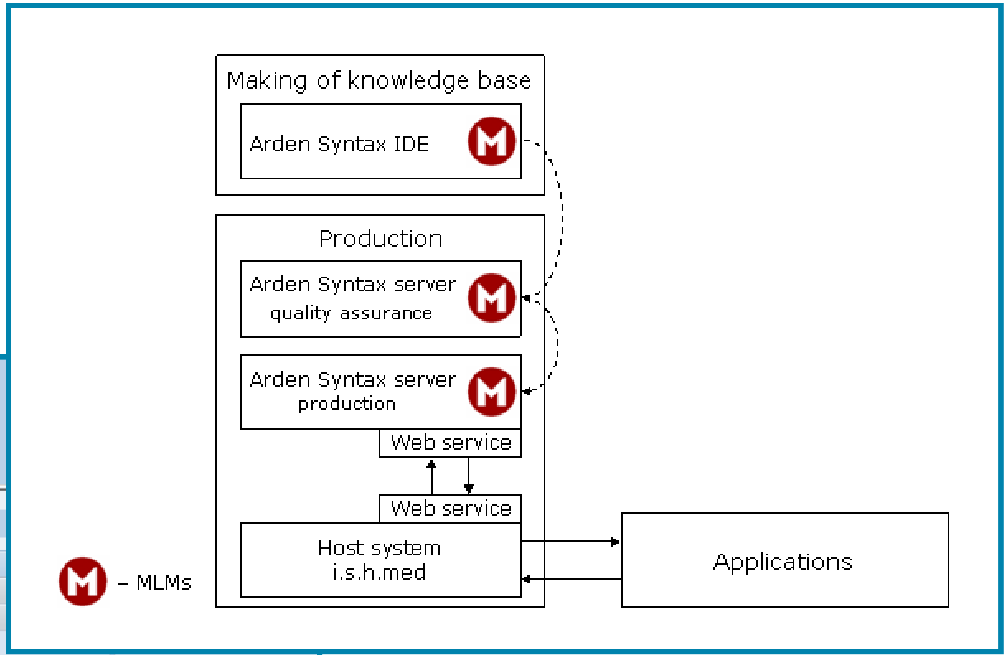


Interoperability

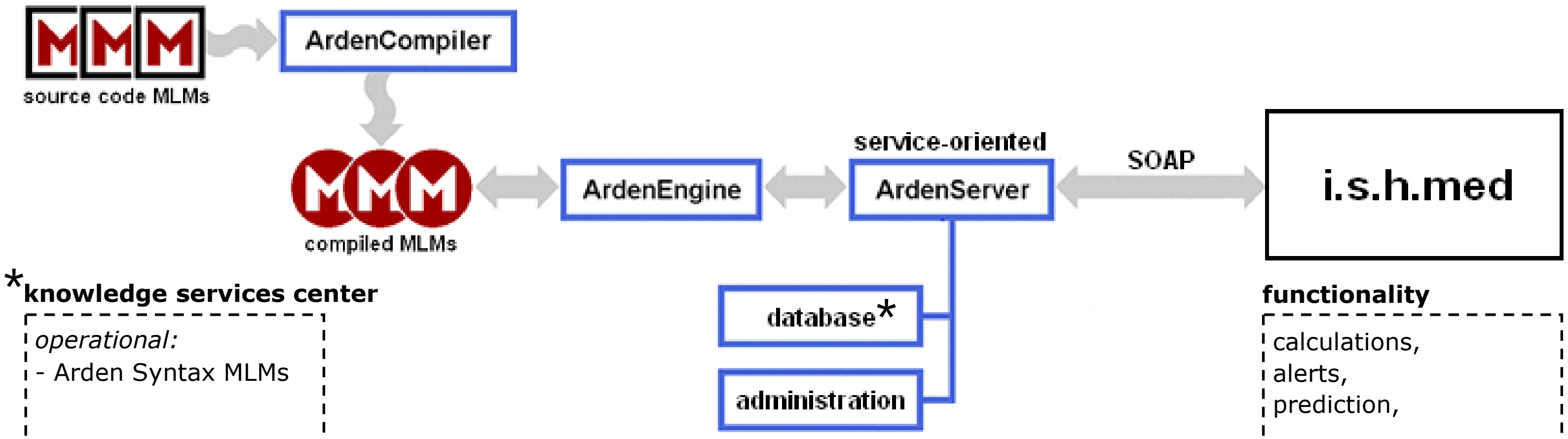


Integration into i.s.h.med





Production at the Vienna General Hospital



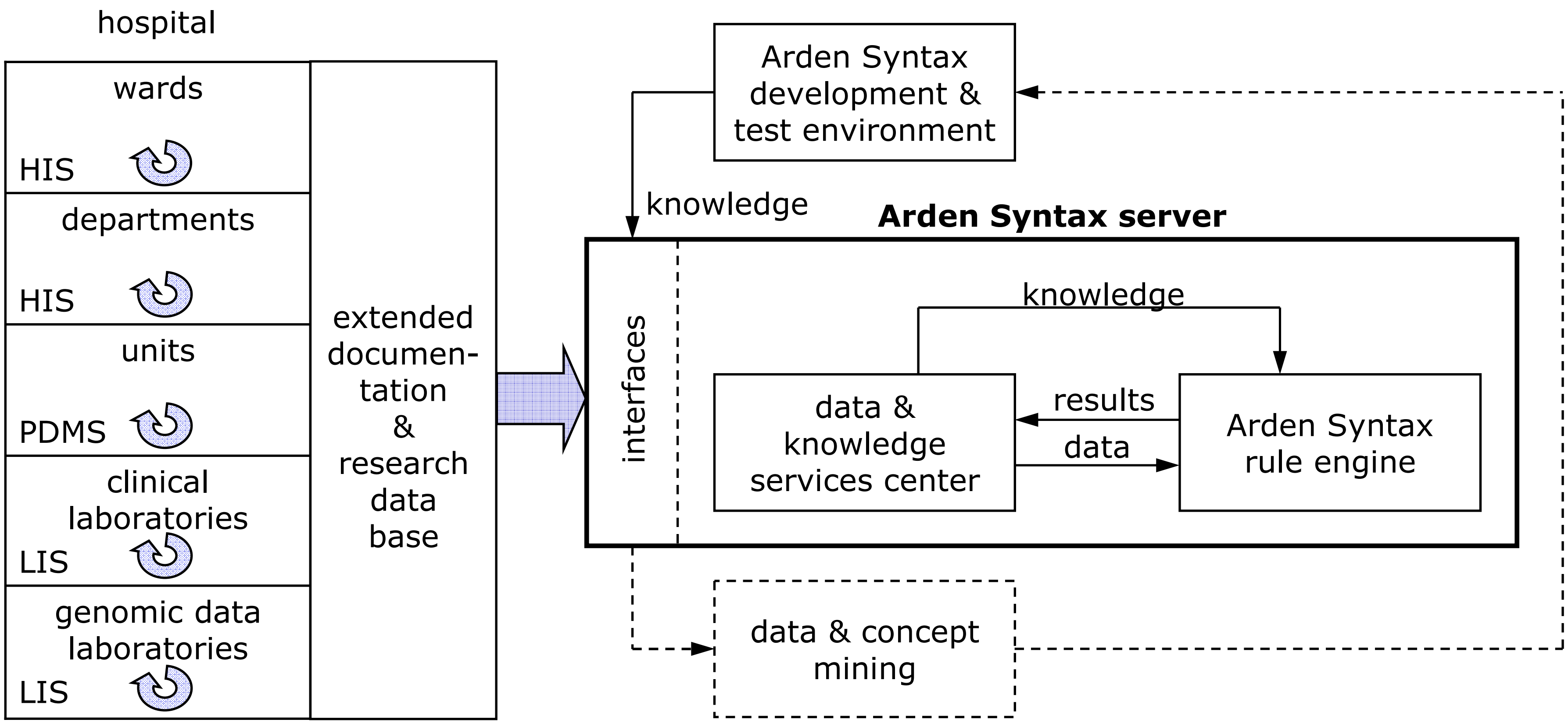
*knowledge services center

operational:
- Arden Syntax MLMs

functionality

calculations,
alerts,
prediction,
...

Development at the Medical University of Vienna

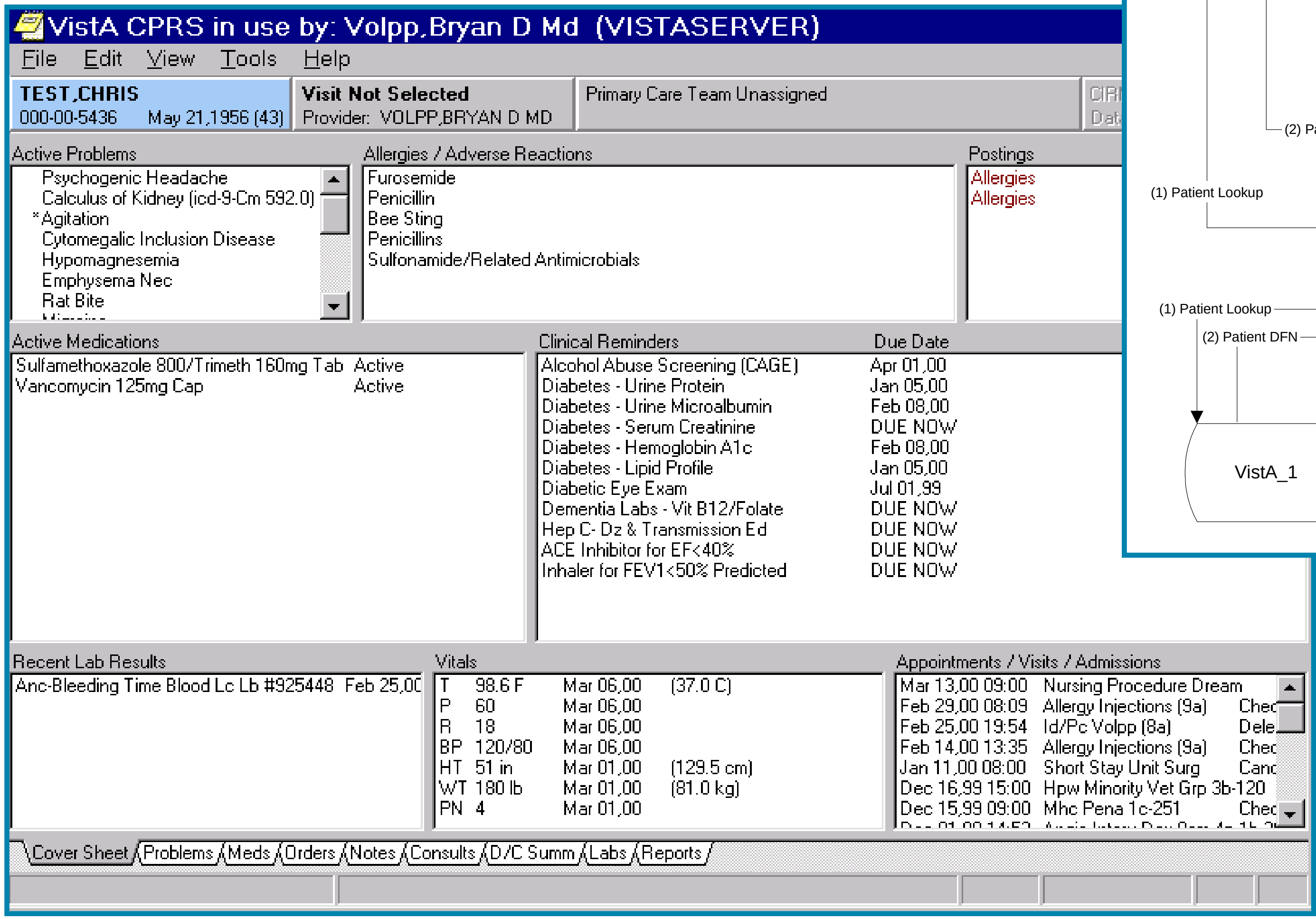


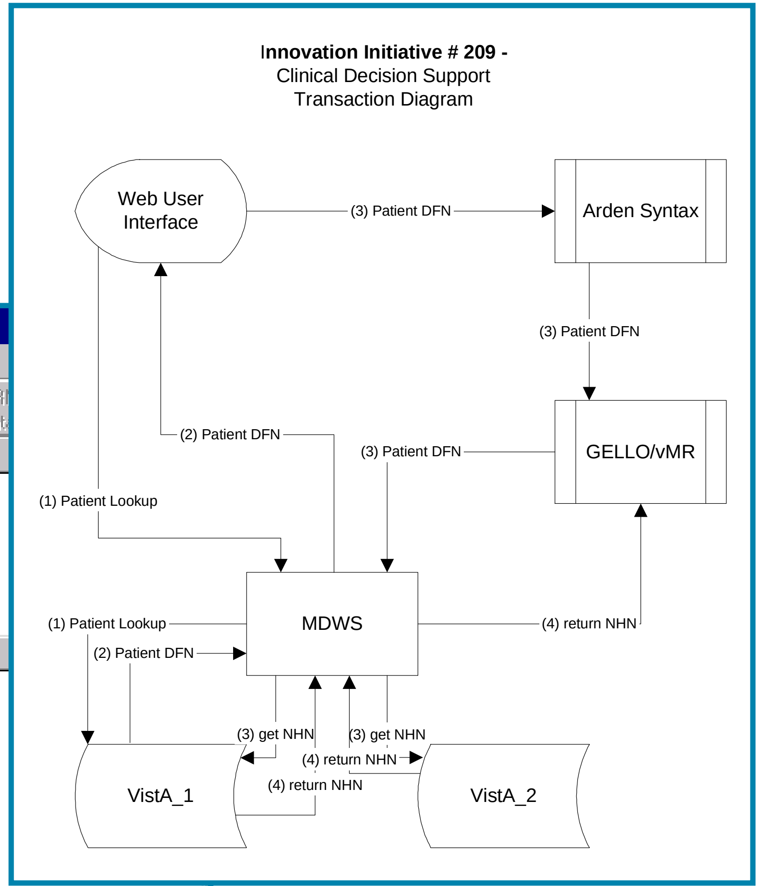
GELLO/vMR—Query and expression language / accessing a virtual medical record data model

GELLO/vMR and Health Level Seven (HL7)

- An object-oriented (OO) query and expression language for decision support
- Originally developed as a guideline expression language for query statements and decision rules
- Based on the existing object constraint language (OCL) and HL7's reference information model (RIM)
- The GELLO language can be used to
  - Build up queries to extract and manipulate data from medical records
  - Construct decision criteria by building up expressions to reason about particular data features/values
- Proposal to use a virtual medical record (vMR) that provides a standard interface to heterogeneous medical record systems
- Includes using of terminologies/ontologies such as SNOMED CT and LOINC
- 2005 adopted as international standard by HL7 and the American National Standards Institute (ANSI)

Innovation project
"Standards-based CDS"
of the
Veterans Health Administration, USA





Clinical decision support with Arden Syntax and GELLO/vMR

- CDS platforms
  - based on Arden Syntax and Fuzzy Arden Syntax
    - with data (sometimes) and knowledge services center and extended interoperability (web-services, XML data interfaces, libraries)
- integrated into or interconnected with
  - CareVue and ICIP PDMSs (by Philips)
    - monitoring and reporting of ICU-acquired infections (ICUs and NICUs)
  - ICM (by Dräger)
    - ICU decision support modules (Universitätsklinikum Erlangen)
  - i.s.h.med HIS (by Siemens AG)
    - dosing of immunosuppressive drugs for kidney transplant patients
    - prediction of metastases in melanoma patients
    - standard operating procedures for chemotherapy treatment of melanoma patients
  - medico//s HIS (by Siemens AG)
    - laboratory-based clinical reminders
  - Soarian HIS (by Siemens AG) and Orbis HIS (by Agfa)
    - hepatitis serology test interpretation
  - VistA HIS (by Department of Veterans Affairs)
    - service-oriented, standards-based CDS (clinical reminders and patient report cards)
  - Monitoring adverse drug events (FFG project with Salzburger Universitätsklinikum)
  - Teleiatros, iPhone, iPad
    - remote CDS, mHealth