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ehealth summit austria

HIMSS Europe

In Kooperation mit

HEALTH 2016 eHEALTH 2016 www.eHealth2016.at

24. – 25. MAI 2016

Schloß Schönbrunn, Wien
Apothekertrakt und Orangerie

PREDICTIVE MODELING IN HEALTHCARE –

FROM PREDICTION TO PREVENTION

www.ehealthsummit.at

Präsentiert von

HIMSS Europe

AIT AUSTRIAN INSTITUTE OF TECHNOLOGY TOMORROW TODAY

Österreichische Gesellschaft für Biomedizinische Technik Austrian Society for Biomedical Engineering

OESTERREICHISCHE COMPUTER GESELLSCHAFT AUSTRIAN COMPUTER SOCIETY

UMIT

medexter
clinical decision support

Big Data oder Wissen als Spezialanfertigung – Transparenz und Zuverlässigkeit

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Medical University of Vienna
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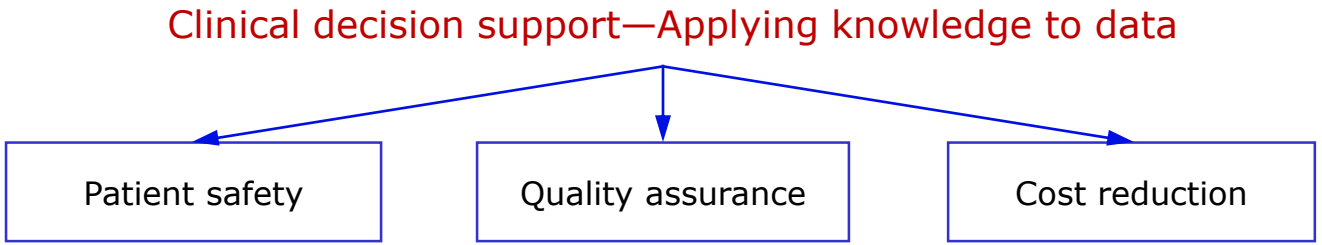
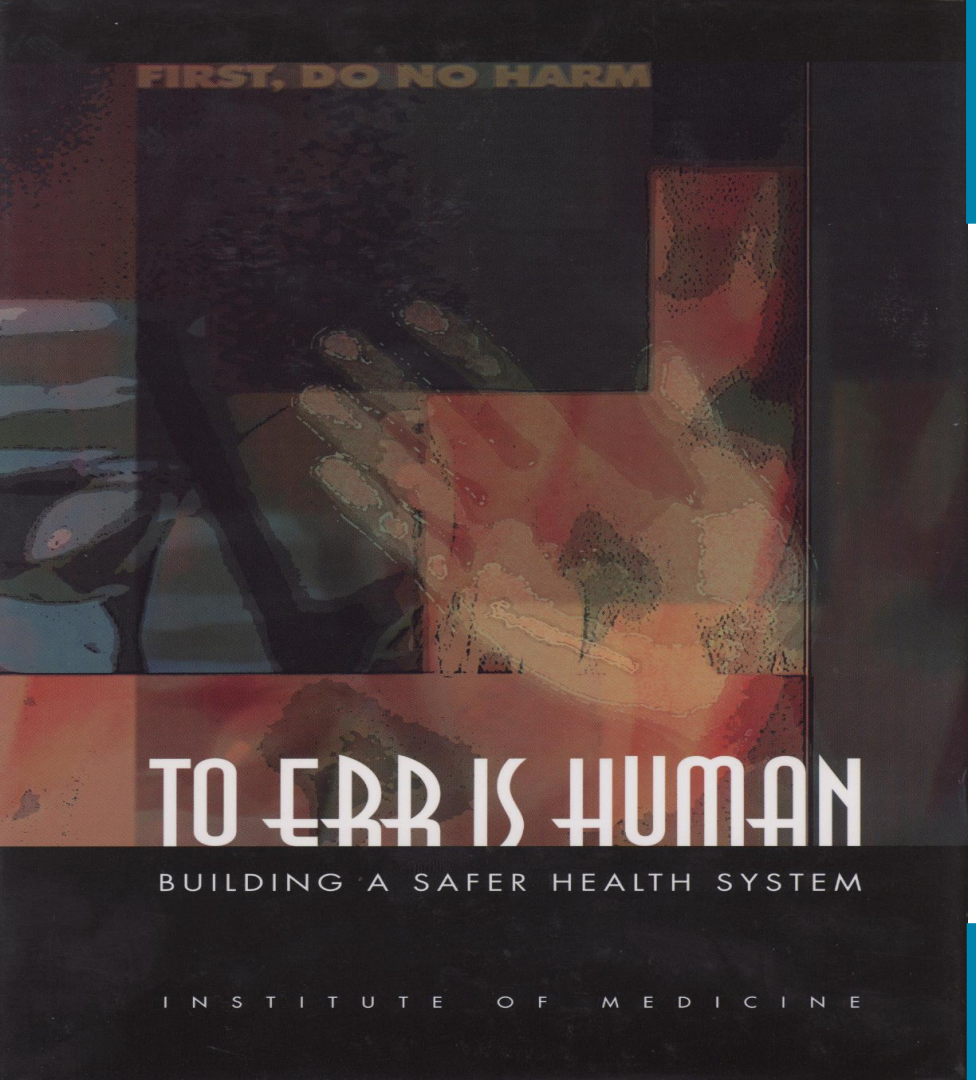
eHealth Summit Austria, Schönbrunn Palace, Vienna, 25 May 2016

Digitalization of clinical medicine

- Stage I: Digitizing patient medical data
  - EHRs, EMRs, Health Apps, …
- Stage II: Digitizing clinical workflows
  - In-patient, out-patient, home
- Stage III: Digitizing medical knowledge
  - Big data vs. knowledge design





- studies in Colorado and Utah and in New York (1997)
  - errors in the delivery of health care leading to the death of as many as 98,000 US citizens annually

- causes of errors
  - error or delay in diagnosis
  - failure to act on indicated tests
  - use of unindicated tests or therapy
  - failure to act on results of testing or monitoring
  - error in the performance of a test, procedure, or operation
  - error in administering the treatment
  - error in the dose or method of using a drug
  - avoidable delay in treatment or in responding to an abnormal test
  - inappropriate (unindicated) care
  - failure in communication
  - equipment failure

errors

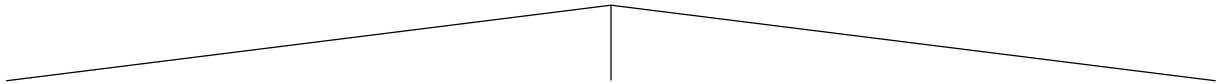
prevention

- prevention of errors
  - we must systematically design safety into processes of care

Big data vs. knowledge design

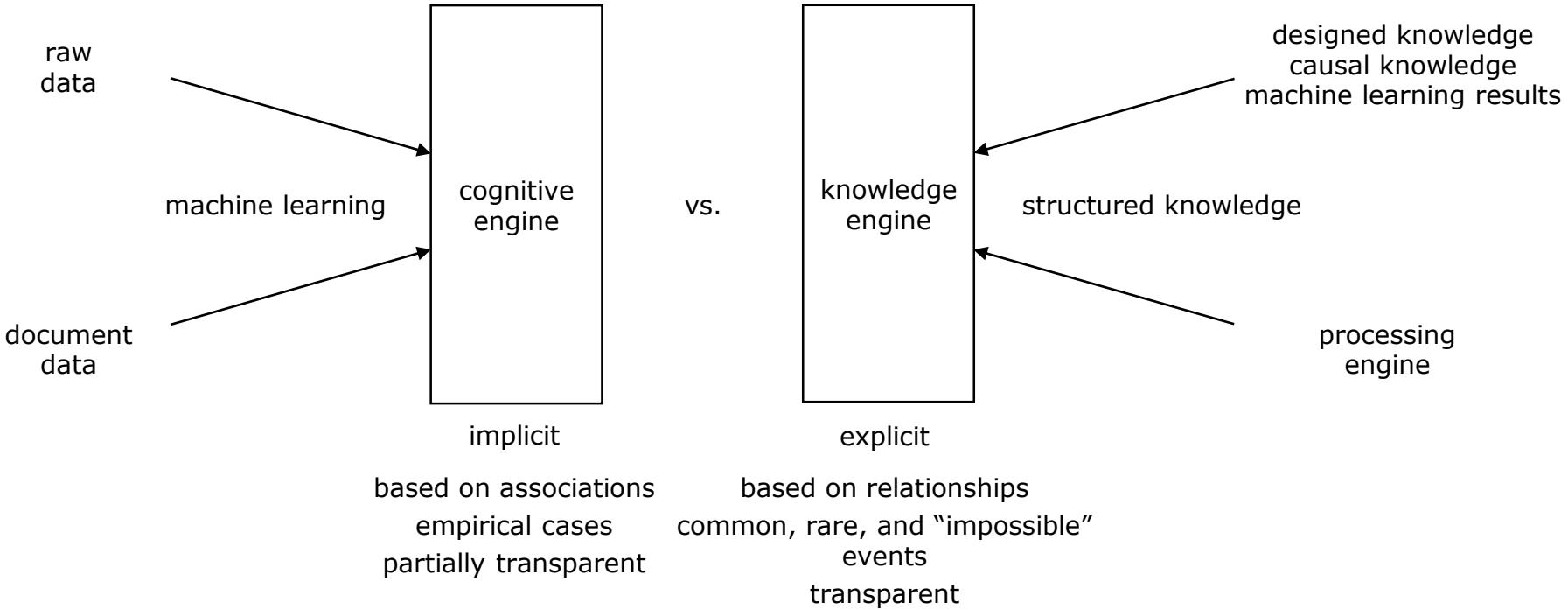
IBM Watson Health vs. Medexter Health Knowledge

Big data vs. knowledge design



big raw data	big document data	structured knowledge design
data mining	text mining	knowledge-based systems
⇩	⇩	⇩
CDS	CDS	CDS
induction	induction	deduction
empirical	mixed	axiomatic

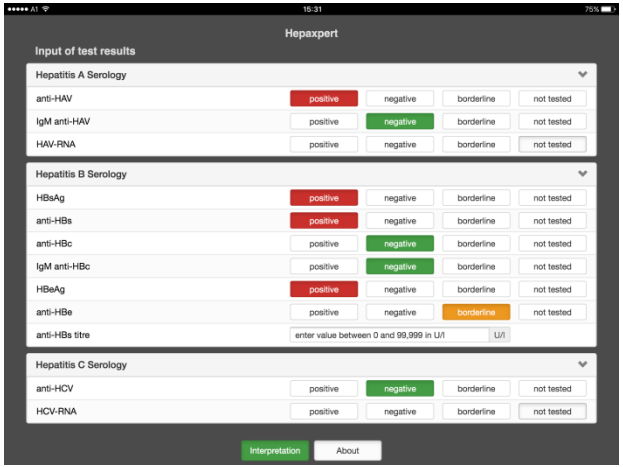
IBM Watson Health vs. Medexter Health Knowledge

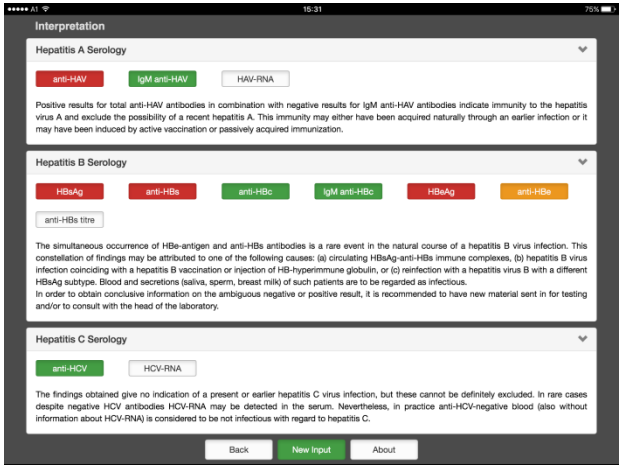


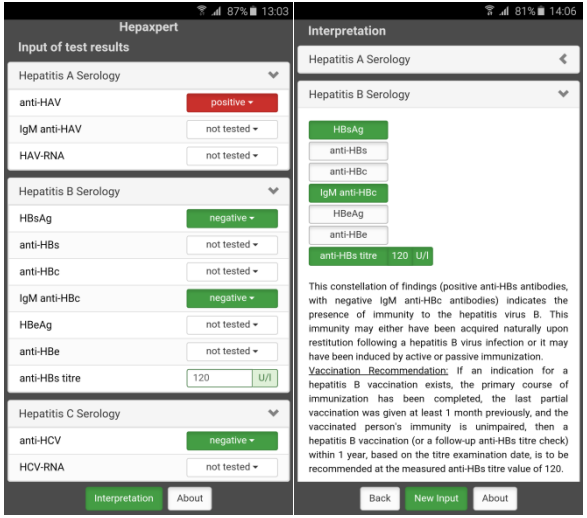
Hepaxpert

Knowledge-based interpretation of hepatitis serology test results

Automated interpretation of hepatitis serology test results







- includes frequent, rare, as well as inconsistent combinations
- complete coverage of the problem domains
- e.g., hepatitis B serology: about 150 rules in 3 layers for 61,440 possible combinations

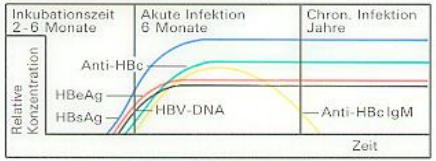
ABBOTT

Diagnostisches Profil Hepatitis B

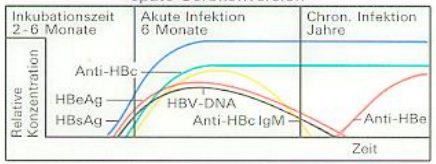
Dieser serologische Verlauf trifft bei 75 - 80 % der Patienten mit akuter Hepatitis B auf.

Profil der serologischen Marker eines chronischen Trägers:

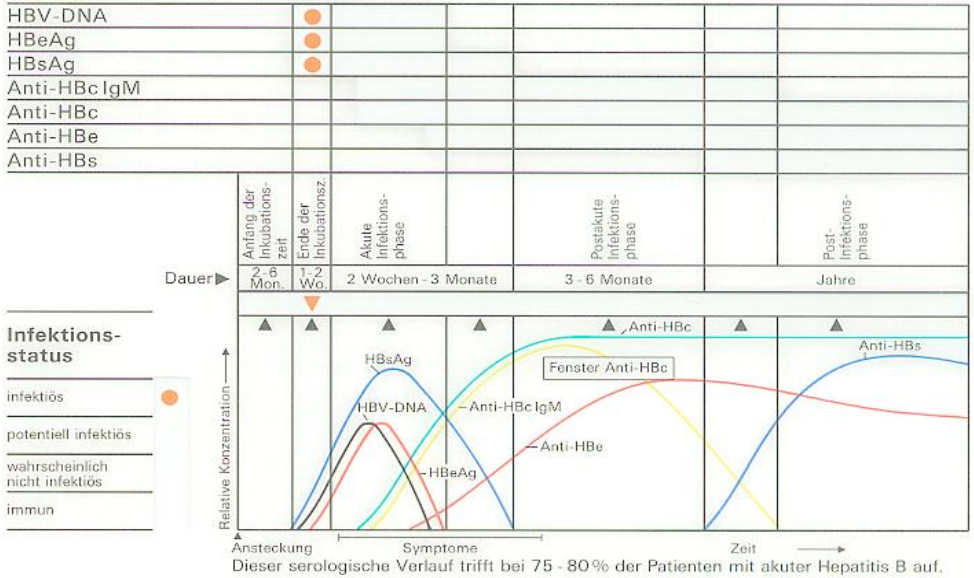
keine Serokonversion (Anti-HBe)



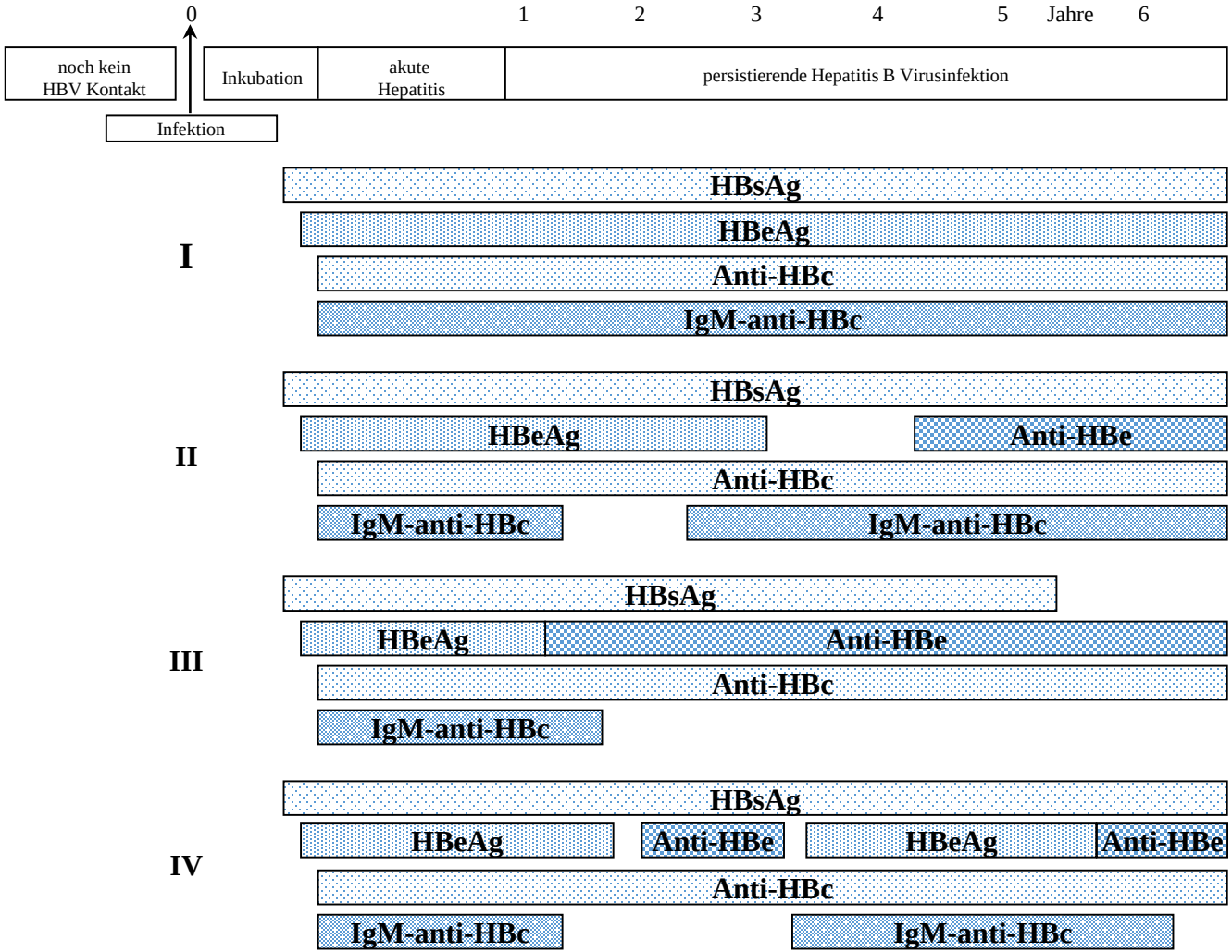
späte Serokonversion



Serologische Marker Hepatitis B



Dieser serologische Verlauf trifft bei 75 - 80 % der Patienten mit akuter Hepatitis B auf.


0
1
2
3
4
5
Jahre
6
noch kein HBV Kontakt
Inkubation
akute Hepatitis
persistierende Hepatitis B Virusinfektion
Infektion
I
HBsAg
HBeAg
Anti-HBc
IgM-anti-HBc
II
HBsAg
HBeAg
Anti-HBe
Anti-HBc
IgM-anti-HBc
IgM-anti-HBc
III
HBsAg
HBeAg
Anti-HBe
Anti-HBc
IgM-anti-HBc
IV
HBsAg
HBeAg
Anti-HBe
HBeAg
Anti-HBe
Anti-HBc
IgM-anti-HBc
IgM-anti-HBc

One of the rules to interpret clinically relevant findings (rule premises form equivalent classes)

RULE 103:

IF one of the following 100 combinations

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

THEN

The simultaneous occurrence of HBe-antigen and anti-HBs antibodies is a rare event in the natural course of a hepatitis B virus infection. This constellation of findings may be attributed to one of the following causes: (a) circulating HBsAg-anti-HBs immune complexes, (b) hepatitis B virus infection coinciding with a hepatitis B vaccination or injection of HB-hyperimmune globulin, or (c) reinfection with a hepatitis virus B with a different HBsAg subtype. Blood and secretions (saliva, sperm, breast milk) of such patients are to be regarded as infectious.

Regel zur Interpretation von „inkonsistente Befunde“

REGEL 3:

WENN

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

DANN

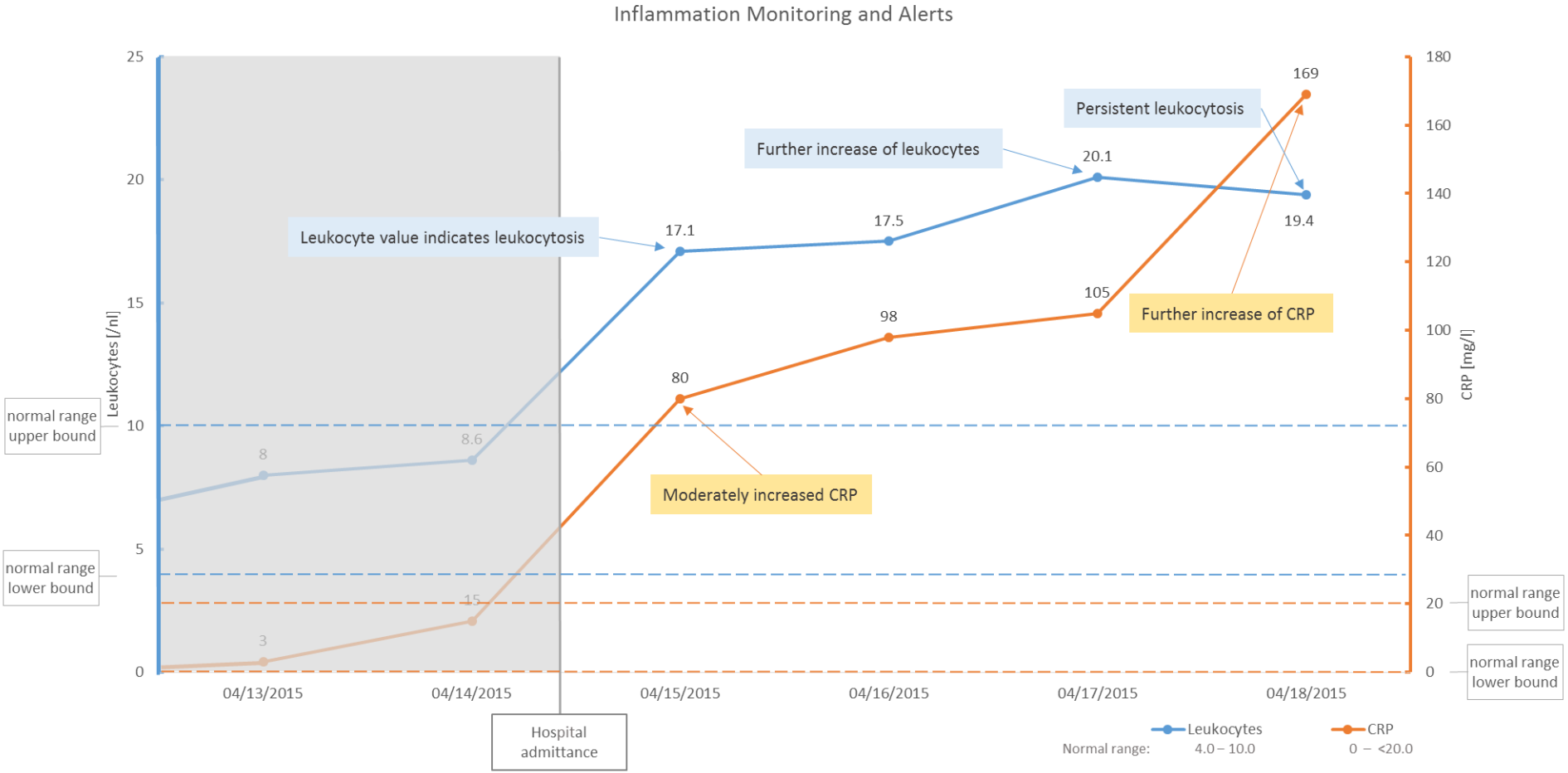
Das Befundmuster enthält Widersprüche, da definitionsgemäß bei Vorliegen von IgM anti-HBc-Antikörpern auch die Anti-HBc-Gesamtantikörper positiv sein müssten. Neueinsendung von Untersuchungsmaterial bzw. Rücksprache mit dem Laborleiter wird empfohlen.

Monate	Anforderungen	Muster (von 4.095)		Regeln (von 105)	
0	0	0	0,0%	0	0%
1	524	25	0,6%	19	18%
2	1.084	39	1,0%	28	27%
3	1.665	52	1,3%	32	30%
4	2.169	65	1,6%	35	33%
5	2.842	75	1,8%	37	35%
6	3.402	83	2,0%	40	38%
7	4.037	87	2,1%	41	39%
8	4.559	93	2,3%	42	40%
9	5.115	98	2,4%	45	43%
10	5.624	102	2,5%	46	44%
11	6.021	103	2,5%	46	44%
12	6.399	105	2,6%	47	45%
13	6.896	112	2,7%	50	48%
14	7.575	115	2,8%	50	48%
15	8.219	118	2,9%	50	48%
16	8.699	124	3,0%	51	49%
17	9.327	129	3,2%	51	49%
18	9.890	131	3,2%	51	49%
19	10.439	134	3,3%	53	50%
20	11.303	135	3,3%	53	50%

Häufigkeit des Auftretens von Befundmustern und Regeln für die Hepatitis B im Verlauf von 20 Monaten

Clinical alerts

Ward-specific, highly-adaptive reminders


Inflammation Monitoring and Alerts
Leukocytes [/nl]
CRP [mg/l]
normal range upper bound
normal range lower bound
Leukocyte value indicates leukocytosis
Further increase of leukocytes
Persistent leukocytosis
Further increase of CRP
Moderately increased CRP
8
8.6
17.1
17.5
20.1
19.4
3
15
80
98
105
169
04/13/2015
04/14/2015
04/15/2015
04/16/2015
04/17/2015
04/18/2015
Hospital admittance
Leukocytes
CRP
Normal range:
4.0 – 10.0
0 – <20.0

Dashboard
Patients
Laboratory
Ambulance
Forms
Medication
Reporting
Preferences

Mustermann, Max
Adam, Reinhard
Auer, Dietmar
Bauer, Stefanie
Berger, Anita
Cruzcer, Karin
Dietrich, Dominik
Falli, Robert
Frauenstein, Lisa
Grutsch, Renate
Heiter, Thomas
Huber, Karl
Hufnagl, Martin
Kaindl, Laura
Kaiser, Franz
Kapferer, Johannes
Lander, Simon
Leitmayer, Sonja
Loidl, Elisabeth
Maier, Franz
Maier, Sabin
Neuwirt, Markus
Schneider, Stefan
Seidl, Anita
Tauern, Barbara

Mustermann, Max

Sex:	male	NINO:	1234100866
Age:	48	Case Number:	468895
Date of Birth:	08-10-1966	Hospital Admittance:	04-15-2015

Documents | Vital Signs | Laboratory | Diagnoses | Radiology | Images | References | Outside Records

	04-18-2015 13:02	04-17-2015 12:52	04-16-2015 11:29	04-15-2015 13:37
HEMATOLOGICAL PROFILE				
Leukocytes	19,4 /nl	20,1 /nl	17,5 /nl	17,1 /nl
Hemoglobin	-	-	-	-
...				
BIOCHEMICAL PROFILE				
Electrolytes				
Potassium	-	-	-	-
...				
Inflammation markers				
C-reactive protein	169 mg/l	105 mg/l	98 mg/l	80 mg/l
...				
Kidney function				
Blood urea nitrogen	-	-	-	-
Serum creatinine	-	-	-	-
Urea	-	-	-	-
...				
Enzymes				
Troponin	-	-	-	-
...				

Clinical Alerts

GENERATED	MESSAGES
04-18-2015 13:02	Further increase of CRP +
04-18-2015 13:02	Persistent leukocytosis −

Persistent leukocytosis (19,4 /nl, 04-18-2015 13:02) compared to previous findings:

04-17-2015 12:52	Leukocytes 20,1 /nl	04-17-2015 12:52	CRP 105 mg/l
04-16-2015 11:29	Leukocytes 17,5 /nl	04-16-2015 11:29	CRP 98 mg/l
04-15-2015 13:37	Leukocytes 17,1 /nl	04-15-2015 13:37	CRP 80 mg/l

04-17-2015 12:52	Further increase of leukocytes +
04-15-2015 13:37	Leukocyte value indicates leukocytosis −

Leukocyte value indicates leukocytosis: 17,1 /nl (04-15-2015 13:37). Consider CRP.

04-15-2015 13:37	Moderately increased CRP +

Summary

- Big data mining
  - Huge amount of data available
  - Erroneous cases are usually part of the data
  - Empirical data are incomplete
  - Low transparency
- Big document mining
  - Huge amount of documents available
  - Documents are humanly preprocessed and checked
  - Learning from erroneous or outdated documents
  - Medium transparency
- Knowledge design
  - Carefully designed knowledge
  - Contains explicit causal explanations
  - Includes rare and outlier cases
  - High transparency