

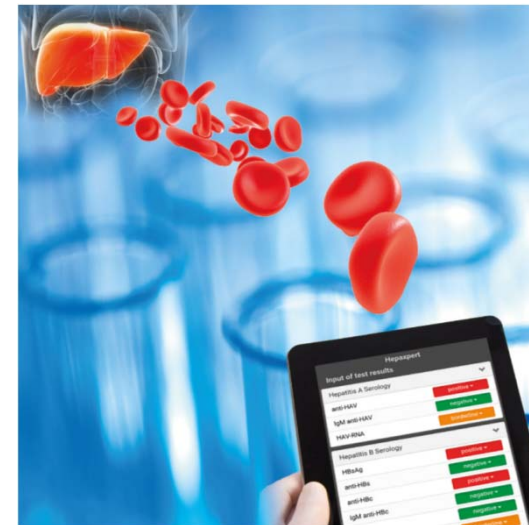
## Daten, Wissen und Transparenz in der klinischen Entscheidungsunterstützung

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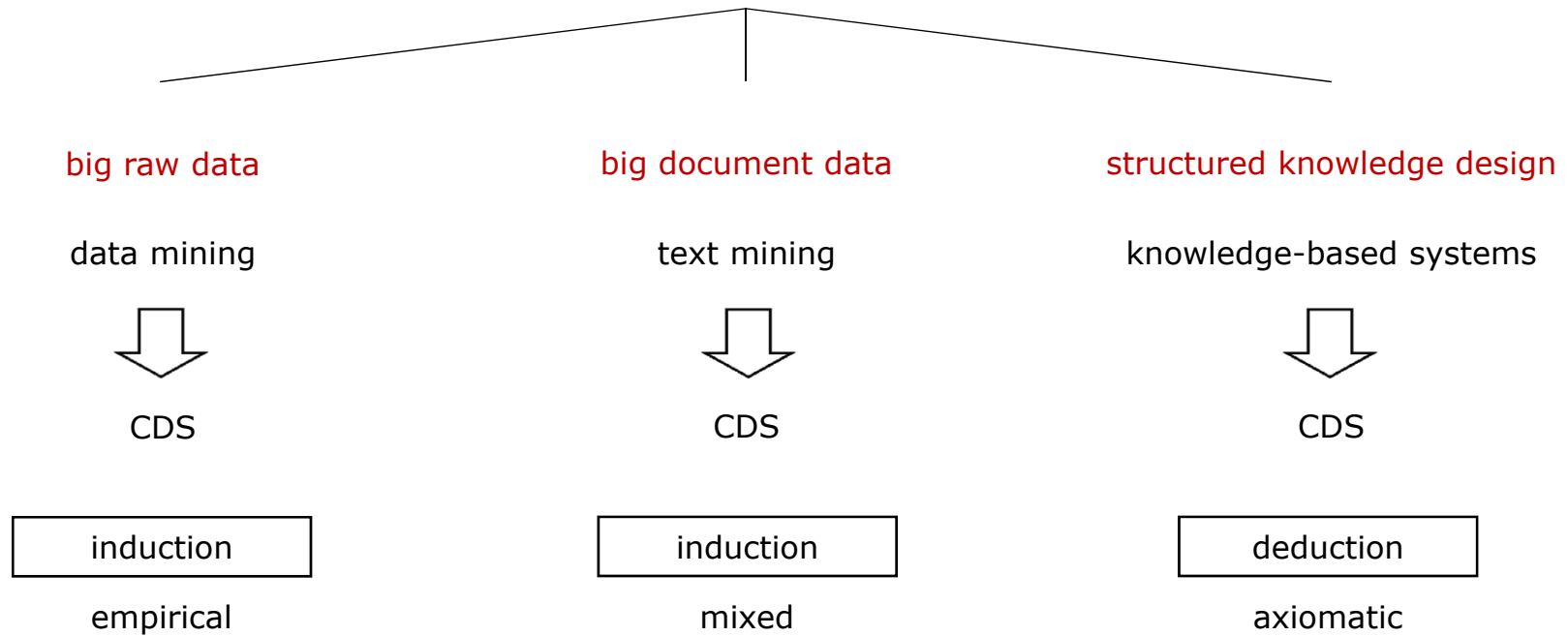
conhIT-Satellitenworkshop 2016 der GMDS-Arbeitsgruppe "Wissensbasierte Systeme in der Medizin" zum Thema "Entscheidungsunterstützung 2.0 – was leistet künstliche Intelligenz in der Medizin?", Berlin, 18. April 2016

## **Big data vs. knowledge design**

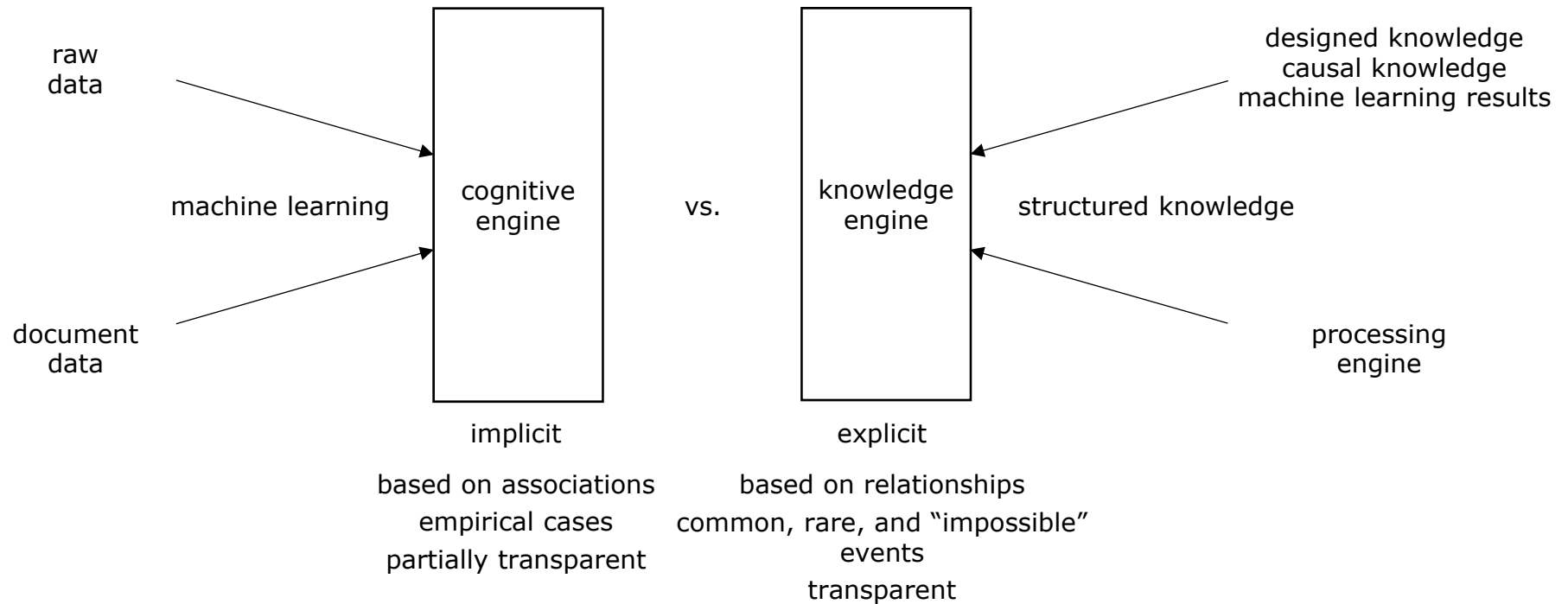
IBM Watson Health vs. Medexter Healthcare Knowledge

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## Big data vs. knowledge design



## IBM Watson Health vs. Medexter Healthcare knowledge



## **Hepaxpert**

Knowledge-based interpretation of hepatitis serology test results

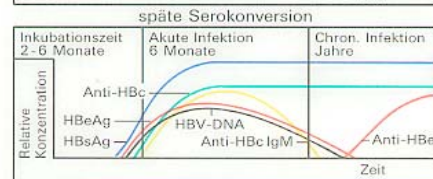
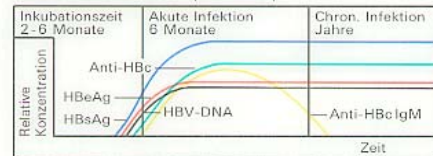
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## Diagnostisches Profil Hepatitis B

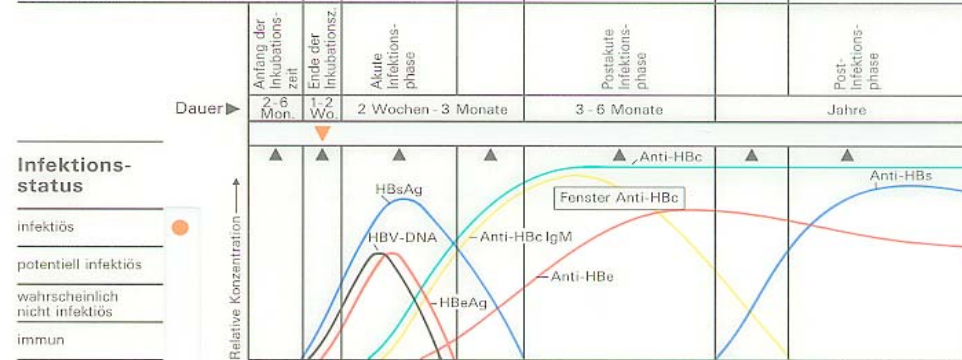
Dieser serologische Verlauf trifft bei 75 - 80% der Patienten mit akuter Hepatitis B auf.

Profil der serologischen Marker eines chronischen Trägers:  
keine Serokonversion (Anti-HBe)

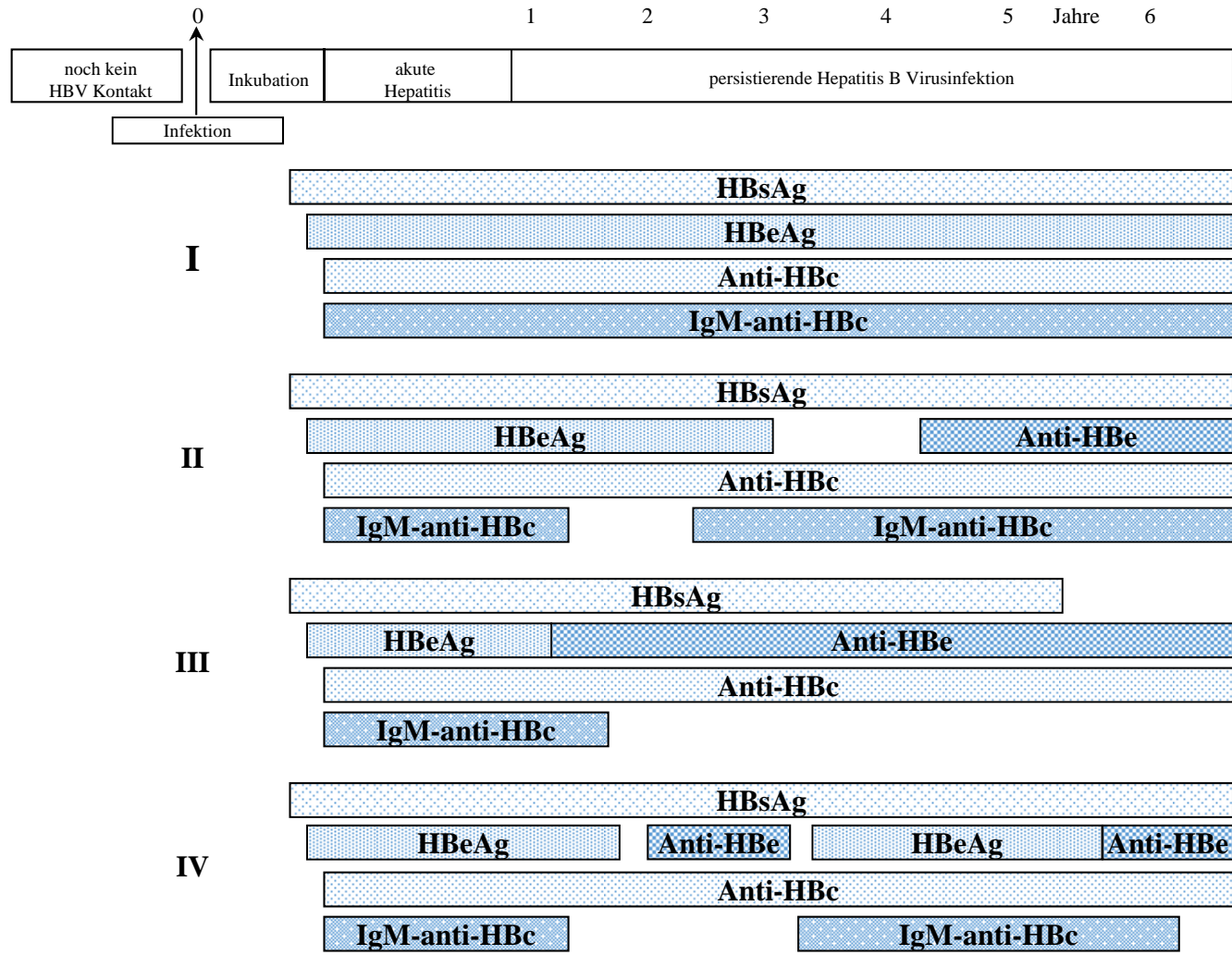


### Serologische Marker Hepatitis B

HBV-DNA	●					
HBeAg	●					
HBsAg	●					
Anti-HBc IgM						
Anti-HBc						
Anti-HBe						
Anti-HBs						



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



## 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%

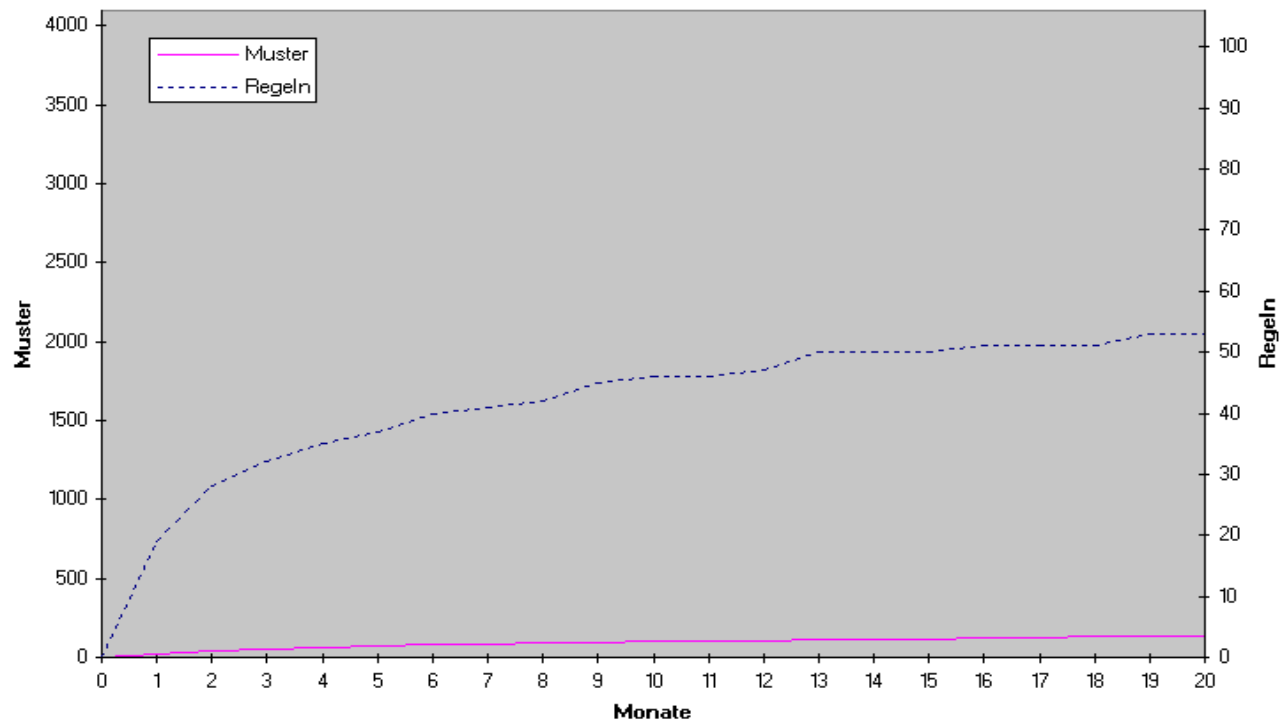
Häufigkeit des Auftretens von Befundmustern und Regeln für die Hepatitis B im Verlauf von 20 Monaten

Gruppenname	HBsAg	Anti-HBs	Anti-HBc	IgM-anti-HBc	HBeAg	Anti-HBe	Regelnummer	Häufigkeit
BGR16	-	-	-	•	•	•	25	6583
BGR100	-	+	-	•	•	•	102	1691
BGR92	-	+	+	•	•	•	94	1165
BGR19	-	±	-	•	•	•	28	264
BGR88	-	-	+	-	•	•	90	213
BGR57	+	-	+	•	-	+	60	192
BGR51	+	-	+	•	+	-	54	127
BGR79	-	-	+	•	•	•	81	85
BGR40	-	-	+	+	•	•	45	77
BGR1	-	•	•	•	•	•	10	56
BGR16	-	-	-	•	-	-	25	54
BGR87	-	±	+	-	•	•	89	48
BGR19	-	•	-	•	-	-	28	48
BGR21	•	•	-	•	•	•	30	46
BGR19	-	•	-	•	•	•	28	42
BGR79	-	-	+	±	•	•	81	38
BGR91	-	+	+	-	•	•	93	37
BGR10	-	-	±	-	•	•	19	37
BGR16	-	-	-	-	•	•	25	36
BGR2	-	-	±	•	•	•	11	30
BGR78	-	±	+	•	•	•	80	30
BGR53	+	-	+	•	-	-	56	27
BGR99	-	+	±	•	•	•	101	27
BGR72	-	+	+	+	•	•	75	16
BGR99	-	+	•	•	•	•	101	14
BGR25	+	-	+	+	+	-	33	13
BGR92	-	+	+	•	-	+	94	12
BGR34	+	-	+	+	-	+	41	11
BGR100	-	+	-	•	-	-	102	11
BGR45	-	±	+	+	•	•	49	11
BGR59	+	-	+	•	±	-	62	10
BGR73	-	+	+	+	-	+	75	10
BGR98	-	+	±	-	•	•	100	10
BGR9	-	±	±	-	•	•	18	10
BGR71	-	-	+	-	-	+	74	8

Gruppenname	HBsAg	Anti-HBs	Anti-HBc	IgM-anti-HBc	HBeAg	Anti-HBe	Regelnummer	Häufigkeit
BGR98	-	+	•	-	•	•	100	1
BGR97	-	-	+	-	-	-	99	1
BGR97	-	-	+	-	±	-	99	1
BGR71	-	-	+	-	•	+	74	1
BGR74	-	-	+	•	-	-	76	1
BGR16	-	-	-	±	-	-	25	1
BGR87	-	±	+	-	-	±	89	1
BGR96	-	±	+	±	-	-	98	1
BGR75	-	±	+	•	-	+	77	1
BGR19	-	±	-	-	•	•	28	1
BGR19	-	±	-	•	-	-	28	1
BGI2	-	±	±	+	-	-	3	1
BGR1	-	±	±	±	•	•	10	1
BGR9	-	±	•	-	•	•	18	1
BGR84	-	•	+	-	±	+	86	1
BGR96	-	•	+	•	-	-	98	1
BGR19	-	•	-	•	-	±	28	1
BGR19	-	•	-	•	±	-	28	1
BGR19	-	•	-	•	•	-	28	1
BGR20	±	-	-	•	•	•	29	1
BGR83	±	±	+	-	±	+	85	1
BGR76	±	±	+	•	-	+	78	1
BGR21	±	±	-	•	•	•	30	1
BGR81	±	•	+	•	•	•	83	1
BGR21	±	•	-	•	•	•	30	1
BGR20	•	-	-	•	•	•	29	1
BGR21	•	•	-	-	•	•	30	1
BGU3	•	•	±	•	•	•	2	1
BGR76	•	•	•	•	•	+	78	1
Total							11303	

BGUx: unzureichende Daten,  
 BGIx: inkonsistente Befunde,  
 BGRx: klinisch relevante Befunde  
 wobei

„+“ = „positiv“, „-“ = „negativ“, „±“ = „grenzwertig“ und „•“ = „nicht untersucht“



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

# Automated interpretation of hepatitis serology test results

**Hepatitis A Serology**

anti-HAV	positive	negative	borderline	not tested
IgM anti-HAV	positive	negative	borderline	not tested
HAV-RNA	positive	negative	borderline	not tested

**Hepatitis B Serology**

HBsAg	positive	negative	borderline	not tested
anti-HBs	positive	negative	borderline	not tested
anti-HBc	positive	negative	borderline	not tested
IgM anti-HBc	positive	negative	borderline	not tested
HBeAg	positive	negative	borderline	not tested
anti-HBe	positive	negative	borderline	not tested
anti-HBs titre	enter value between 0 and 99,999 in U/l U/l			

**Hepatitis C Serology**

anti-HCV	positive	negative	borderline	not tested
HCV-RNA	positive	negative	borderline	not tested

**Hepatitis A Serology**

anti-HAV (positive), IgM anti-HAV (negative), HAV-RNA (not tested)

Positive results for total anti-HAV antibodies in combination with negative results for IgM anti-HAV antibodies indicate immunity to the hepatitis virus A and exclude the possibility of a recent hepatitis A. This immunity may either have been acquired naturally through an earlier infection or it may have been induced by active vaccination or passively acquired immunization.

**Hepatitis B Serology**

HBsAg (positive), anti-HBs (positive), anti-HBc (negative), IgM anti-HBc (negative), HBeAg (positive), anti-HBe (borderline), anti-HBs titre (120 U/l)

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. In order to obtain conclusive information on the ambiguous negative or positive result, it is recommended to have new material sent in for testing and/or to consult with the head of the laboratory.

**Hepatitis C Serology**

anti-HCV (negative), HCV-RNA (not tested)

The findings obtained give no indication of a present or earlier hepatitis C virus infection, but these cannot be definitely excluded. In rare cases despite negative HCV antibodies HCV-RNA may be detected in the serum. Nevertheless, in practice anti-HCV-negative blood (also without information about HCV-RNA) is considered to be not infectious with regard to hepatitis C.

**Hepatitis B Serology**

HBsAg (positive), anti-HBs (positive), anti-HBc (negative), IgM anti-HBc (negative), HBeAg (not tested), anti-HBe (not tested), anti-HBs titre (120 U/l)

This constellation of findings (positive anti-HBs antibodies, with negative IgM anti-HBc antibodies) indicates the presence of immunity to the hepatitis virus B. This immunity may either have been acquired naturally upon restitution following a hepatitis B virus infection or it may have been induced by active or passive immunization. **Vaccination Recommendation:** If an indication for a hepatitis B vaccination exists, the primary course of immunization has been completed, the last partial vaccination was given at least 1 month previously, and the vaccinated person's immunity is unimpaired, then a hepatitis B vaccination (or a follow-up anti-HBs titre check) within 1 year, based on the titre examination date, is to be recommended at the measured anti-HBs titre value of 120.

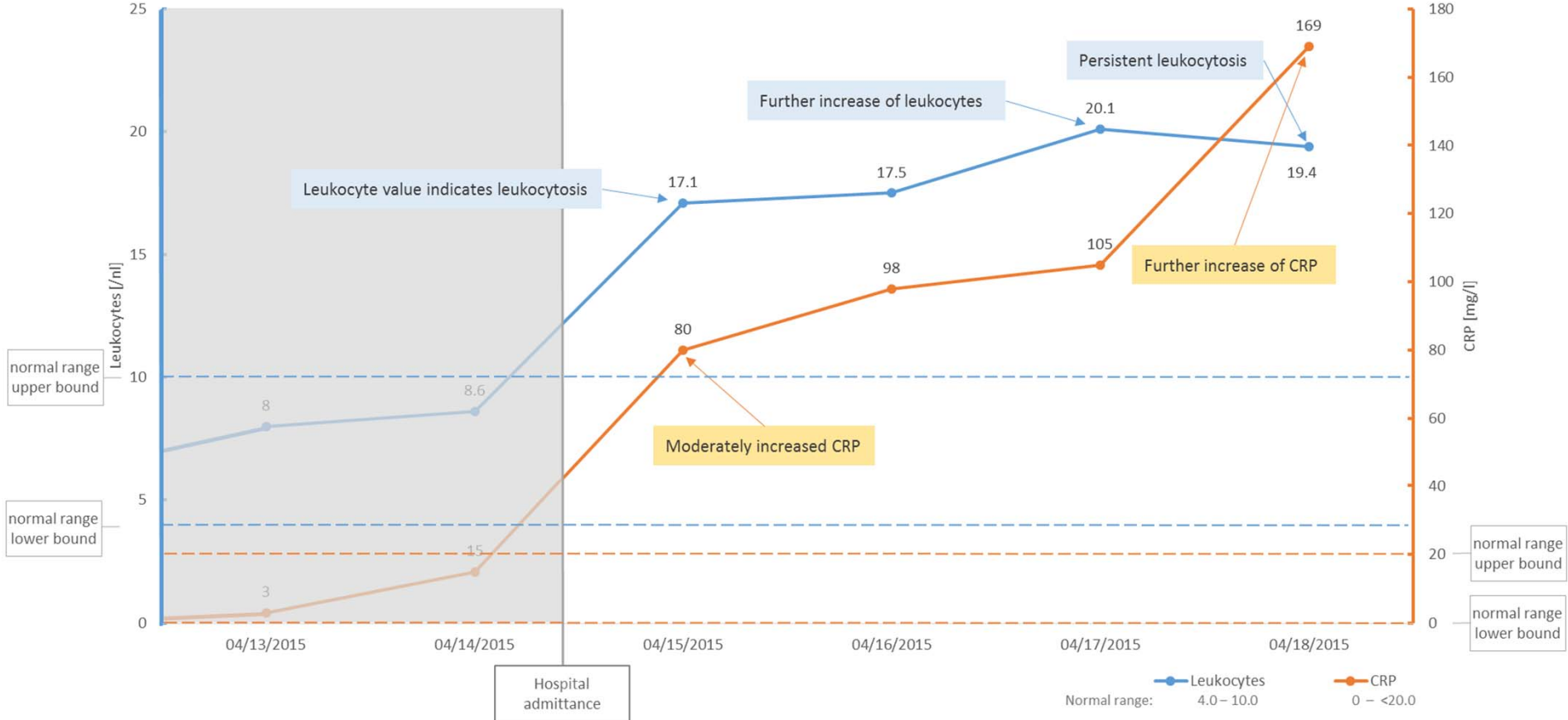
- includes frequent, rare, as well as inconsistent combinations
- complete coverage of the problem domains
- e.g., hepatitis B serology: about 150 rules in 3 layers for 61,440 possible combinations

## **Clinical alerts**

Ward-specific, highly-adaptive reminders


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### Inflammation Monitoring and Alerts





- Dashboard Mustermann, Max
- Patients Adam, Reinhard
- Laboratory Auer, Dietmar
- Ambulance Bauer, Stefanie
- Forms Berger, Anita
- Medication Cruzcer, Karin
- Reporting Dietrich, Dominik
- Preferences Falli, Robert



## Mustermann, Max

Sex: male

Age: 48

Date of Birth: 08-10-1966

NINO: 1234100866

Case Number: 468895

Hospital Admittance: 04-15-2015

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

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

**Clinical Alerts**

GENERATED	MESSAGES
04-18-2015 13:02	Further increase of CRP <span style="float: right;">+</span>
04-18-2015 13:02	Persistent leukocytosis <span style="float: right;">-</span>
Persistent leukocytosis (19,4 /nl, 04-18-2015 13:02) compared to previous findings:	
04-17-2015 12:52	Leukocytes 20,1 /nl
04-16-2015 11:29	Leukocytes 17,5 /nl
04-15-2015 13:37	Leukocytes 17,1 /nl
04-17-2015 12:52	CRP 105 mg/l
04-16-2015 11:29	CRP 98 mg/l
04-15-2015 13:37	CRP 80 mg/l
04-17-2015 12:52	Further increase of leukocytes <span style="float: right;">+</span>
04-15-2015 13:37	Leukocyte value indicates leukocytosis <span style="float: right;">-</span>
Leukocyte value indicates leukocytosis: 17,1 /nl (04-15-2015 13:37). Consider CRP.	
04-15-2015 13:37	Moderately increased CRP <span style="float: right;">+</span>

## Summary

- Data mining
    - Huge amount of data available
    - Erroneous cases are usually part of the data
    - Empirical data are incomplete
    - Low transparency
  
  - 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
-