



AMPEL-CDSS: Aus der Forschung in die Versorgung

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Model-based Decision Support

If / Then
Guideline-oriented

Machine
Learning



Patient Safety

Diagnostic Innovation

From the clinic to the clinic



AMPEL
Clinical Decision Support System



Clinical Decision Support System (CDSS) for structured data

>5

Years of clinical
application

>10

Models

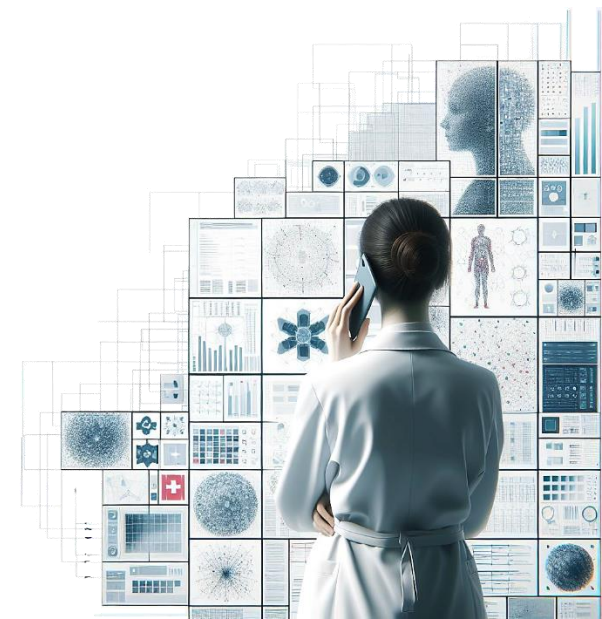
>15

Publications

>6000

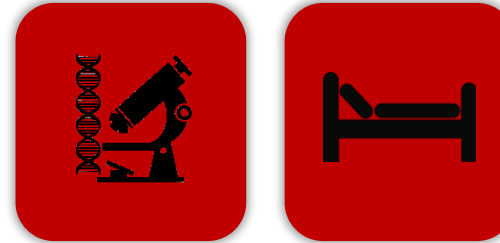
Patient alarms
per year

- Europe's only academic CDSS in routine care
- Germany's leading CDSS in terms of scope and evidence



Features

**Real-time
monitoring**



**Traceable data
streams**

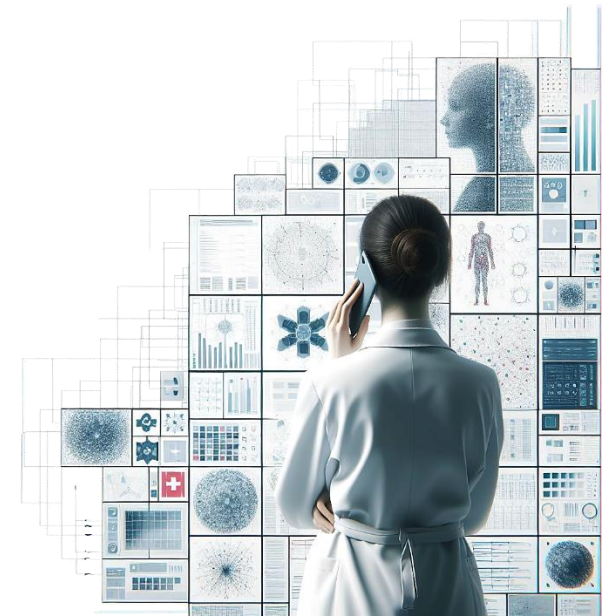
Machine Learning



**Evidenced
patient safety**

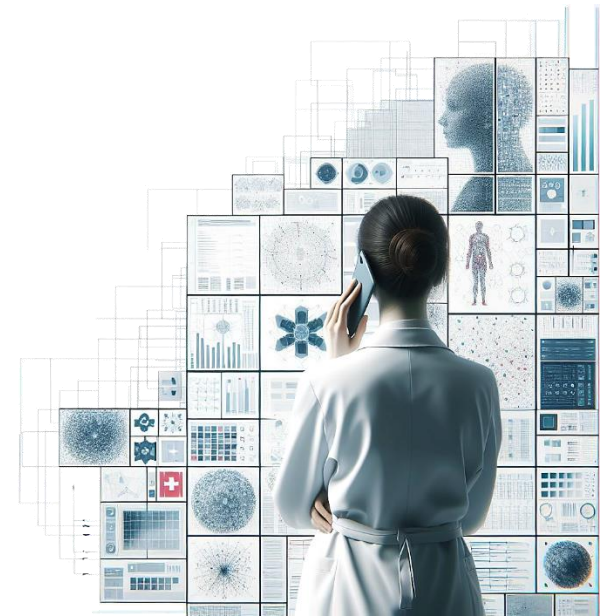
Open Source

**From research
straight to routine**



Previous Project and what we have learnt from it

- Funded project: Collaboration with an industry partner
- Goals:
 - Work on specific alarm algorithms for different medical end points
 - Design and implementation of an infrastructure
- Results:
 - >10 AMPEL algorithms
 - Infrastructure
 - Tight integration into SAP i.s.h.med.
 - No integration of AI-based algorithms
 - Strong dependence on industry partner and SAP infrastructure
 - No MDR certification



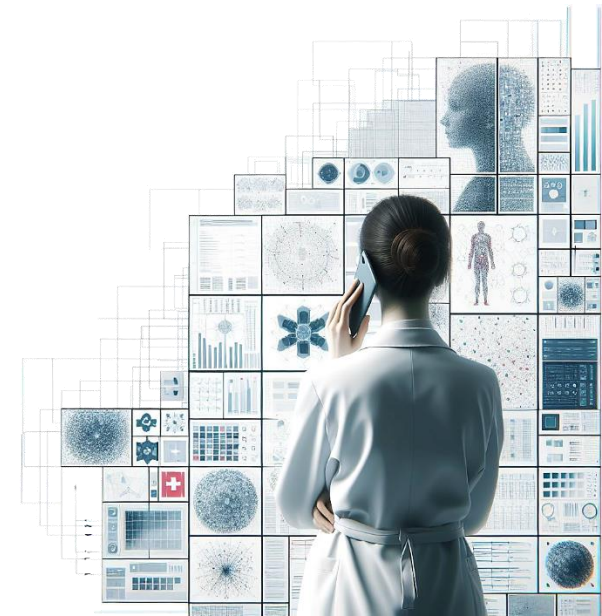
Version 2 - Design Principles

- **Real-time** processing of clinical data
- Based on and provided as **Open Source**
- Respect **Medical Device Regulation** (MDR)
- Support for
 - Rule-based approaches
 - AI-based solutions
 - Different data source platforms
- Performance, Scalability, Security, Traceability, Explainability...

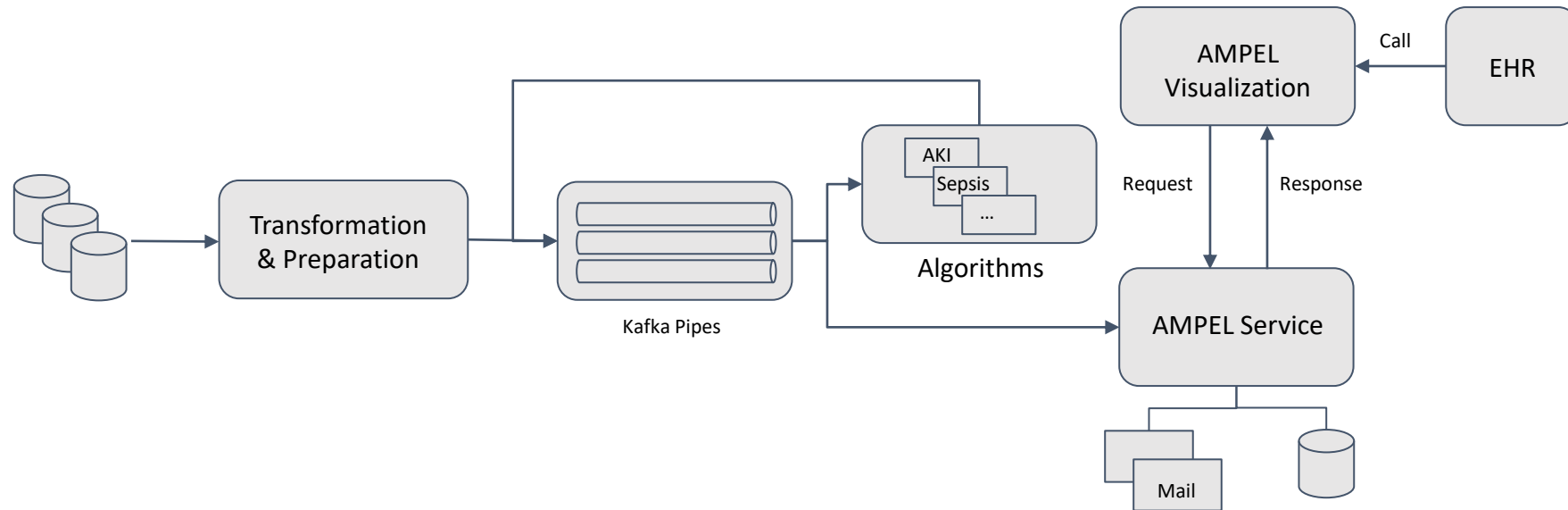
Medical Device

Real-time

Open Source



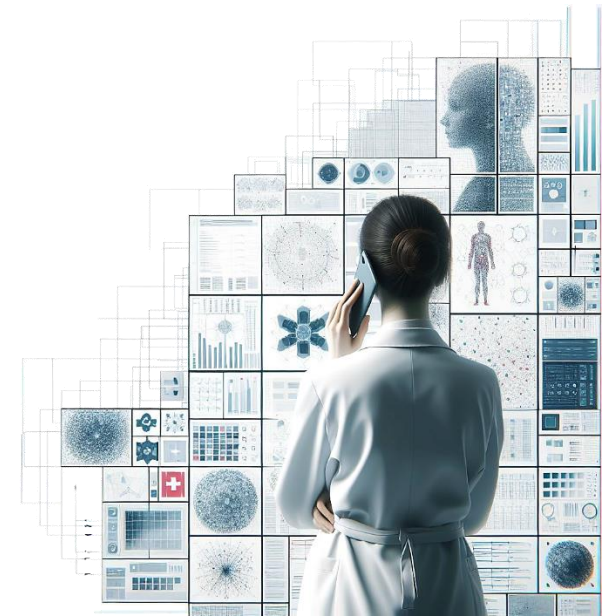
High-Level System Architecture



Data Source(s)

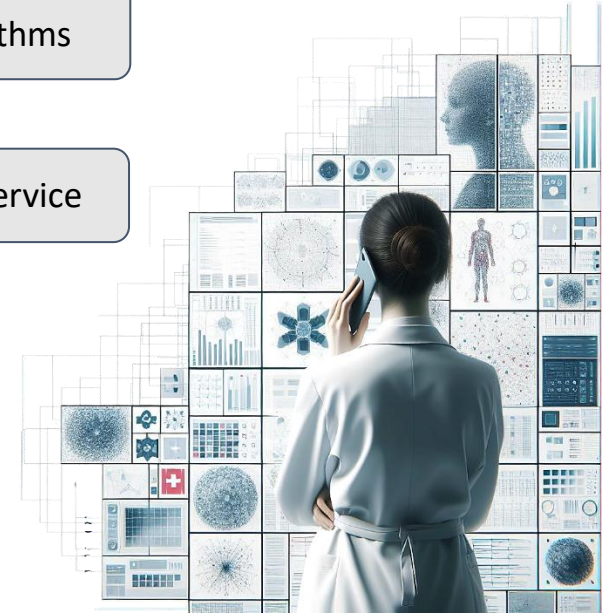
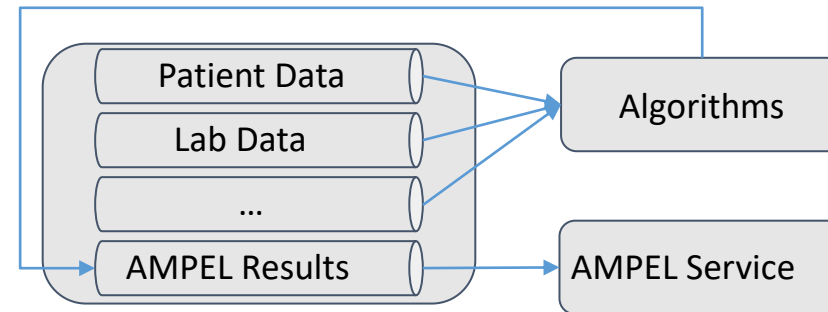
Topic-based Data Streams

Notifications



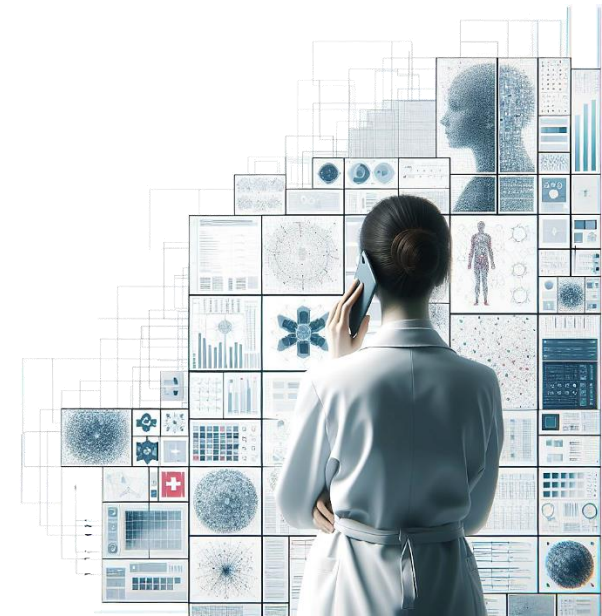
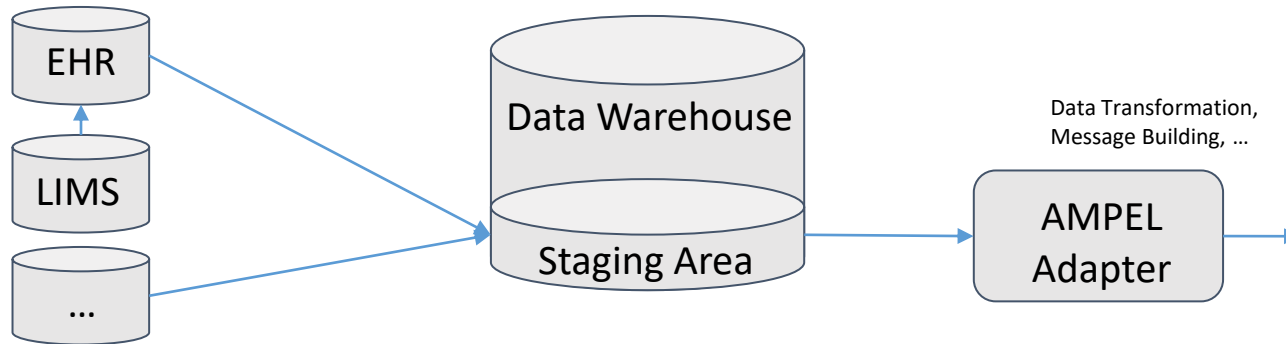
Apache Kafka - Basics and Pipes

- Open Source streaming framework: <https://kafka.apache.org>
- High performance and scalability
 - Many adapters for source management systems
 - Read transaction logs for performant recognition of data manipulation actions
- Topic-specific Pipes transporting messages for each new event in source system(s)
- Application in AMPEL
 - Pipes for source data → algorithms
 - Pipe for algorithm results



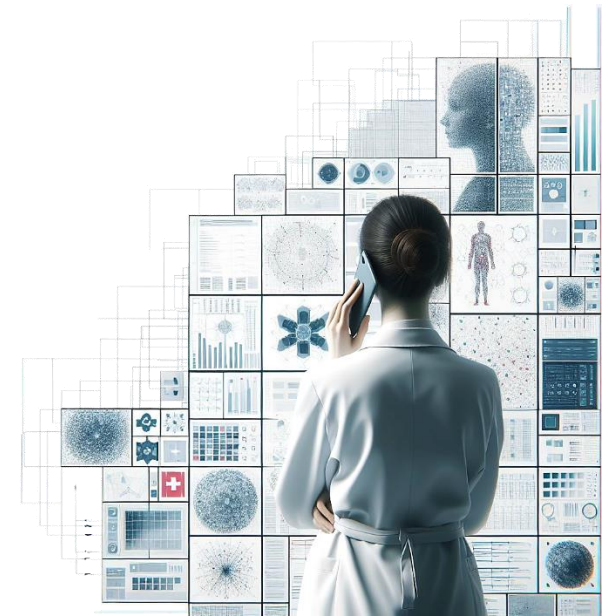
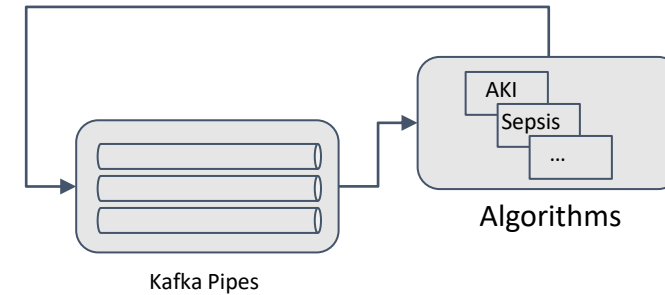
Data Sources

- Highly depend on used EHR and related systems
- Specific solution in Leipzig
 - SAP i.s.h.med as EHR
 - Laboratory information management system
 - Data warehouse integrating relevant information



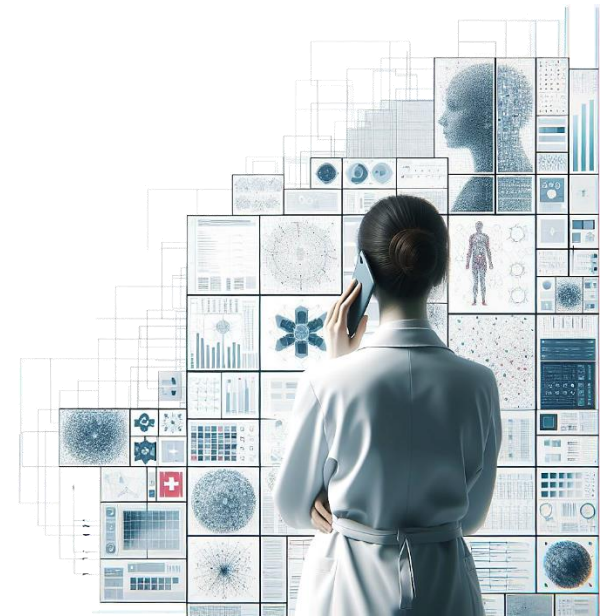
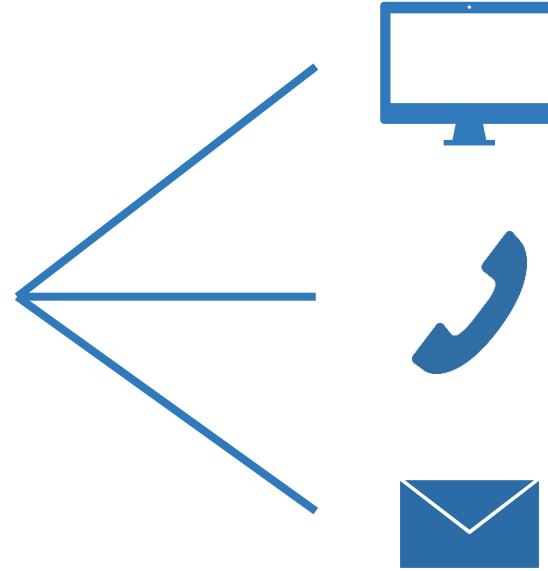
AMPEL Models

- Implemented as autonomous services
 - Polling Kafka pipes for new messages
- No limitation on programming languages
 - Currently available for Java
 - Further programming languages will follow (R, Python)



Alarming

- Different alarm notification modes
 - Visual alarming - user interface
 - Phone support
 - Alarm sent by e-mail
 - Messages to potentially any device
- Alarm (noise) suppression
- Logging



Visualization

- Direct integration into the clinical workplace
 - Often limited capabilities for extensions
 - Column with aggregated information
 - Coloured coding of current patient state
- Link to separate web page providing more information
 - Details resulting from each algorithm & explanations
 - History of computed results

AMPEL Meldesystem

Automatisch generierter Hinweis aus dem AMPEL-Meldesystem

Es handelt sich um ein Forschungssystem zur Unterstützung der Patientensicherheit. Auf Grund des Forschungscharakters und der Randomisierung kann die Verfügbarkeit und Validität der Alarme nicht zugesichert werden. Es darf nicht allein aus der Alarmierung eine medizinische Konsequenz abgeleitet werden. Die zugrundeliegenden Befunde müssen geprüft werden.
Website: www.ampel.care | Mail: feedback@ampel.care | laboratoriumsmedizinischer Dienst: 22221

Name	Geschlecht	Alter	Ausgabe am
Maximilian Müller	Weiblich	82	10.07.2023
Einrichtung	Fall	Patient	Uhrzeit
1	100001	100001	10:23:07

AKUTE NIERENSCHÄDIGUNG [AKIN 2]

Der Kreatininanstieg weist auf eine akute Nierenschädigung hin (AKIN-Stadium 2 nach KDIGO-Kriterien). Weiterführende Diagnostik- und Therapiemaßnahmen (KDIGO-Bundle) und ggf. nephrologisches Konsil empfohlen.

Weitergehende Informationen (DEXIMED)

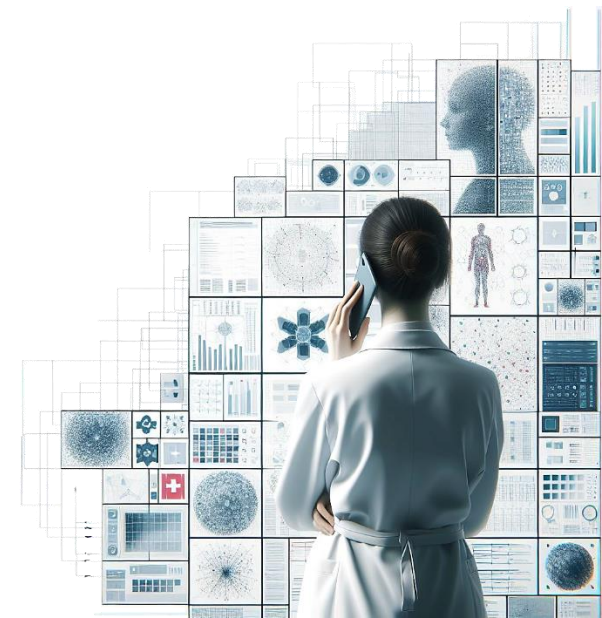
Status	Angelegt am	Angelegt um	Analyt	Ergebnis	Quittierung
07.07.2023	08:30:23	Kreatinin im Serum/Plasma	277 µmol/l	War diese Information hilfreich?	Ja Nein
05.07.2023	13:04:15	Kreatinin im Serum/Plasma	283 µmol/l		
03.07.2023	13:40:15	Kreatinin im Serum/Plasma	231 µmol/l		
02.07.2023	08:21:55	Kreatinin im Serum/Plasma	129 µmol/l		
30.06.2023	12:31:20	Kreatinin im Serum/Plasma	236 µmol/l		

Belegung mit 23 Patienten

Zimmer	Bett	Gsp.	Patient/Geschl./Alter	Gebdatum	AMPEL	R	Studie	Abw.	PP
F4092	F04X1014								
F4090	F04X1018								
F4094	F04X1017								
F4084	F04X1002								
F4097	F04X1021								
F4092	F04X1013								
F4091	F04X1012								
F4090	F04X1024								
F4084	F04X1001								
F4086	F04X1003								
F4095	F04X1019								
F4088	F04X1005								
F4098	F04X1023								
F4095	F04X1020								

Medical Device Regulation (MDR)

- All algorithms with direct impact on physicians decision
- MDR risk class IIa / IIb
- Self-made development declaration
 - Cooperation with the clinic's quality management department (QM)
 - Detailed documentation and software tests
- Cooperation with ICCAS (Innovation Center Computer Assisted Surgery, Leipzig)
 - Supporting medical devices from research to market readiness
 - > 100 employees



AMPEL Concept

Input



Computation



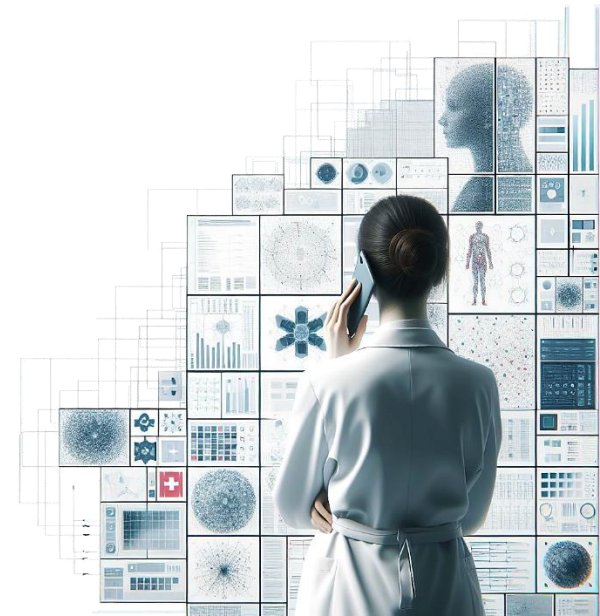
Output



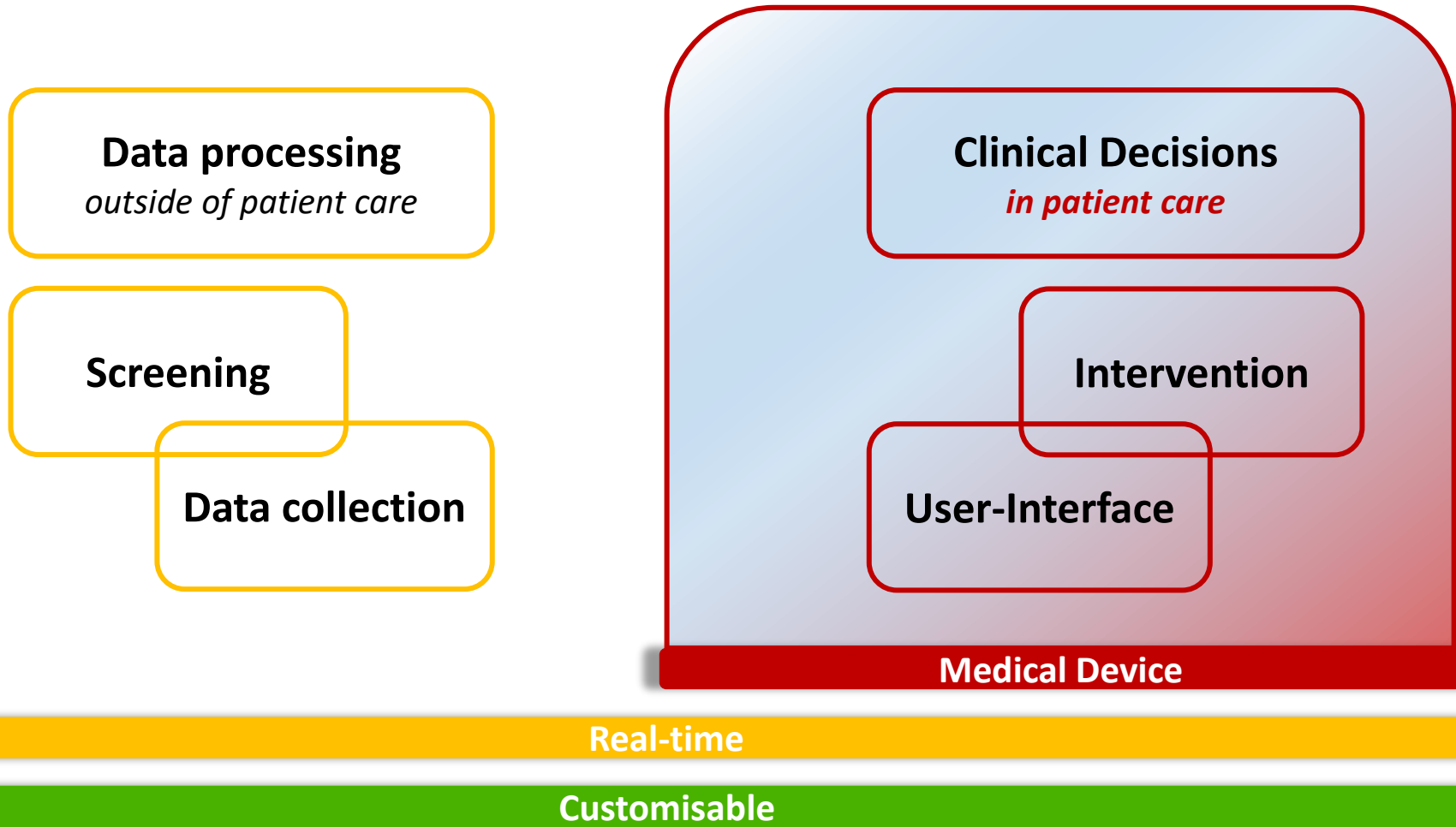
Medical Device

Real-time

Customisable

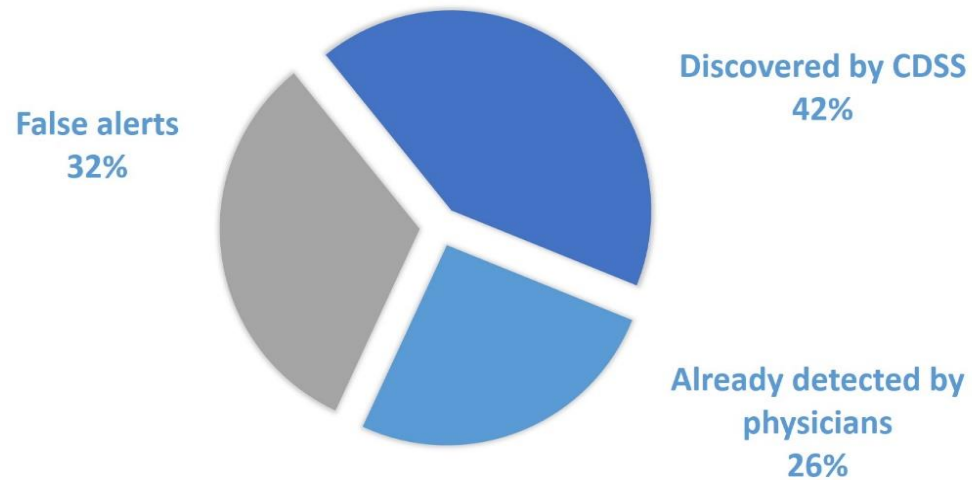


AMPEL Studies



Refeeding Syndrome

Refeeding Syndrome 31 Alerts in 6 Months



Pressemitteilung vom 23.05.2023

Refeeding-Syndrom bleibt häufig unerkannt

Selbstentwickeltes automatisiertes Diagnose-Unterstützungssystem kann dies ändern und warnt am UKL rechtzeitig vor schweren Folgen einer Mangelernährung



Das Team der Ernährungsmedizin am UKL kommt zusammen, wenn das automatisierte System einen für einen Verdacht auf das Refeeding-Syndrom auslöst.



Refeeding Syndrom

Data Input

Electrolytes	Lab
Dialysis	OPS
Transfusions	Blood bank
Reduced food intake known?	Nursing

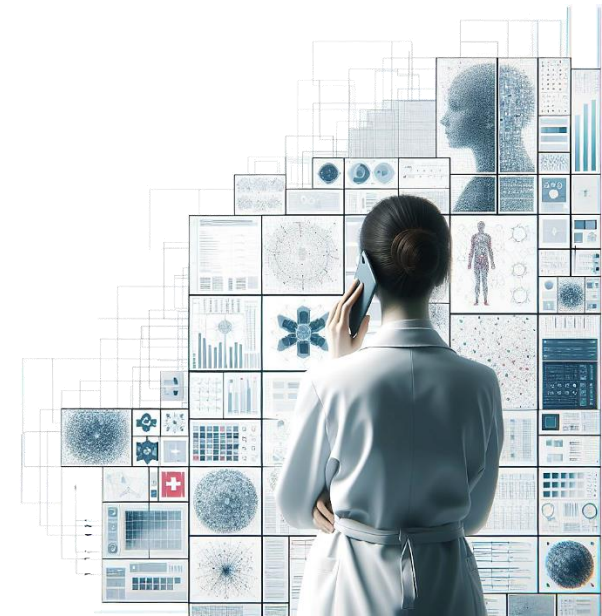
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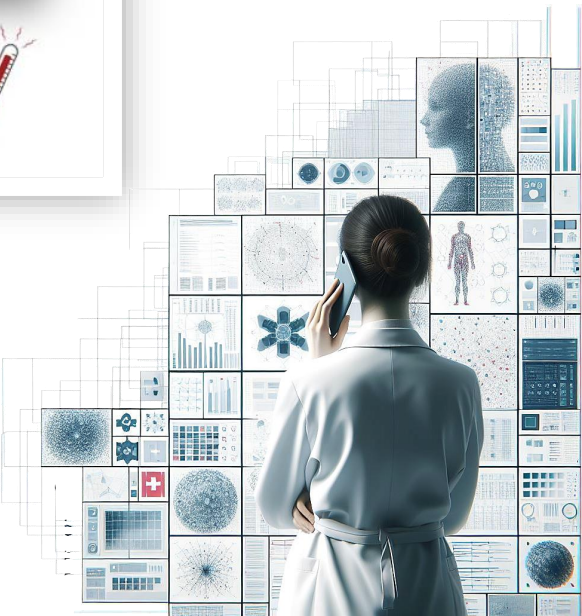
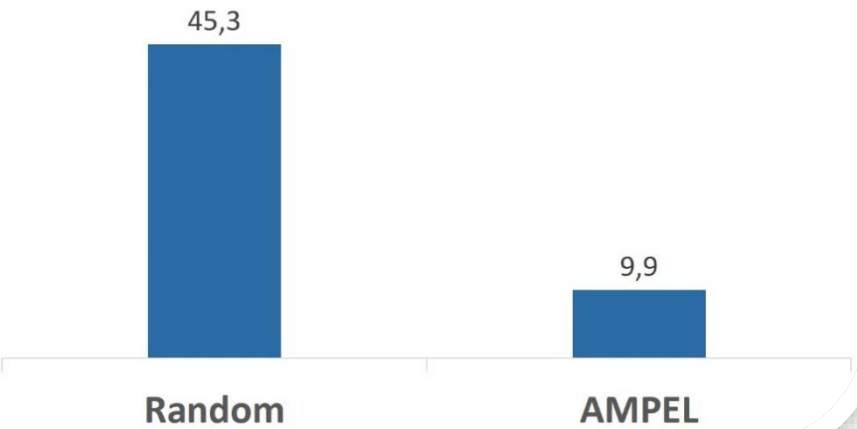


Sepsis

Early Sepsis Detection

Emergency Department: AI-Screening with blood count data

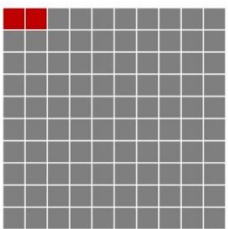
■ False alerts per detection (50% Sensitivity)



Sepsis

Early Sepsis Detection with AI

■ Sepsis Patient ■ False Alert



Emergency Department

Total population with sepsis prevalence: 2,16%



Basic Model

Based on blood count
Sensitivity: 50%

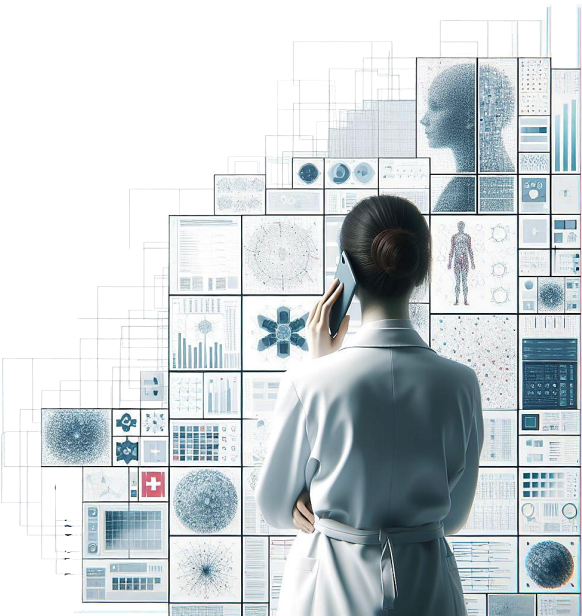
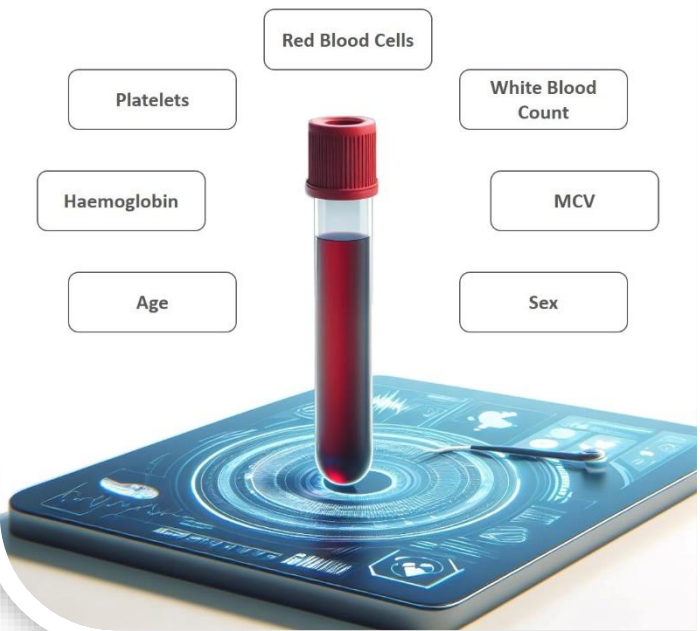
AI-Screening



Custom Model

Extended Data

Sepsis Screening: Minimal Blood Count Parameters Required for Basic-Model



AMPEL Core Team

Martin Federbusch



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Alexander Twrdik



Daniel Steinbach



Let's make medical AI open and collaborative!

