



AMPEL-CDSS: Aus der Forschung in die Versorgung

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Model-based Decision Support

If / Then
Guideline-oriented

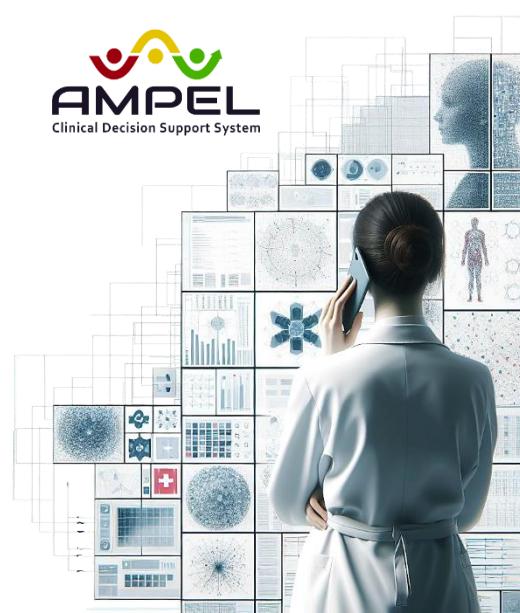
Machine
Learning



Patient Safety

Diagnostic Innovation

From the clinic to the clinic



Clinical Decision Support System (CDSS) for structured data

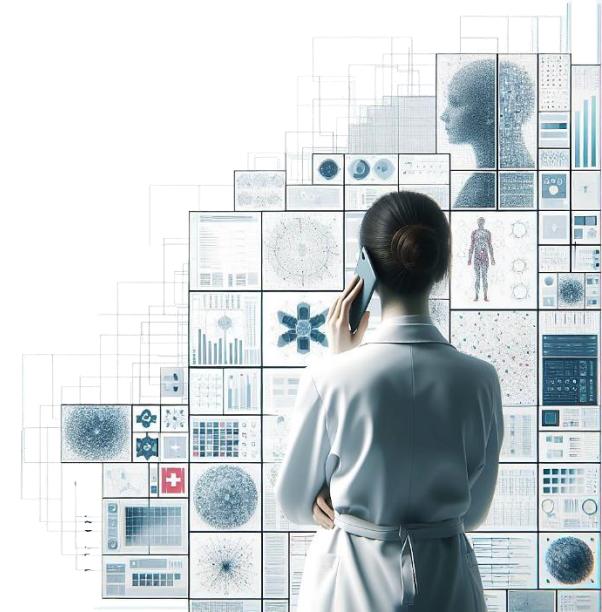
>5
Years of clinical application

>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

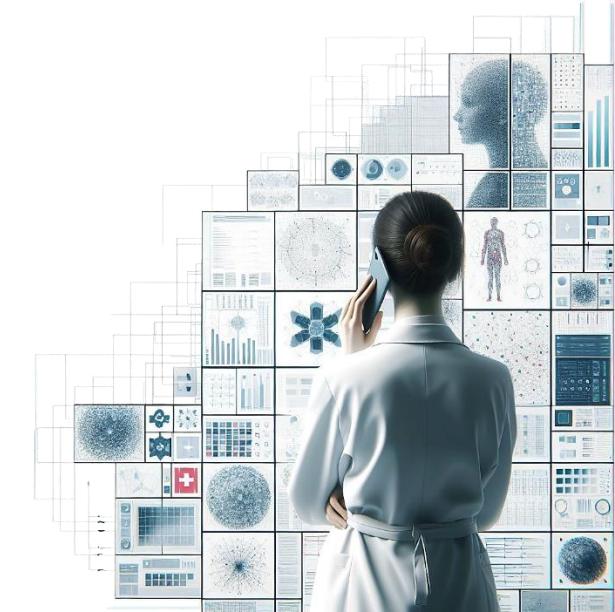


Machine Learning



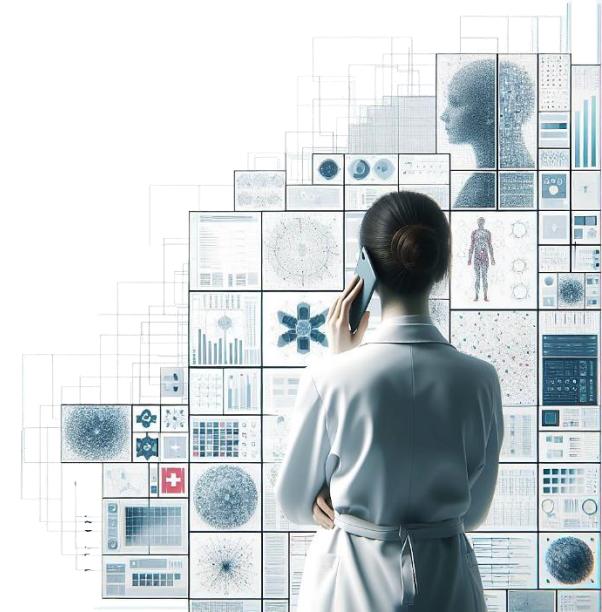
Evidenced patient safety

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...

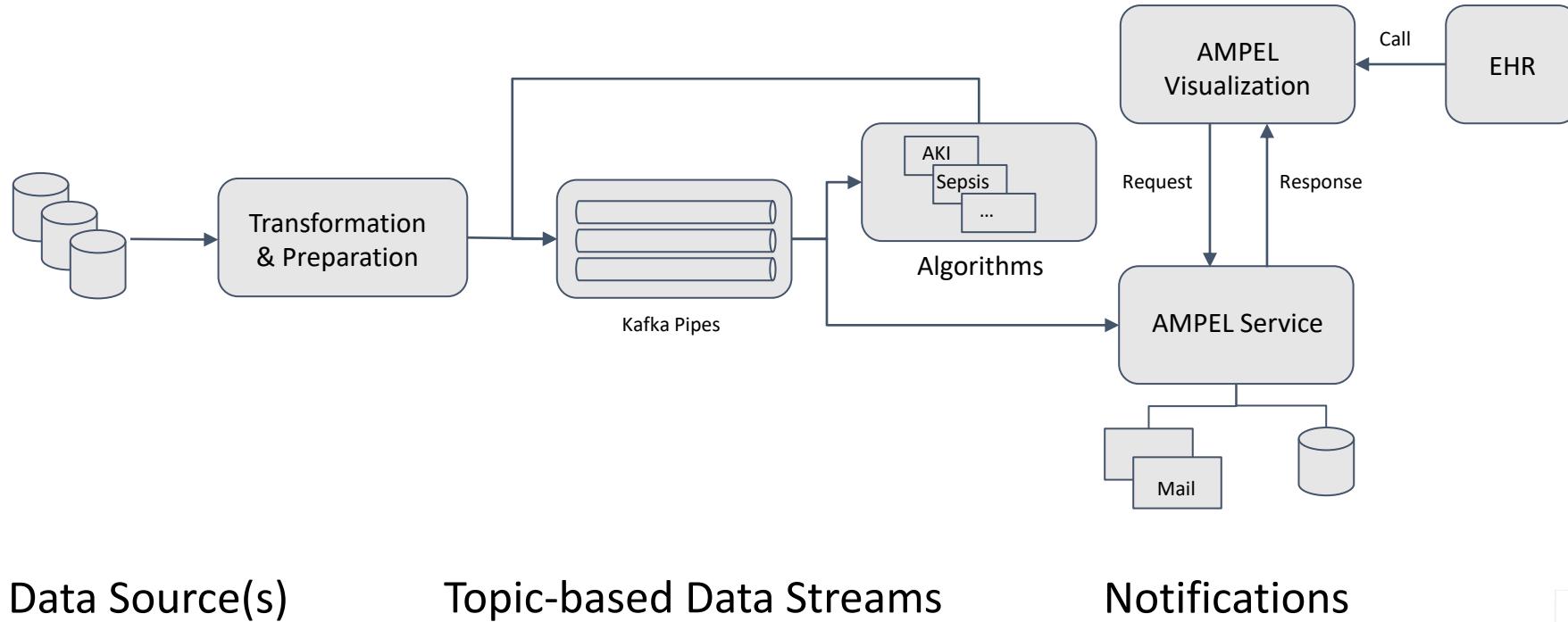
Medical Device

Real-time

Open Source

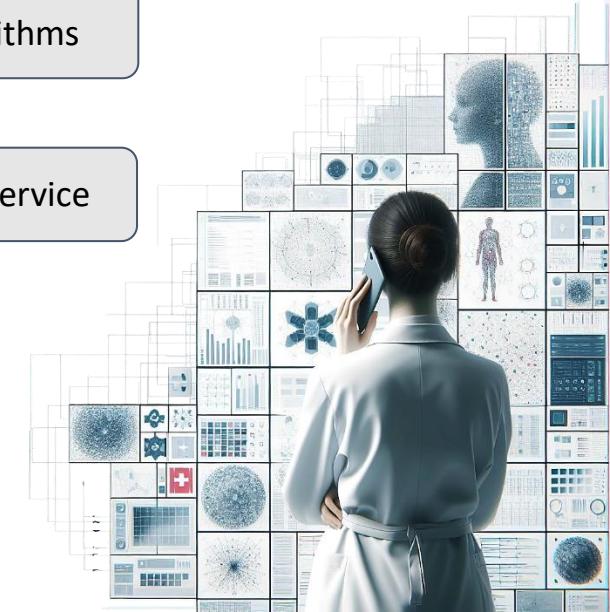
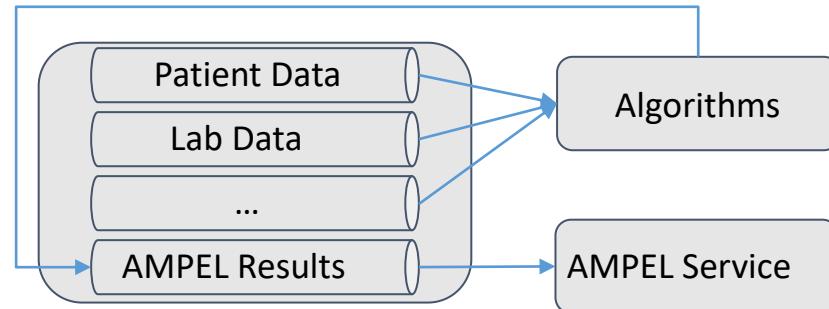


High-Level System Architecture



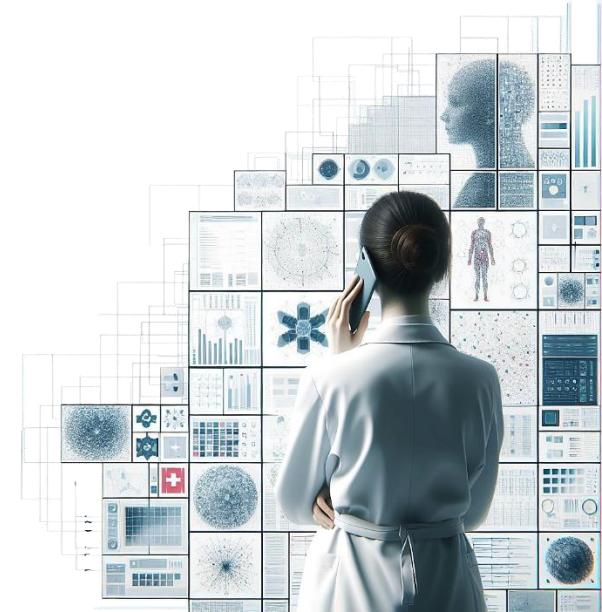
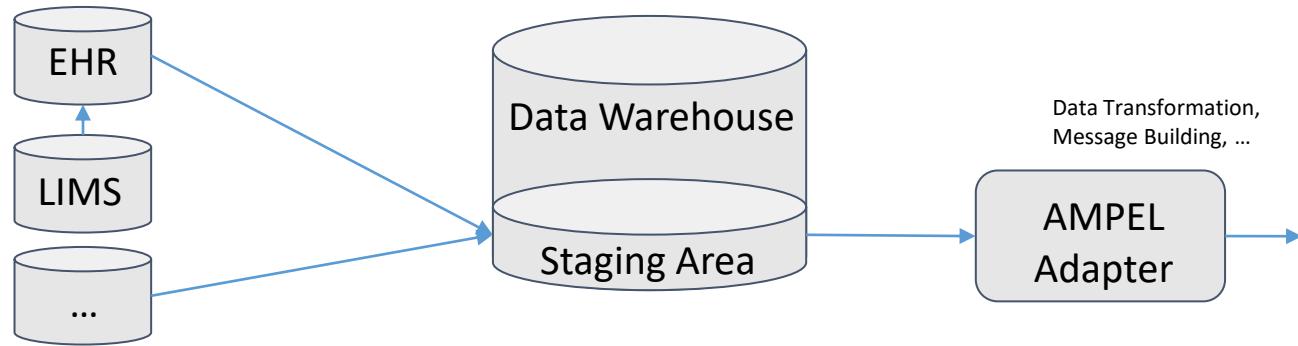
Apache Kafka - Basics and Pipes

- 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



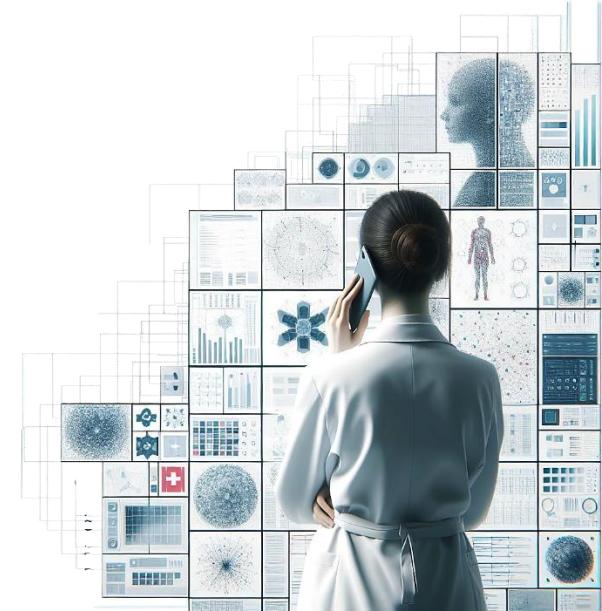
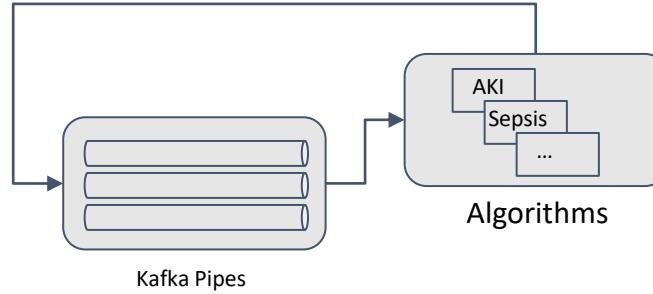
Data Sources

- 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



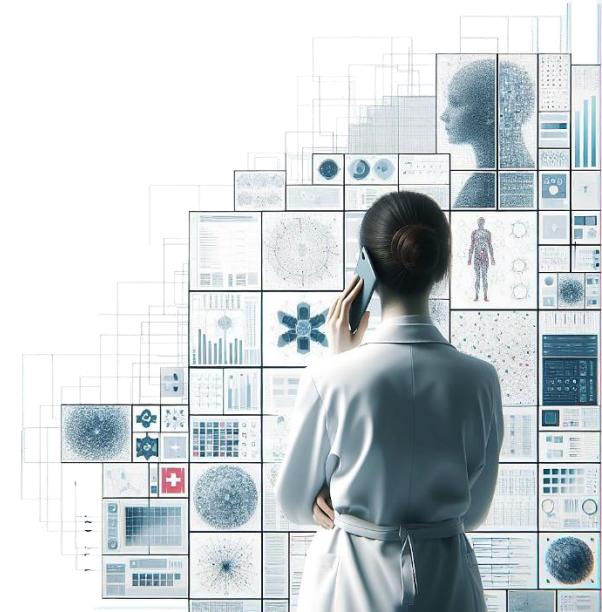
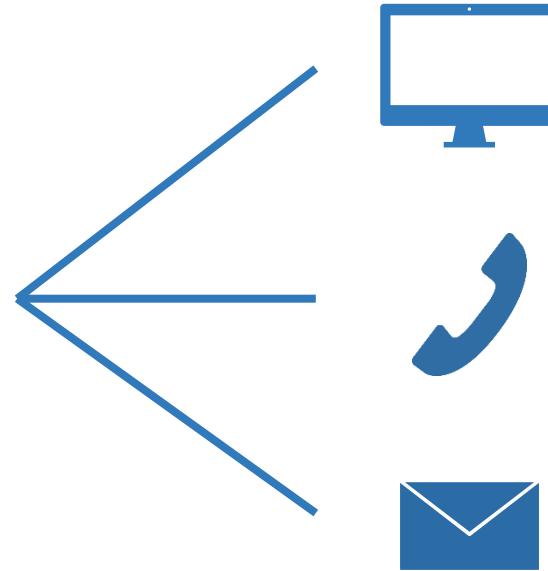
AMPEL Models

- 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 Alarne 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: **Leipziger Universitätsklinikum** Geschlecht: **Weiblich** Alter: **82** Ausgabe am: **10.07.2023**

Einrichtung: **Fall** Patient: **22221** Uhrzeit: **10:23:07**

AMPEL Clinical Decision Support System

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? <input type="button" value="Ja"/> <input type="button" value="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	Geb.Datum	AMPEL	R	Studie	Abw.	PP
F1092	F04X1014							
F1090	F04X1010							
F1094	F04X1017							
F1084	F04X1002							
F1097	F04X1021							
F1092	F04X1013							
F1091	F04X1012							
F1098	F04X1024							
F1084	F04X1001							
F1086	F04X1003							
F1095	F04X1019							
F1088	F04X1005							
F1088	F04X1023							
F1095	F04X1020							

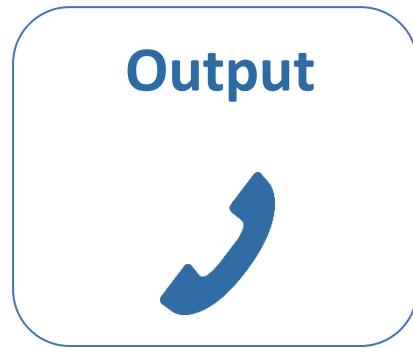
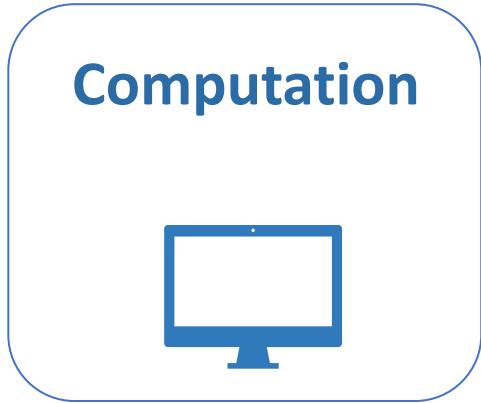
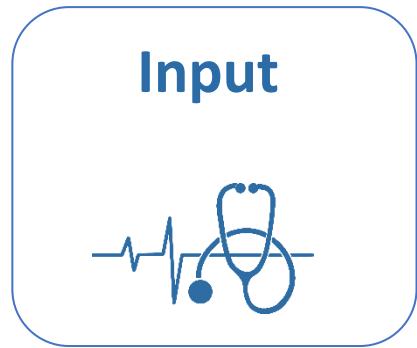


Medical Device Regulation (MDR)

- 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



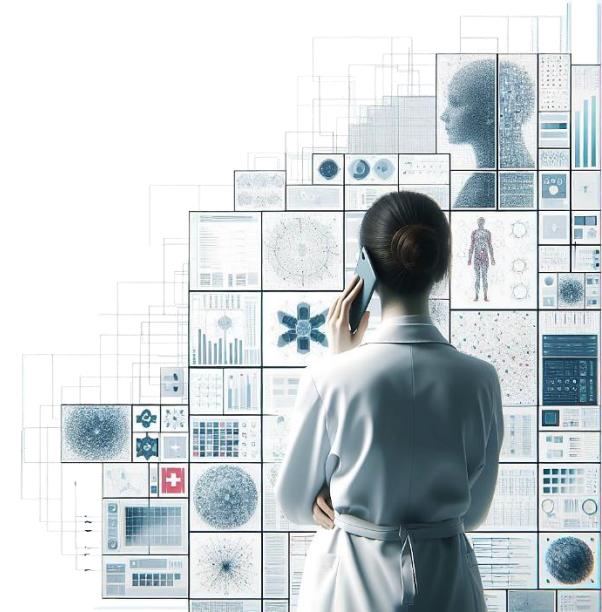
AMPEL Concept



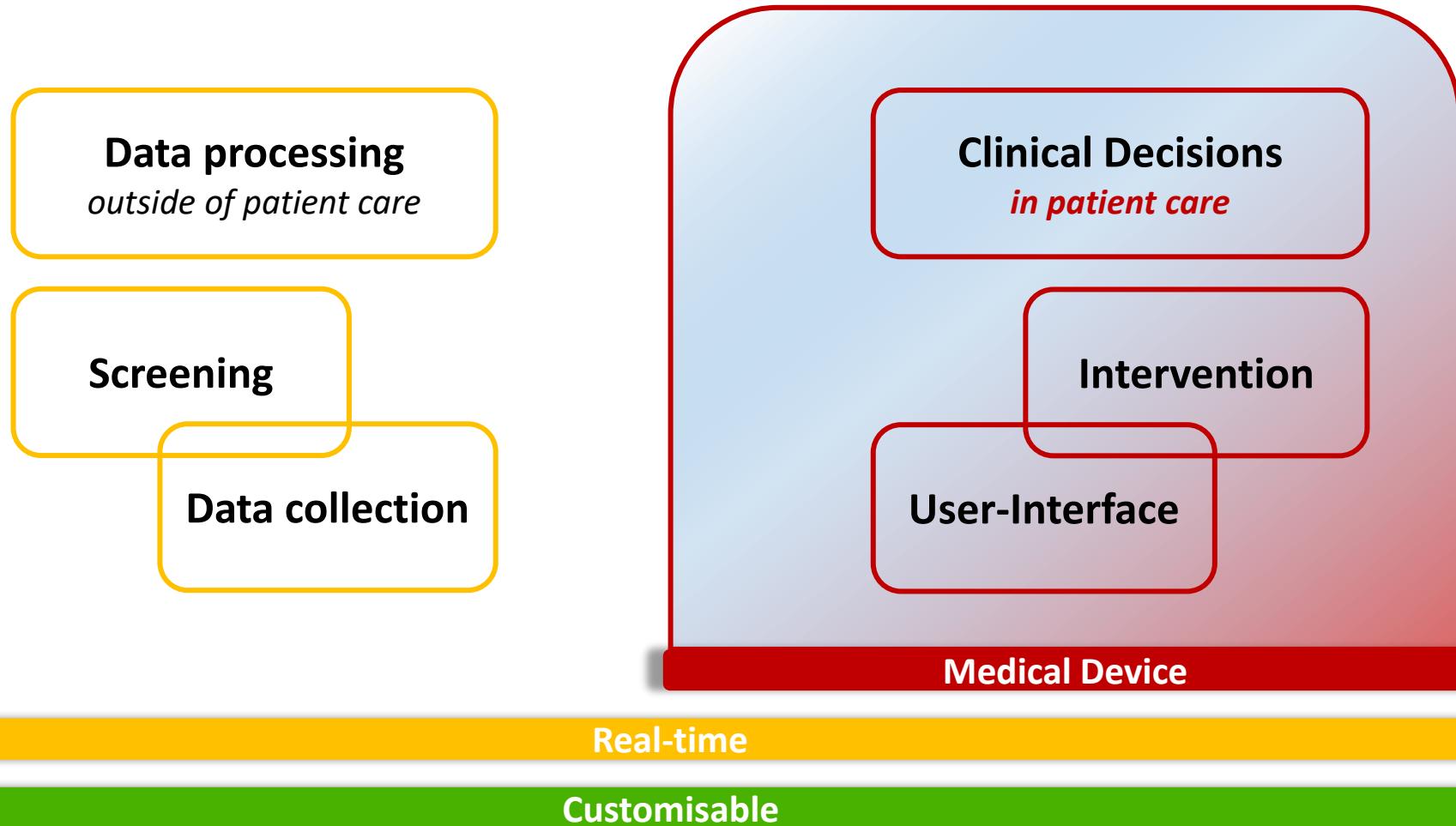
Medical Device

Real-time

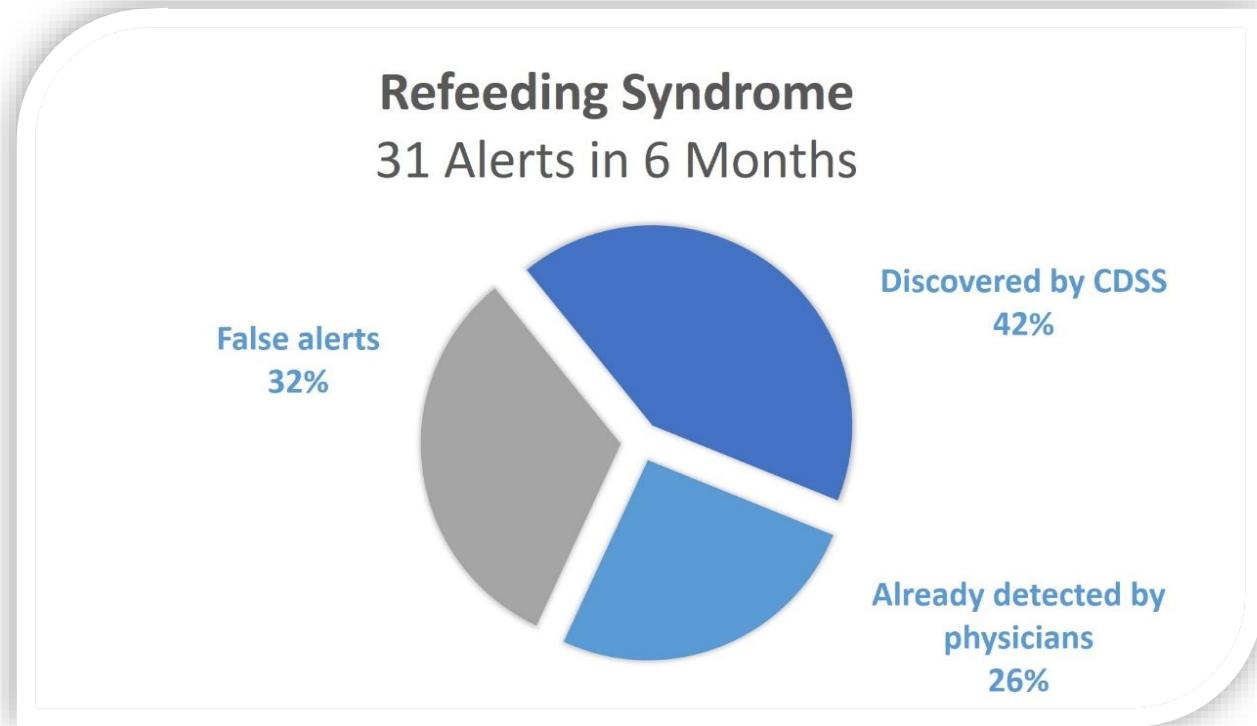
Customisable



AMPEL Studies



Refeeding Syndrome



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 Verdacht auf das Refeeding-Syndrom auslöst.



Refeeding Syndrom

Data Input

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

Pressemitteilung vom 23.05.2023

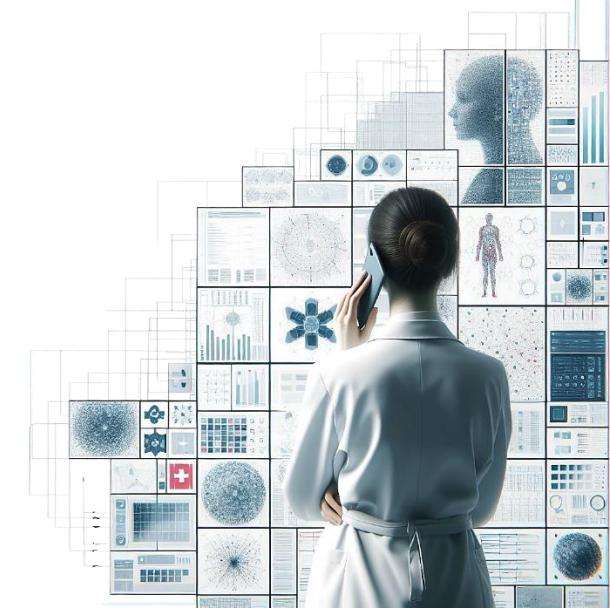
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Lara Heuft, Jenny Voigt, Lars Selig et al. (2023): Development, Design and Utilization of a CDSS for Refeeding Syndrome in Real Life Inpatient Care—A Feasibility Study. In *Nutrients*



Sepsis

Early Sepsis Detection

Emergency Department: AI-Screening with blood count data

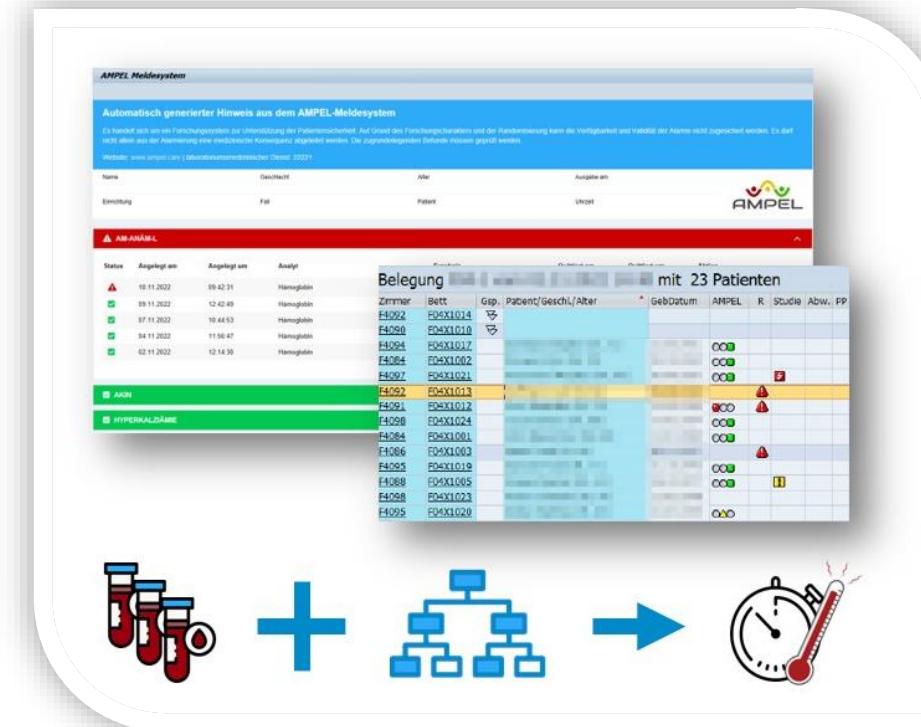
- False alerts per detection (50% Sensitivity)

45,3

Random

9,9

AMPEL



AMPEL-Meldesystem

Automatisch generierter Hinweis aus dem AMPEL-Meldesystem

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Werber: www.ampel.org | Observationalmedizinischer Dienst 2024

Name	Geschlecht	Alter	Ausgabe am
Einstellung	Frau	Patient	Unsichtbar

AMPEL

AM-ANÄMIE

Status	Angenommen am	Angenommen von	Analyse
⚠️	19.11.2022	09:42:31	Hämoglobin
✅	19.11.2022	12:42:49	Hämoglobin
✅	07.11.2022	10:44:53	Hämoglobin
✅	04.11.2022	11:56:47	Hämoglobin
✅	02.11.2022	12:14:39	Hämoglobin

Belegung

mit 23 Patienten

Zimmer	Bett	Gip., Patient/Geschl./Alter	Gebdatum	AMPEL	R.	Studie	Abw.	PP
F4022	F04X1014	...	...	...	...	...	...	...
F4029	F04X1019	...	...	...	...	...	...	...
F4024	F04X1017	...	...	...	...	...	...	...
F4026	F04X1002	...	...	...	...	...	...	...
F4027	F04X1021	...	...	...	...	...	...	...
F4022	F04X1013	...	...	...	...	...	...	...
F4021	F04X1012	...	...	...	...	...	...	...
F4028	F04X1024	...	...	...	...	...	...	...
F4024	F04X1001	...	...	...	...	...	...	...
F4026	F04X1003	...	...	...	...	...	...	...
F4025	F04X1019	...	...	...	...	...	...	...
F4028	F04X1005	...	...	...	...	...	...	...
F4029	F04X1023	...	...	...	...	...	...	...
F4095	F04X1020	...	...	...	...	...	...	...

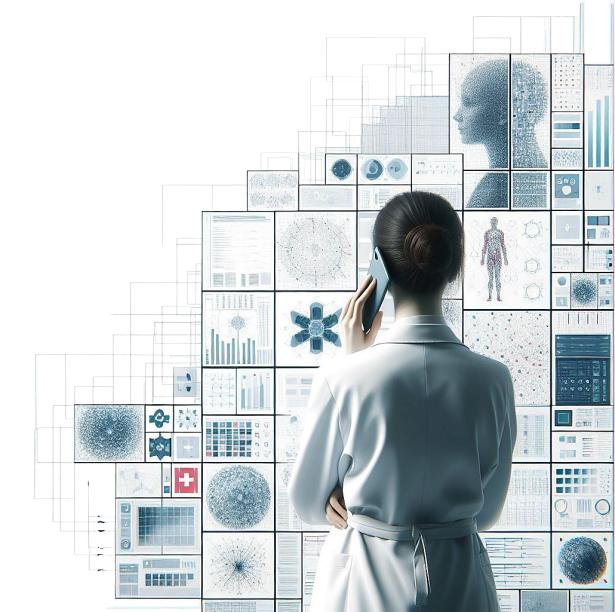
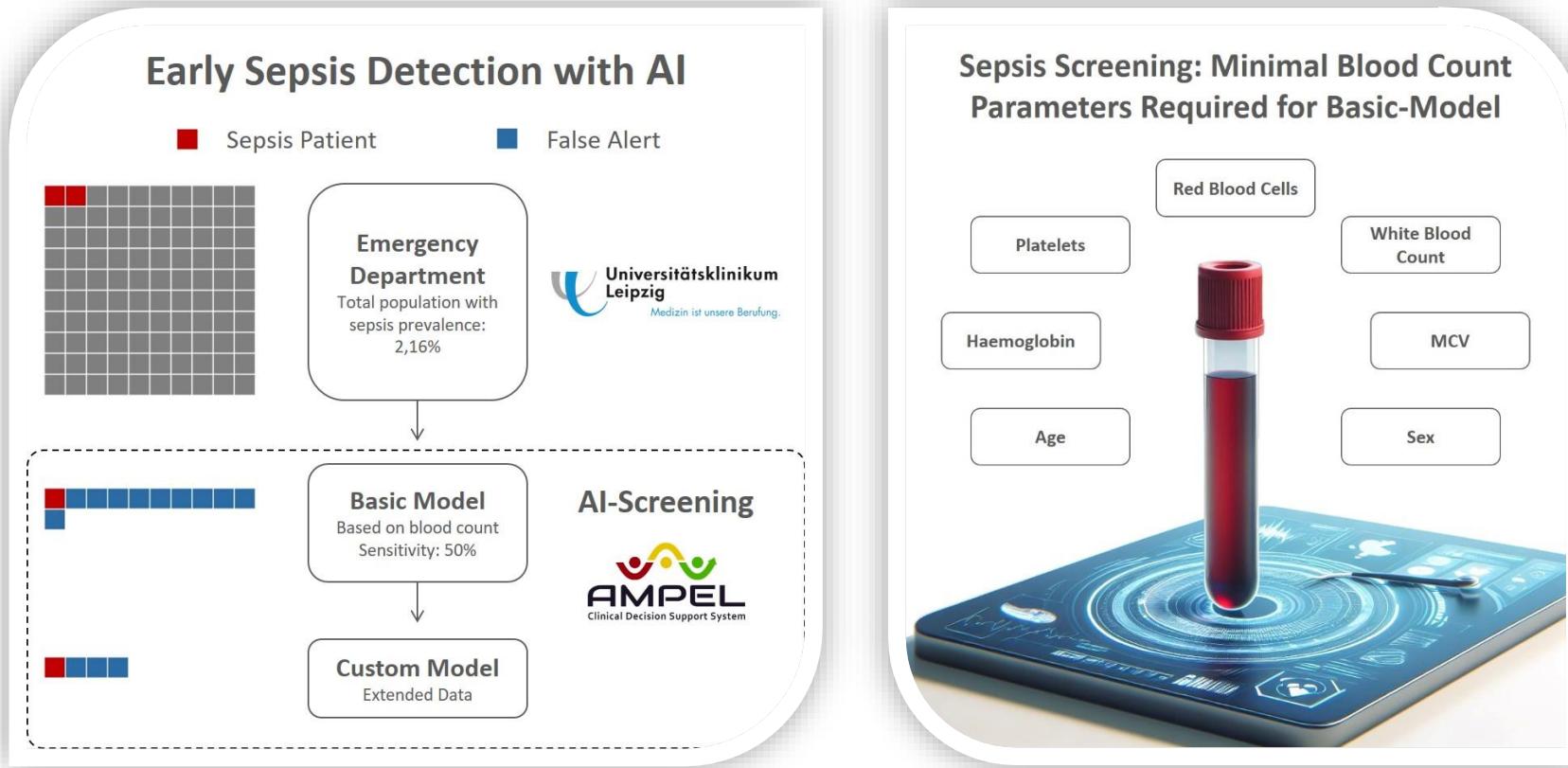
AKN

HYPERALKALIEMIE

Icon: Blood samples + Machine learning model = Early detection



Sepsis



AMPEL Core Team

Martin Federbusch



Toralf Kirsten



Maria Schmidt



Alexander Twrdik



Daniel Steinbach



Let's make medical AI open and collaborative!

