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PERISCOPE: an AI tool for the early detection of postoperative infections

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Disclosures of interest - Siri van der Meijden

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- Head of clinical affairs at Healthplus.ai, Amsterdam, The Netherlands

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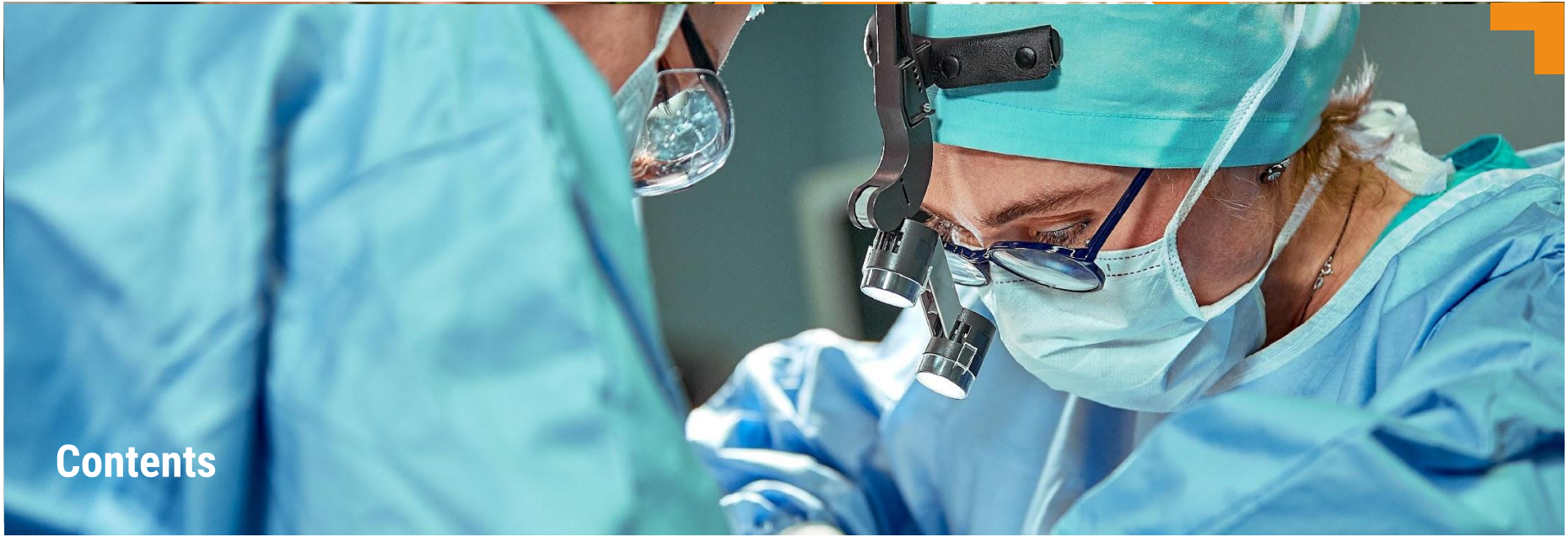
POSTOPERATIVE INFECTION
AI PREDICTIONS



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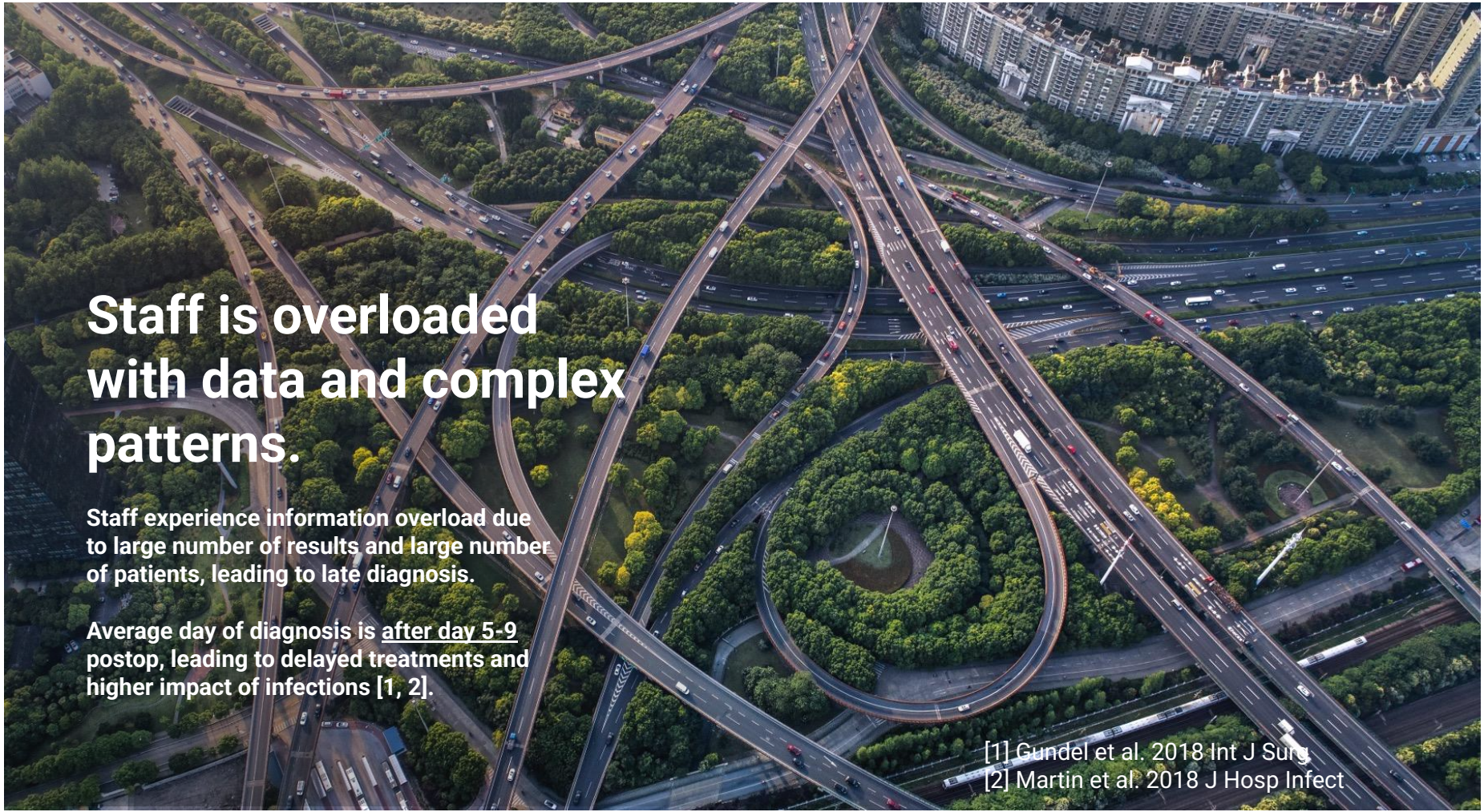
Postoperative infections impact everyone

Up to 1 in 5 patients run into an infection after their surgery despite programs like ERAS.

An infection can be a superficial or deep wound infection, pneumonia, urinary tract infection or other type of infection.



Staff is overloaded with data and complex patterns.

Staff experience information overload due to large number of results and large number of patients, leading to late diagnosis.

Average day of diagnosis is after day 5-9 postop, leading to delayed treatments and higher impact of infections [1, 2].

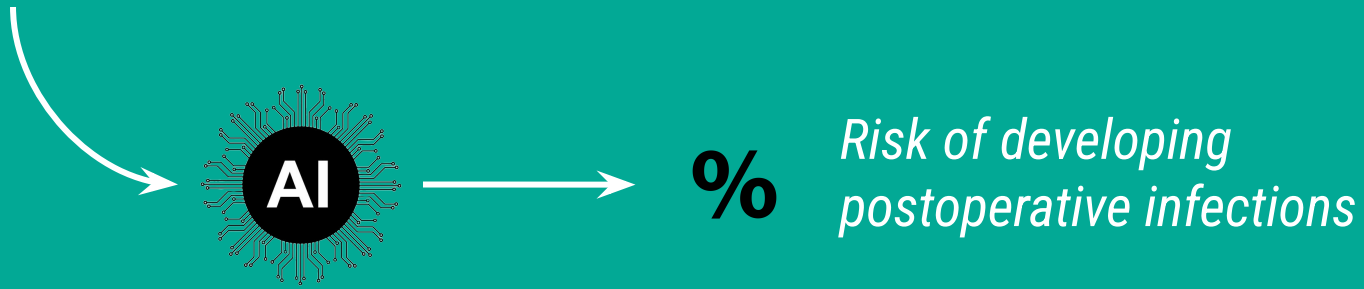
[1] Gundel et al. 2018 Int J Surg
[2] Martin et al. 2018 J Hosp Infect

Patient data could be used to support decision making

~15,000 surgical patients per hospital per year

Up to 10 years of electronic health record data

~ 150,000 patient records per hospital available

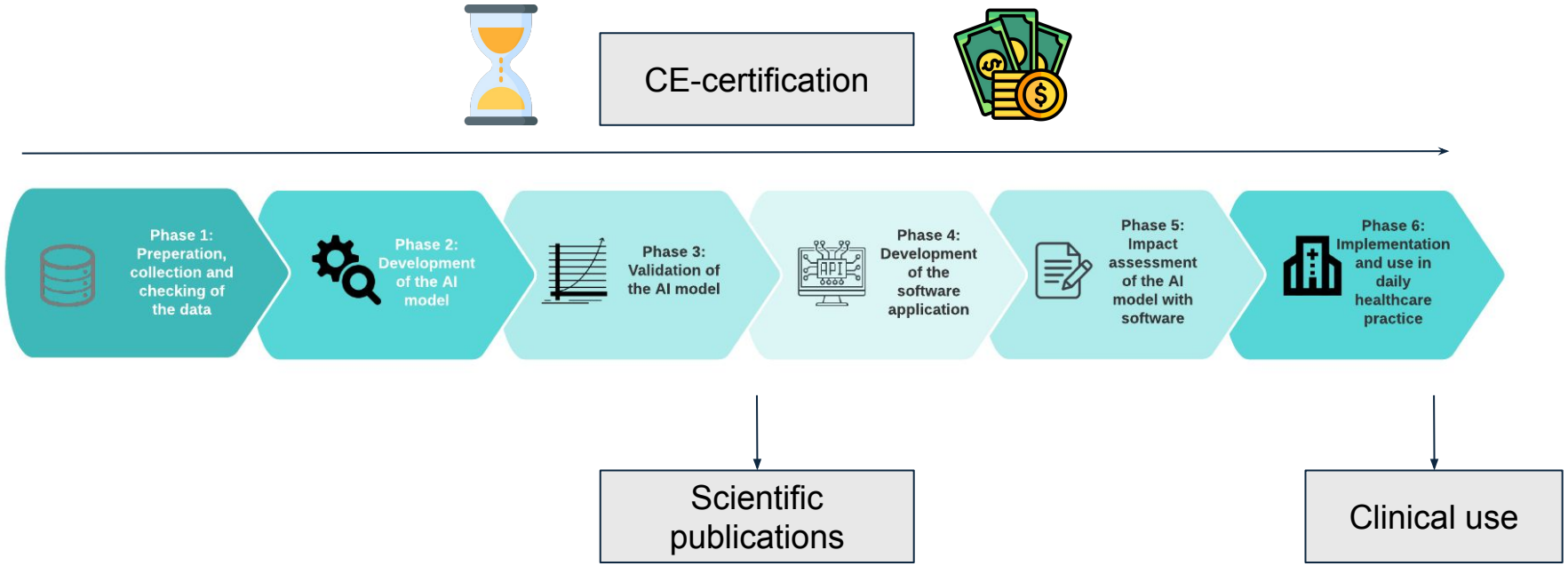


Accurate postoperative infection risk estimates

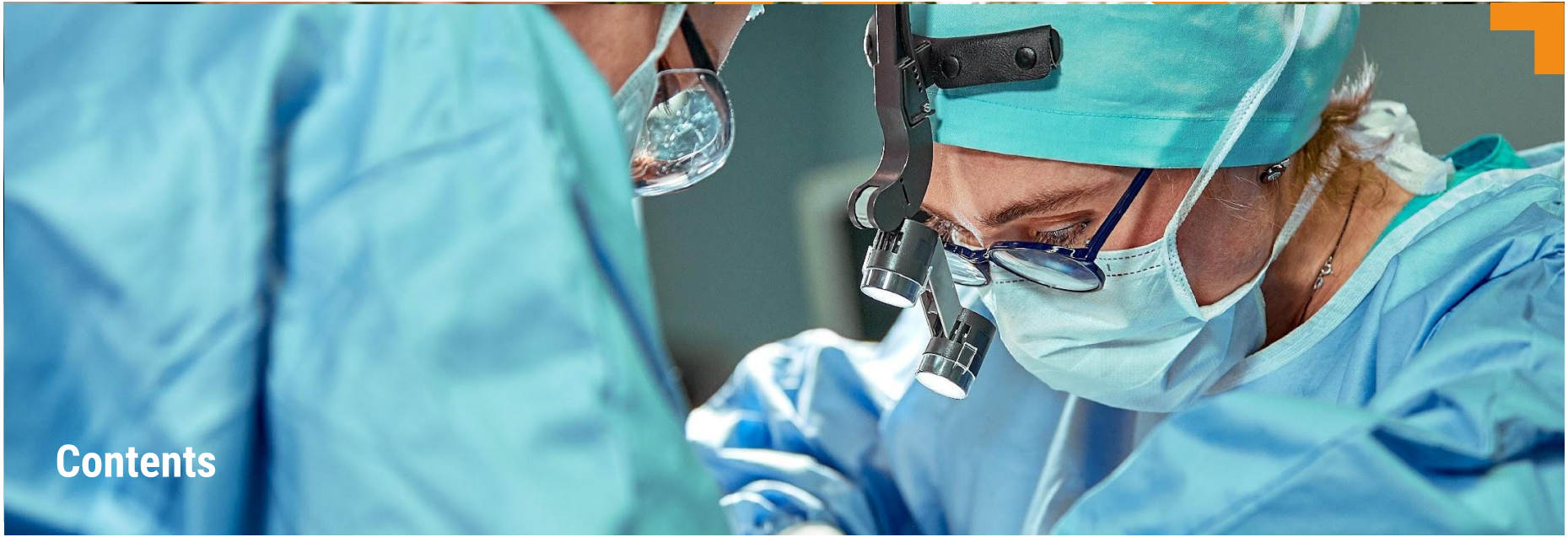
*before, during, and/or **after** surgery*

- ➔ *Enable better decision-making*
- ➔ *Tailored prevention and monitoring*
- ➔ *Potentially reduce the impact of postoperative infections*

Gap between model development and clinical implementation



98% of projects end here!



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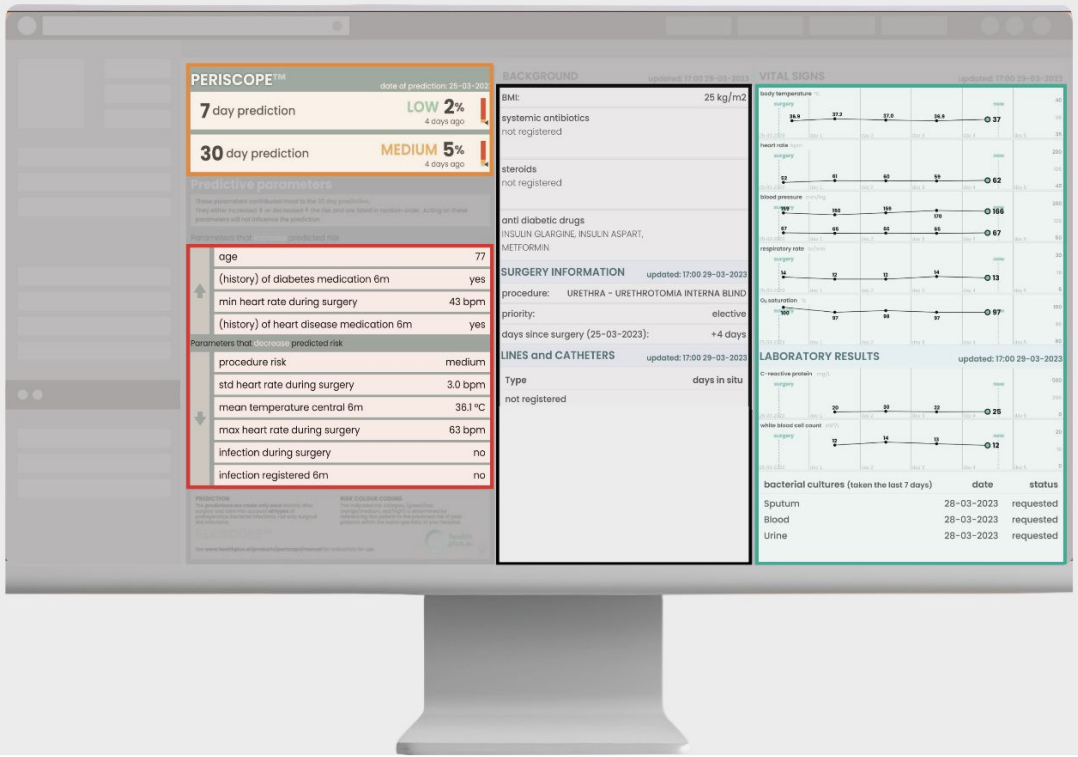
Goals of PERISCOPE providing postoperative infection risk predictions to enable proactive care

PERISCOPE is CE-certified and integrated in the electronic health record



Predictions

Single 7 & 30-day & traffic light

Background

Relevant surgery and patient data

Trend display

Continuously updated relevant laboratory and vital signs information

Explainability

Parameters that increase and decrease the likelihood of an infection

PERISCOPE™

date of prediction : 22-07-2022

7 day prediction — **HIGH 23 %**

30 day prediction — **HIGH 30 %**

Predicitive parameters

These parameters contributed most to the **30 day prediction**.
They either increased ▲ or decreased ▼ the predicted risk and are listed in random order. Acting on these parameters will not influence the prediction.

Parameters that **increase** predicted risk

BMI	33 kg/m²
age	68 years
diabetes mellitus type 2	
hypertension	
specialty	URO
gender	male
procedure time	5.2 hrs

Parameters that **decrease** predicted risk

procedure type	elective
respiratory rate 23-07-2022	12 br/min
heart rate 23-07-2022	74 bpm

PREDICTION
The prediction is made only once directly after surgery and includes all types of postoperative bacterial infections (e.g., surgical site infections, pneumonia, urinary tract infections)

RISK COLOUR CODING
The indicated risk category (low/green, medium/orange, high/red) is determined by referencing this patient to the predicted risk of past patients in your hospital.

PERISCOPE™

See **www.healthplus.ai/product/periscope/manual** for instruction for use.

health plus.ai

BACKGROUND

updated : 12:22 28-07-2022

BMI	33 kg/m²
systemic antibiotics	
steroids	
diabetic drugs	metformin

SURGERY INFORMATION

updated : 12:22 28-07-2022

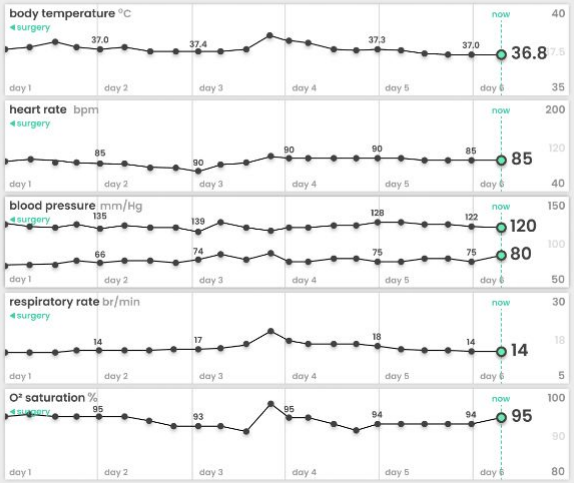
procedure :	partial nephrectomy
type of surgery :	elective
days since surgery (24-07-2022)	+6 days

INDWELLING LINES and CATHETERS

Location	days in situ
urine	6 days
wound drain	6 days
peripheral venous	6 days

VITAL SIGNS

updated : 12:22 28-07-2022



LABORATORY RESULTS

updated : 12:22 28-07-2022

bacterial cultures (taken the last 7 days)	date	status
sputum	24-07-2022	requested

THE LANCET *Regional Health*
Europe

Articles

Development and validation of artificial intelligence models for early detection of postoperative infections (PERISCOPE): a multicentre study using electronic health record data

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The Lancet Regional Health - Europe
2025;49: 101163

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Summary

Background Postoperative infections significantly impact patient outcomes and costs, exacerbated by late diagnoses, yet early reliable predictors are scarce. Existing artificial intelligence (AI) models for postoperative infection prediction often lack external validation or perform poorly in local settings when validated. We aimed to develop locally valid models as part of the PERISCOPE AI system to enable early detection, safer discharge, and more timely treatment of patients.

Methods We developed and validated XGBoost models to predict postoperative infections within 7 and 30 days of surgery. Using retrospective pre-operative and intra-operative electronic health record data from 2014 to 2023 across various surgical specialities, the models were developed at Hospital A and validated and updated at Hospitals B and C in the Netherlands and Belgium. Model performance was evaluated before and after updating using the two most recent years of data as temporal validation datasets. Main outcome measures were model discrimination (area under the receiver operating characteristic curve (AUROC)), calibration (slope, intercept, and plots), and clinical utility (decision curve analysis with net benefit).

Findings The study included 253,010 surgical procedures with 23,903 infections within 30-days. Discriminative performance, calibration properties, and clinical utility significantly improved after updating. Final AUROCs after updating for Hospitals A, B, and C were 0.82 (95% confidence interval (CI) 0.81–0.83), 0.82 (95% CI 0.81–0.83), and 0.91 (95% CI 0.90–0.91) respectively for 30-day predictions on the temporal validation datasets (2022–2023). Calibration plots demonstrated adequate correspondence between observed outcomes and predicted risk. All local models were deemed clinically useful as the net benefit was higher than default strategies (treat all and treat none) over a wide range of clinically relevant decision thresholds.

Interpretation PERISCOPE can accurately predict overall postoperative infections within 7- and 30-days post-surgery. The robust performance implies potential for improving clinical care in diverse clinical target populations. This study

Development & validation steps of PERISCOPE

1. Data preparation:
   a. Identify relevant risk factors
   b. Identify patients with infections
2. Model training (hospital A)
3. Model validation & evaluation (hospital B&C)
4. Model ***recalibration*** (hospital B&C)
5. Final evaluation

→ Implementation in clinical settings

van der Meijden, Siri L.de Heer, Pieter et al. Development and validation of artificial intelligence models for early detection of postoperative infections (PERISCOPE): a multicentre study using electronic health record data. The Lancet Regional Health – Europe, Volume 49, 101163

Objective

To develop **locally valid** postoperative infection predictive models to assist early detection of a postoperative infection

Patient population

All **adult** (>18 years old) surgical patients from **general surgery, neurosurgery, orthopedic surgery, gynecology, urology and cardiothoracic surgery,** that underwent **invasive surgery** and did not have an infection at the moment of surgery.

Development & validation steps of PERISCOPE

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→ Implementation in clinical settings

Data collection and preparation

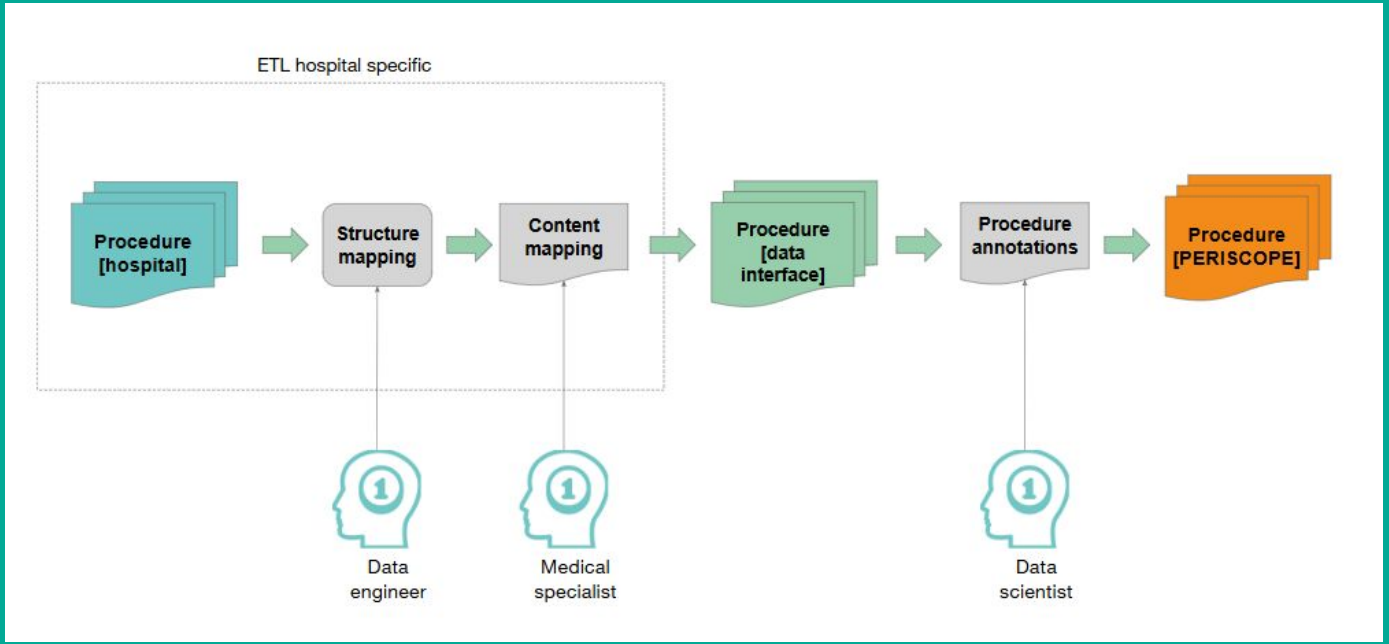
Predictive parameters (n = 60)
Pre-and intraoperative data

- Surgery information
- Demographics
- Medication
- Patient history
- Vital signs
- Laboratory results

Input variables Pre- and intraoperative features

Procedures	Surgery priority, Body location, Procedure start/end date and time, Name
Patients	Sex, age
Medications	Diabetes medication, hypertension medication, corticosteroids
Conditions	Diabetes, hypertension
Vital signs	**Pre- and intraoperative:** Heart rate, Temperature, Temperature nose, Respiratory rate, Systolic blood pressure, Diastolic blood pressure, SpO2, FiO2
Lab results	**Preoperative:** Haemoglobin, ALAT, CRP, Leukocytes, Cultures
Others observations	Body Mass Index (BMI), Height, Weight
Questionnaire	ASA score, Expected amount of days of admission, Actual days admitted before surgery, Presence of hypertension, Presence of diabetes

Data collection, quality checks and preprocessing



Data collection and preparation

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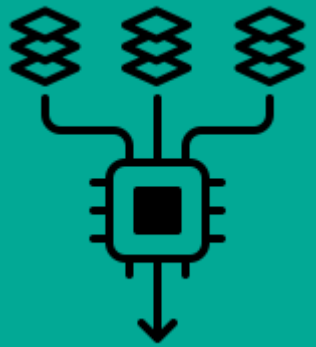
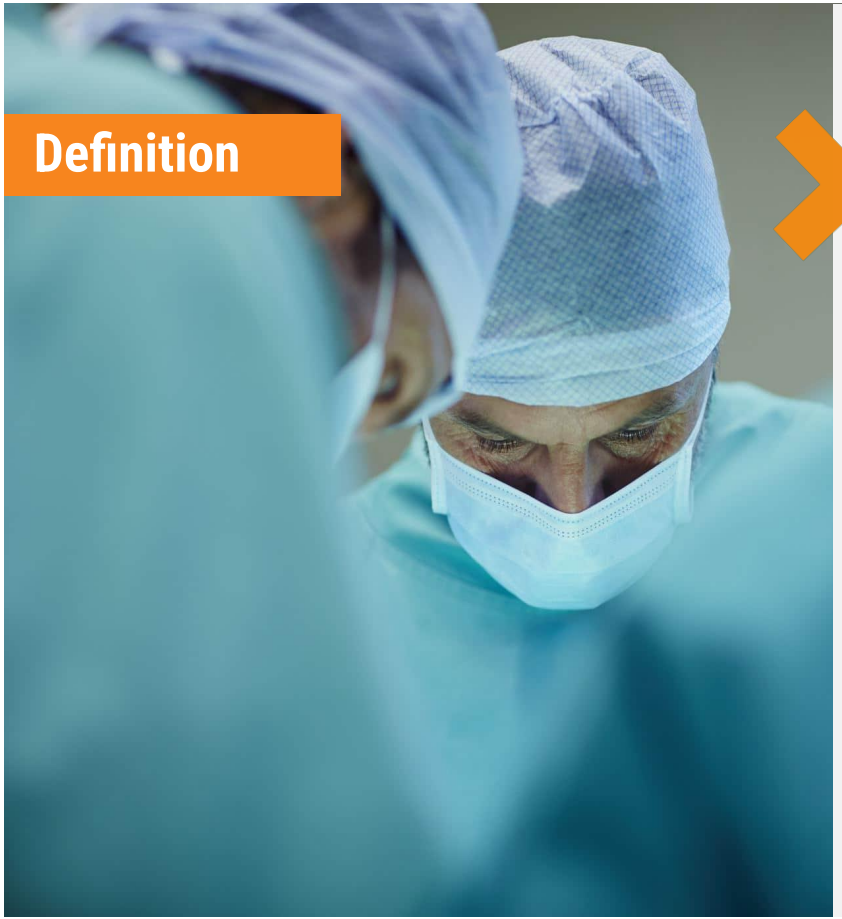
- Vital signs
- Laboratory results

Predictive parameters



Outcome: postoperative infection



Definition

Objective: Scoping review methods for identifying patients with postop infections with EHR data

Methods: Systematic search PubMed, Embase, Web of Science, Cochrane and Emcare

Results: 75 different methods and definitions used to identify patients with postoperative infections in studies published between 2003 and 2023.

Manual labelling: 65% (49/75)

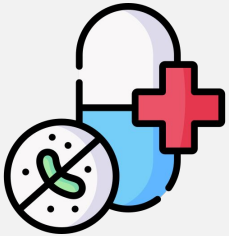
Fully automated surveillance systems limited value with PPV between 0.31 and 0.76.

Conclusions: Fully automated labelling in studies not reliable.

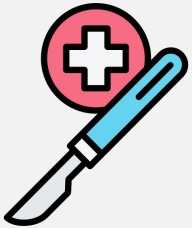
van der Meijden SL, van Boekel AM, et al. Automated Identification of Postoperative Infections to Allow Prediction and Surveillance Based on Electronic Health Record Data: Scoping Review. JMIR Med Inform 2024;12:e57195

Predicted outcome of interest (needed for model training and validation)

Infections registered by clinician



Non-prophylactic abx usage (>72h, start >24h after surgery)



Surgical intervention to treat infections

Development & validation steps of PERISCOPE

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2. **Model training (hospital A)**
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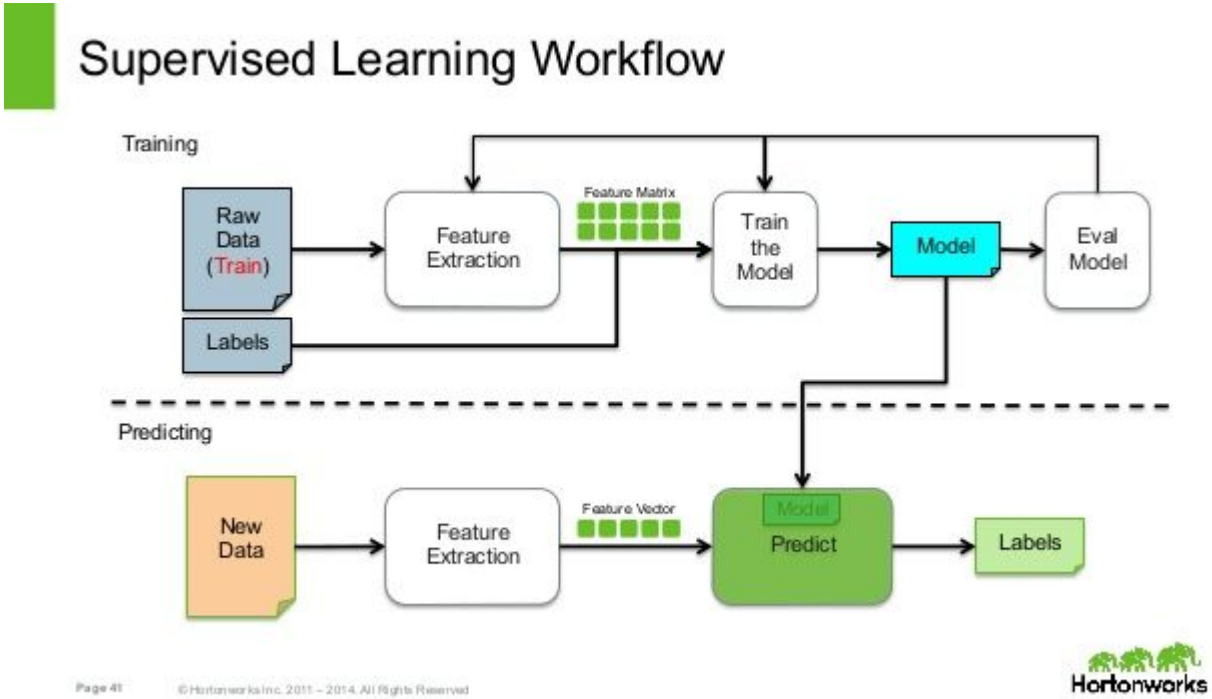
4. **Model recalibration (hospital B&C)**
5. Final evaluation

→ Implementation in clinical settings

Model training



Objective

To develop **locally valid** postoperative infection predictive models to assist early detection of a postoperative infection

What is needed to ensure that PERISCOPE performs well in a new hospital?

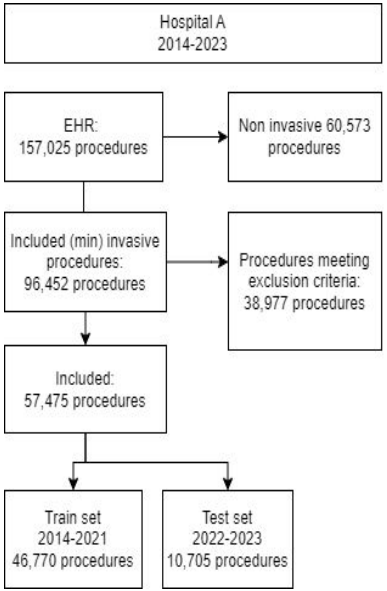
Need for model recalibration

Model recalibration may be necessary due to differences in:

- Patient populations
- Measurement methods
- Protocols
- Electronic health record systems

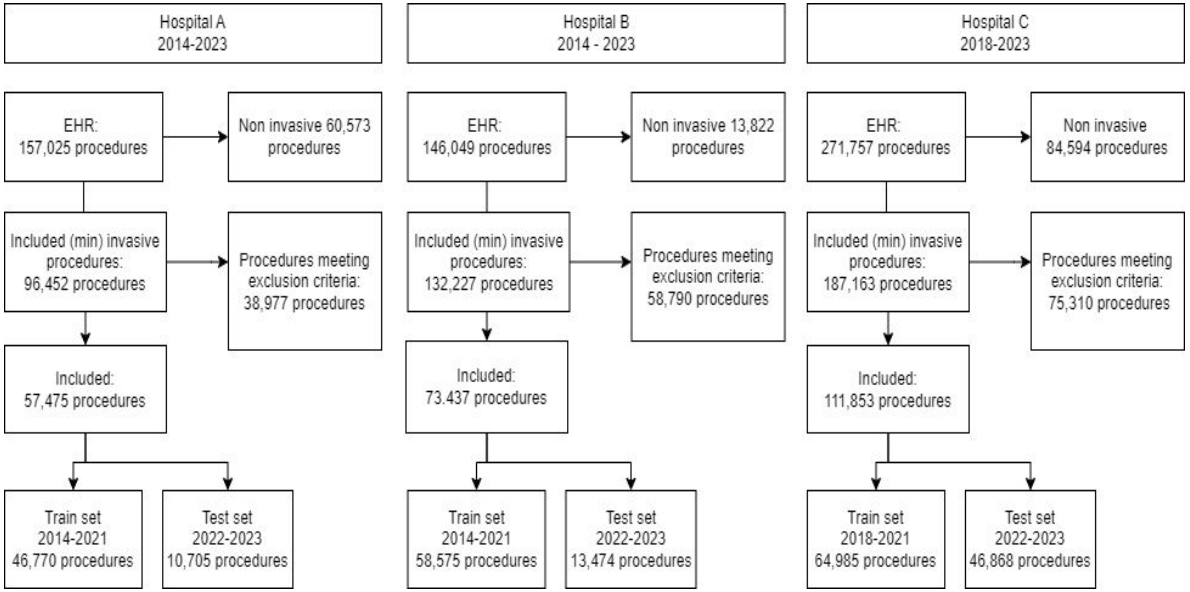
Therefore we need historical data from every hospital to recalibrate the model on!

Model training and validation in three hospitals



Initial model training

Model training and validation in three hospitals



Initial model training

Model validation and recalibration

Model validation and recalibration

AI models such as PERISCOPE need local validation and recalibration to ensure locally valid models

		Hospital A
Prediction timeframe	Metric	Test dataset
30 days	AUROC	0·82

[8] van der Meijden et al. 2024 Lancet Regional Health

AI models such as PERISCOPE need local validation and recalibration to ensure locally valid models

		Hospital A	Hospital B		Hospital C	
Prediction timeframe	Metric	Test dataset	Test dataset (before recalibration)		Test dataset (before recalibration)	
30 days	AUROC	**0·82**	0·77		0·85	

[8] van der Meijden et al. 2024 Lancet Regional Health

AI models such as PERISCOPE need local validation and recalibration to ensure locally valid models

Opinion | Open access | Published: 24 February 2023

There is no such thing as a validated prediction model

Ben Van Calster, Ewout W. Steyerberg, Laure Wynants & Maarten van Smeden

BMC Medicine **21**, Article number: 70 (2023) | Cite this article

20k Accesses | **167** Citations | **174** Altmetric | Metrics

[8] van der Meijden et al. 2024 Lancet Regional Health

Development & validation steps of PERISCOPE

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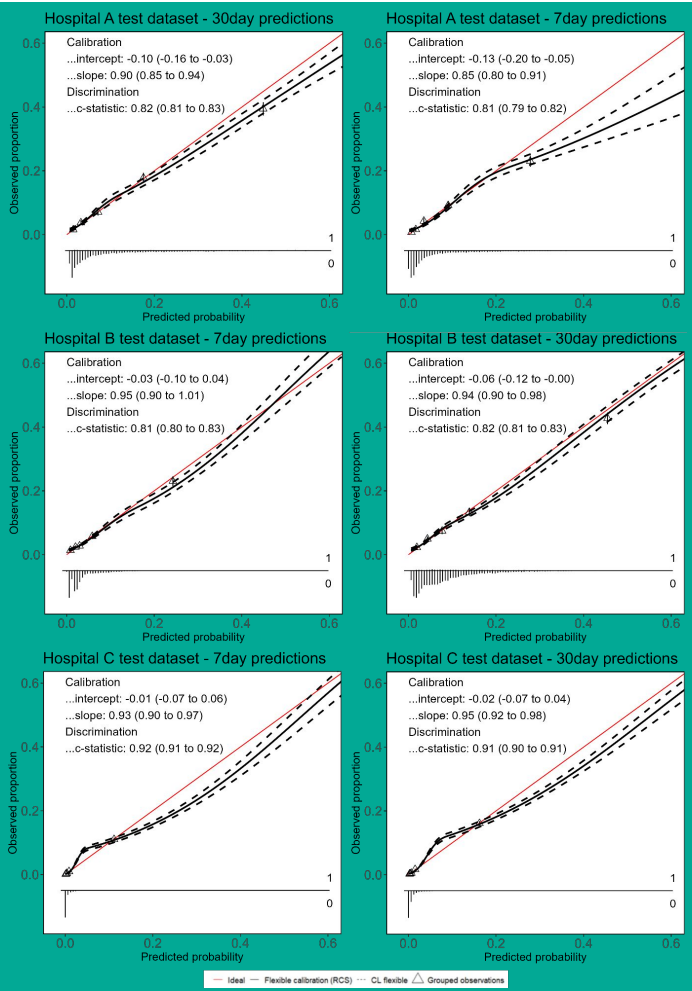
4. Model recalibration (hospital B&C)
5. **Final evaluation**

→ Implementation in clinical settings

Final evaluation

Metric	Hospital A	Hospital B	Hospital C
Infection rate (%)	14%	14%	4%
Specificity	0.74 (0.73-0.75)	0.80 (0.79-0.81)	0.86 (0.86-0.86)
Negative predictive value	0.95 (0.94-0.95)	0.94 (0.94-0.94)	0.99 (0.99-0.99)
Sensitivity	0.75 (0.73-0.77)	0.68 (0.67-0.70)	0.82 (0.80-0.84)
AUROC	0.82 (0.81-0.83)	0.82 (0.81-0.83)	0.91 (0.90-0.91)

Final evaluation



Final evaluation

Subgroup analysis

Per hospital, performance was evaluated on subgroups based on:

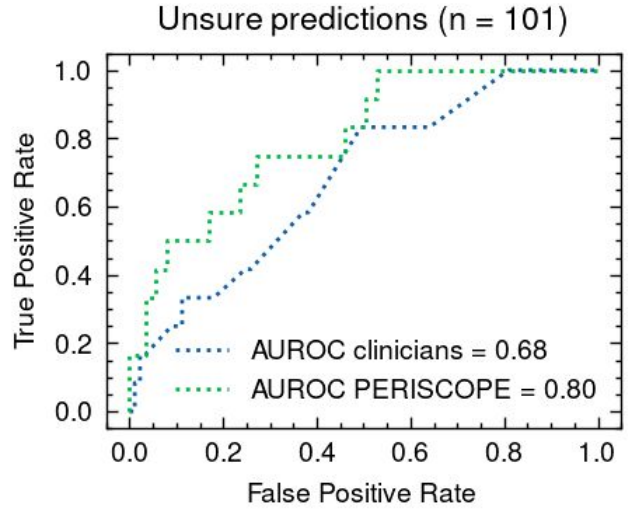
- Age
- Sex
- Surgical specialty
- Type of surgery
- Emergency vs. elective surgery

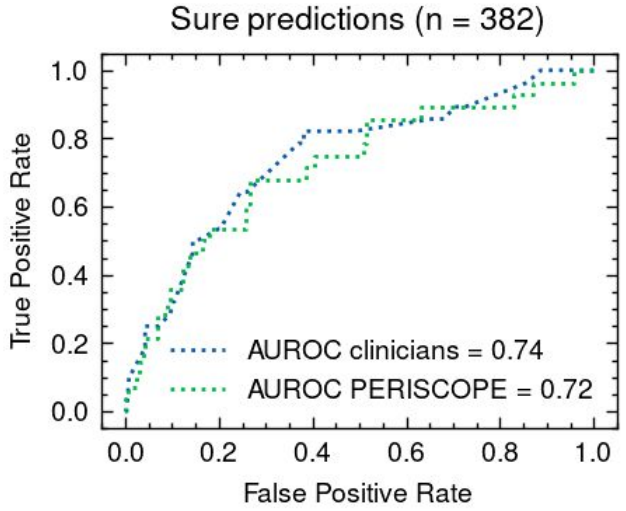
For subgroups not meeting the benchmark (AUROC > 0.70), PERISCOPE will not be implemented

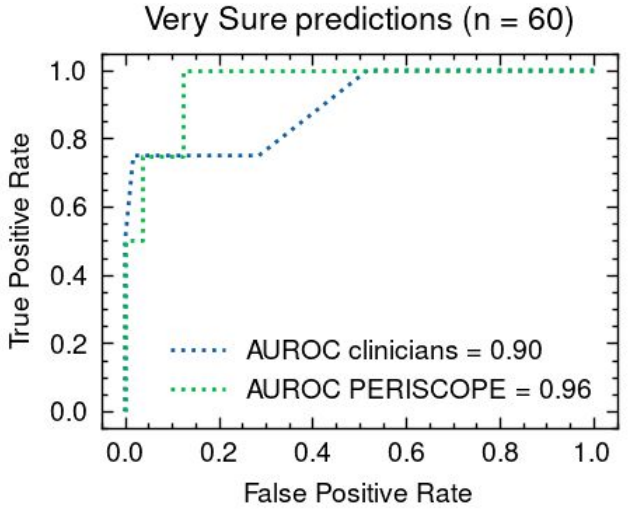
Follow-up study: doctor versus algorithm

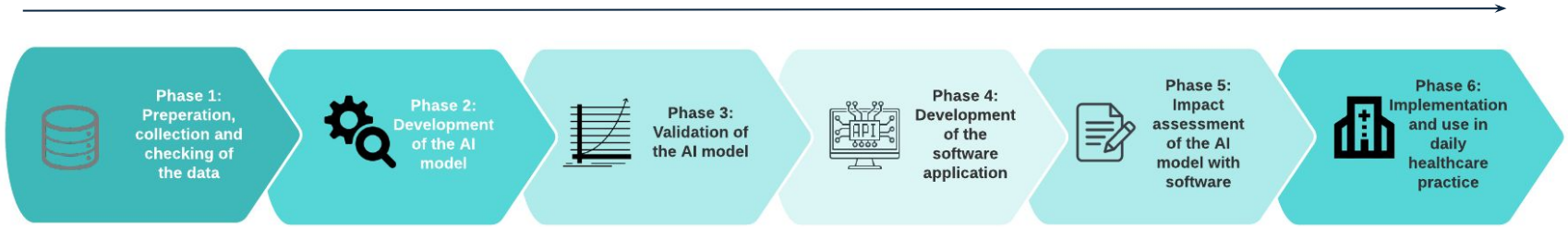
51 surgeons were asked to estimate the risk of infection directly after surgery which were compared to PERISCOPE for 501 procedures

Surgeons needed to indicate how sure they were about there predictions.



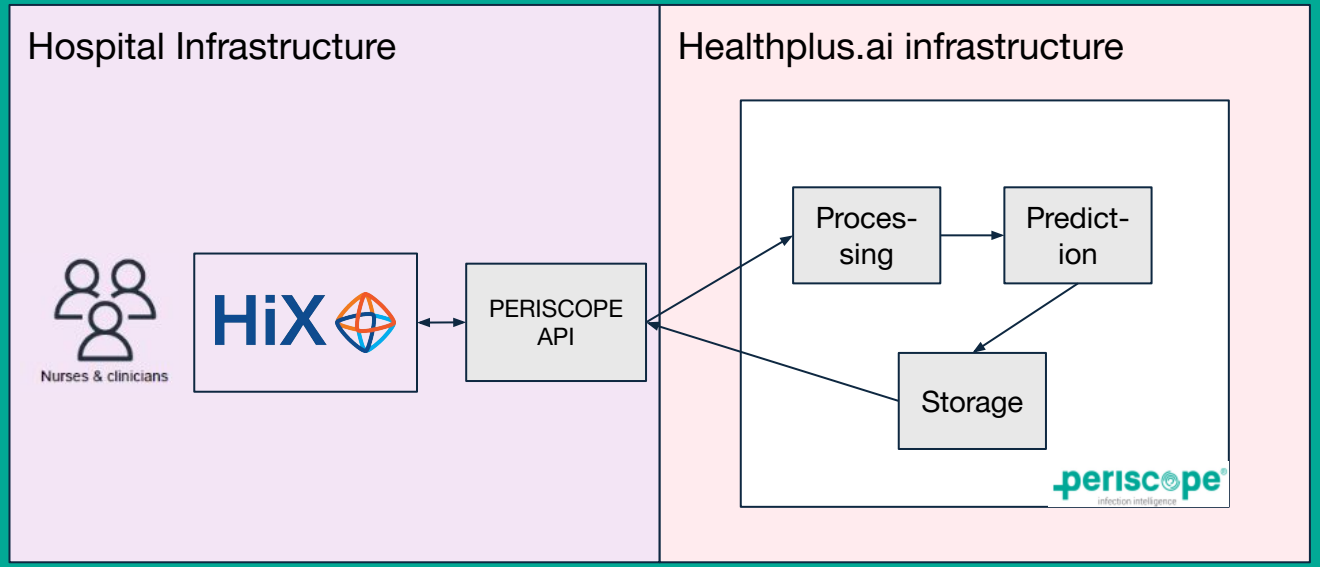


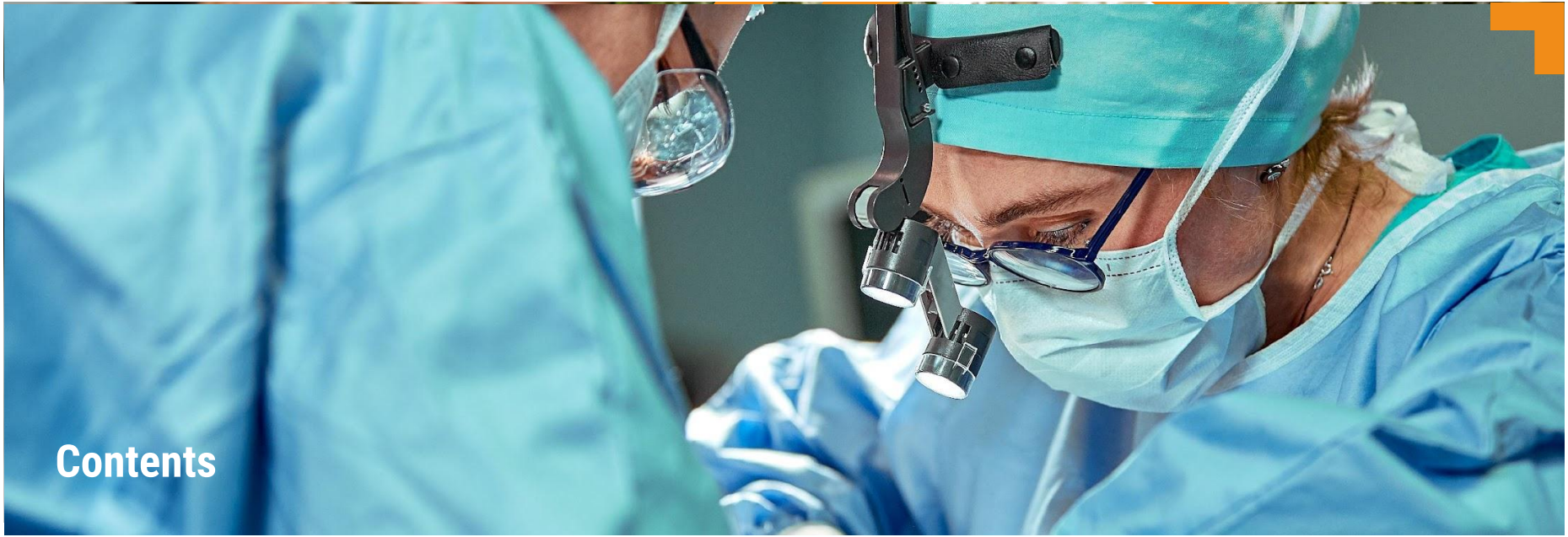




Clinical use

Software application development





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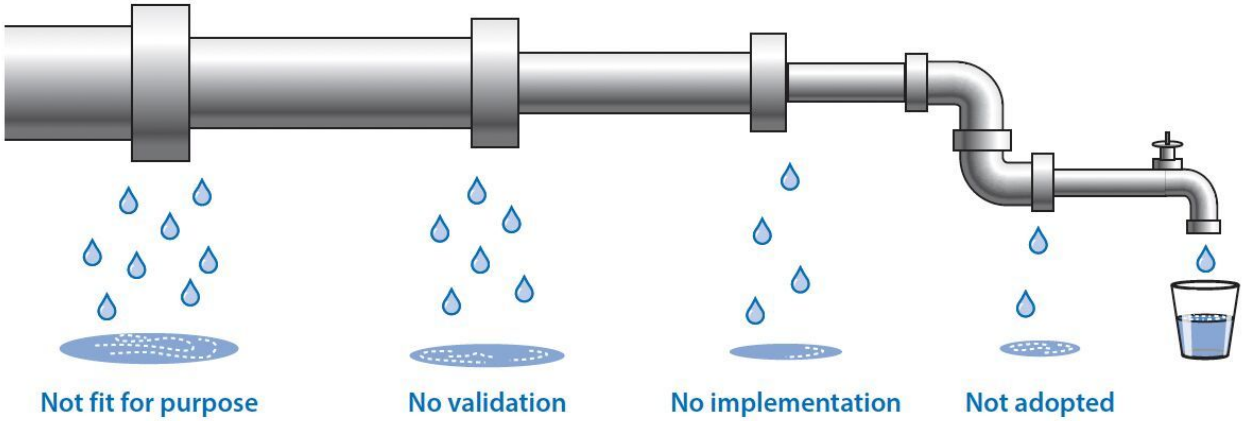
Only a fraction of developed AI models are **externally validated** and even less **clinically implemented**

Systematic review on AI-based surveillance systems for HAI (249 studies included) [3]

12%	externally validated
12%	integrated in software tool
4%	**tested in clinical practice**

[3] Cozzolino et al. 2025 Artif Intell Med

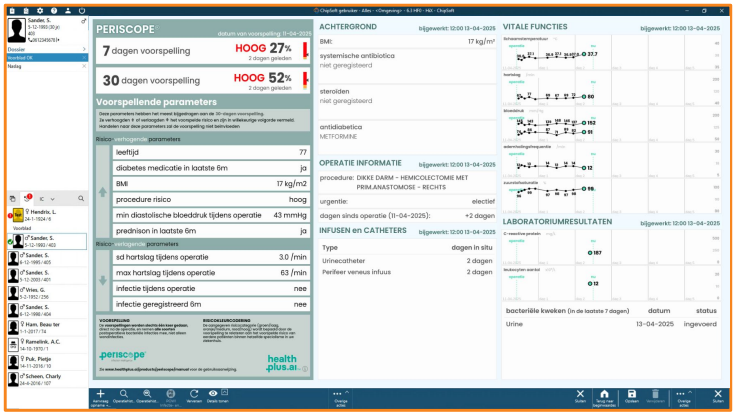
Only 2-4% of AI models reach clinical practice



[5] Van Calster et al. 2025 Annual Review of Statistics and Its Application

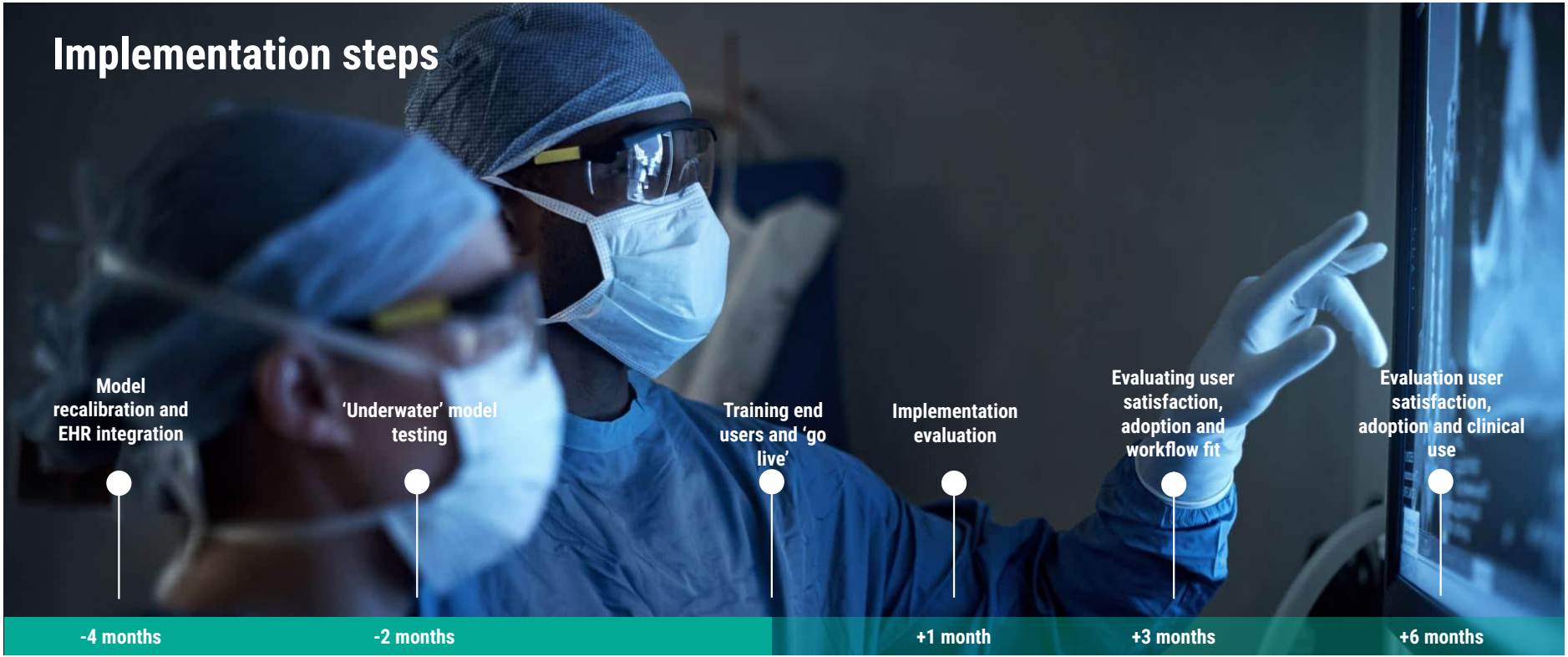
Adoption in clinical practice

Besides integration in the electronic health record..



AI models need to be integrated in local clinical workflows and protocols

Implementation steps

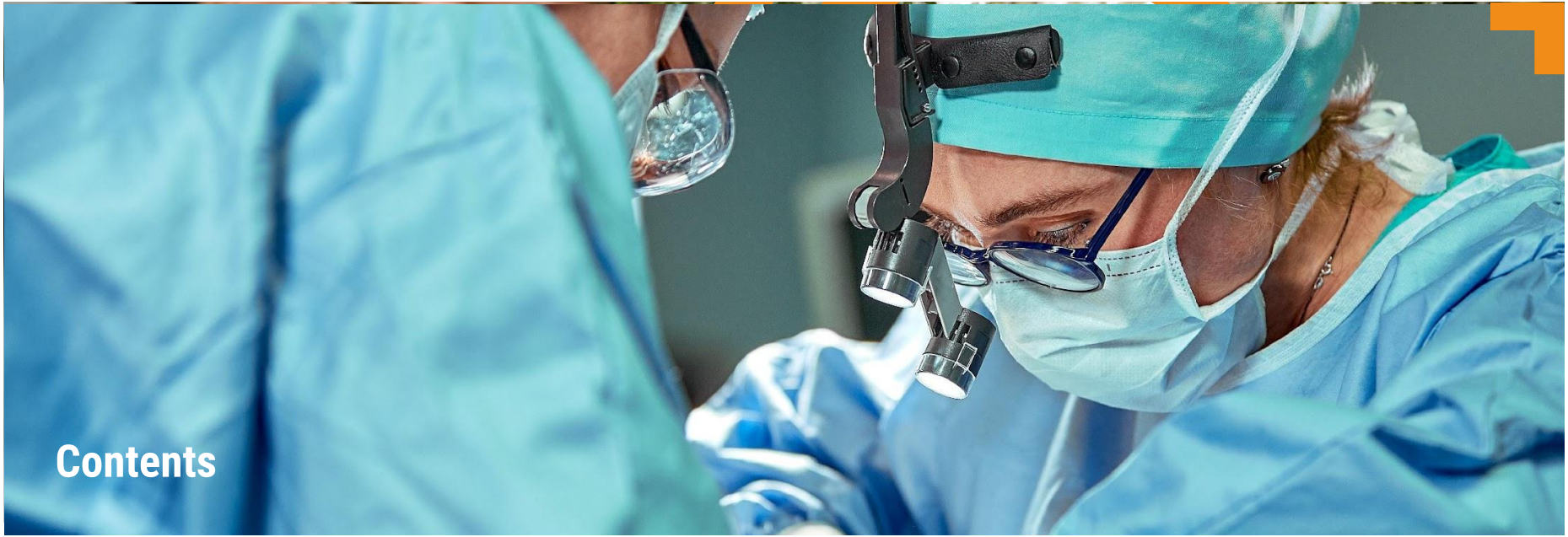


Adjust protocols and determine place in workflow

Go live

Examples of clinical actions determined with end users

Type of action	Surgical (sub)specialty	Risk group	Action
Infection surveillance	All patients	High-risk	Intensify wound inspection: daily and before discharge
Infection diagnostics	GI surgery	High-risk	Infection laboratory measurements at postop day 3
Discharge and follow-up	Orthopedics	High-risk	Postoperative photos of wound by patients at day 5 postop, earlier (virtual-) follow-up by physician
Discharge and follow-up	GI surgery	Low-risk	Consider same-day discharge



Contents

Next steps

First pilots in Dutch hospitals start end of 2025

Evaluate

- Implementation process
- Adoption, trust and satisfaction end-users
- Impact on patient outcomes and costs
  - Hospital length of stay
  - Readmissions
  - Surgical infection treatments

Takeaways

PERISCOPE is one of the first AI tools being implemented in surgical clinical practice

AI models need to be locally validated and recalibrated before implementation in clinical practice

A good clinical implementation strategy is necessary to support clinical adoption

Groupe Infectiologie Digit@le

PERISCOPE: an AI tool for the early detection of postoperative infections

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October 24, 2025

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