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Original study

AI-based risk prediction of postoperative infection (PERISCOPE®): A risk-stratified analysis of financial impact of postoperative infections: a Belgian single center retrospective analysis

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Abstract

Background: Postoperative infections drive excess healthcare costs. Predicting which patients are at risk of infection enables targeted prevention and earlier intervention strategies plus resource optimization.

Objectives: To quantify healthcare costs, (billed) hospital length of stay ((B)LOS), and the difference between financed length of stay (FLOS) minus BLOS in surgical patients with and without postoperative infections, and to evaluate whether PERISCOPE® AI predictions identify patients at risk for excess costs.

Design: Retrospective observational cohort study.

Setting: A large non-university teaching hospital in Belgium.

Methods: Surgical patients from five specialties (neurosurgery, orthopedic surgery, general surgery, urology, and vascular surgery) were analyzed. PERISCOPE® postoperative infection risk predictions (low, medium, high) were applied to all patients. Healthcare costs, length of stay, antibiotic costs, and FLOS-BLOS were compared between infected and non-infected patients and across risk categories.

Main outcome measures: Total healthcare costs (including antibiotics), length of stay, FLOS-BLOS difference, and cost distribution across PERISCOPE® risk categories.

Results: Among 31,735 surgical procedures across five specialties between 2022 and 2024, the 30-day postoperative infection rate was 7.3%. Infected patients were older, more often male, more likely to undergo emergency surgery, and incurred markedly higher healthcare costs (€36,196 vs €3,768), longer hospital stays

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Letitia Van Pachtenbeke contributed to study conception and drafting of the manuscript. Dieter Mesotten contributed to study conception and design and critical revision of the manuscript for important intellectual content. Mark Janssens, Ben Goethuys and Noëlla Pierlet contributed to data acquisition, data analysis and interpretation. Bart Geerts and Laurens Schinkelshoek contributed to study conception, interpretation of data and critical revision of the manuscript. Siri van der Meijden contributed to all stages from study conception to drafting and revising the manuscript.

(27.9 vs 4.0 days), and net-financial losses for the hospital. PERISCOPE® stratified patients into low- (0.7%), medium- (1.4%), and high-risk (12.4%) infection groups and demonstrated clear cost and resource gradients, effectively identifying infection risk and associated financial burden across specialties.

Conclusions: Postoperative infections impose a significant financial burden on healthcare systems. PERISCOPE® accurately identified high-risk surgical patients, enabling cost-efficiency through early intervention and prevention. Artificial intelligence (AI) guided early intervention in high-risk patients may reduce costs and may support value-based surgical care. Meanwhile, low-risk patients may benefit from less invasive monitoring and earlier discharge.

Key words: **Artificial intelligence, Intelligent systems, Economics, Perioperative care, Prevention and control.**

Introduction

Postoperative infections remain a significant burden on healthcare systems, typically manifesting late beyond day nine after surgery[1,2]. These complications drive morbidity, prolonged hospital stays and unplanned readmissions, imposing substantial financial consequences for hospitals operating under Belgium's Diagnosis Related Groups (DRG) based reimbursement system[2-5]. In Belgium, nosocomial infections affect approximately 6-7% of hospitalized patients, resulting in an estimated 900,000 hospital bed-days occupied by infected patients annually[3,6]. Current approaches to infection risk stratification remain limited. Existing risk scores, such as the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) calculator, have shown only moderate predictive accuracy for postoperative infectious complications[7]. Similarly, biomarkers such as C-reactive protein (CRP) primarily reflect ongoing systemic inflammation rather than reliably predicting imminent infection. Although CRP has been extensively studied as an early marker for postoperative complications, its predictive performance has proven limited, particularly in the early postoperative period when inflammatory responses to surgery itself confound interpretation[8]. As a result, the standard of surgical care remains largely reactive rather than proactive, missing critical opportunities for prevention, early intervention and resource optimization.

Artificial intelligence (AI) offers the potential to transform perioperative management by enabling personalized, proactive infection prevention strategies. PERISCOPE® is a clinical decision support system that uses machine-learning models to predict postoperative infections, such as surgical site infections and pneumonia, and to support risk-adjusted clinical decision making. PERISCOPE® is a software as a medical device (SaMD) and was Conformité Européenne (CE-) certified (IIa) under Medical Device Regulation (MDR) on 29 January 2024. The platform re-uses routinely collected electronic health record (EHR) data, like body mass index, medication use, surgical characteristics, to generate individualized risk estimates. By enabling earlier identification of high-risk patients, PERISCOPE® aims to support targeted preventive interventions and improve both surgical outcomes and resource utilization. The system has been validated on large multi-institutional datasets and is designed for integration within existing clinical workflows. It was shown in studies to be accurate in preoperative risk stratification for postoperative infections[9]. However, the financial implications of implementing AI-guided risk stratification in routine surgical practice remain unexplored. A robust financial case is required for all stakeholders to obtain hospital approval to implement predictive AI tools in practice, particularly when complications' prevention strategies must remain viable without dedicated reimbursement mechanisms.

The objective of this study was twofold: first, to quantify the excess healthcare costs, (billed) hospital length of stay ((B)LOS), and deviation from financed hospital length of stay (FLOS) (FLOS minus BLOS) associated with postoperative infections across surgical specialties in a Belgian hospital setting. Second, to evaluate whether PERISCOPE® predictions accurately identify surgical patients who will incur excess healthcare costs and resources due to postoperative infections. By aiming to demonstrate the economic consequences of postoperative infections and to validate PERISCOPE®'s ability to prospectively identify high-cost patients, this retrospective analysis may provide a foundation for implementing targeted, cost-effective prevention strategies for surgical infections.

Methods

Study Design

This is a retrospective, observational cohort study. We followed the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) checklist for observational cohort studies.

Ethics committee approval

The ethics committee of the hospital, Ziekenhuis Oost-Limburg (ZOL) (Synapspark 1, 3600 Genk), approved this retrospective, observational cohort study on 29 January 2026 (protocol number Z-2026010). The chairperson of the ethics committee was Dr. Patrick Noyens. A patient informed consent was not necessary.

Setting

Administrative and patient data from patients who underwent surgery from 2022 to 2024 at the ZOL, Genk, Belgium, a large non-university teaching hospital care center, were analyzed.

Participants

All consecutive adult patients (>18 years old) undergoing surgery from the departments of neurosurgery, orthopedic surgery, urology, vascular surgery, and general surgery from 01-01-2022 to 31-12-2024 were included. Patients were excluded if meeting one of the following criteria: pediatric patient (<18 years old), non-Belgian residents, day case admissions, incomplete cost data, or non-invasive surgical procedures. Patients with an active infection prior to surgery were included, provided that the primary surgery was not performed to treat that infection. If the indication for the primary surgery during the admission was treatment of the infection, these patients were excluded.

Variables

Patients in the dataset were marked to have an infection within 30 days of surgery if meeting one or more of the following criteria: 1) infection registered by a clinician, 2) non-prophylactic antibiotics administered for at least 72 hours, starting >24 hours after surgery and after the last prophylactic dose, or 3) surgical procedure performed to treat an infection[9].

The primary outcome was total healthcare costs in Euros from the healthcare payer perspective, defined as the total billed direct hospital costs from admission to discharge (time horizon: index hospital stay). Secondary outcomes were financed hospital length of stay, billed hospital length of stay, the difference between the two (FLOS-BLOS), and antibiotic costs. A negative FLOS-BLOS (< 1) indicates that the hospital gets reimbursed less than the total costs incurred in terms of hospital admission.

Predictions of the AI tool PERISCOPE® (low, medium, or high risk of infection) were made as described previously, based on observational patient data available directly postoperatively[9]. PERISCOPE® uses a machine learning model trained on electronic health record data from multiple European centers to predict 30-day postoperative infection risk. The model incorporates preoperative patient characteristics, procedure-related factors, and pre- and intraoperative vital signs and laboratory values to generate individualized risk predictions within the first 15 minutes after surgery[9]. The model was first locally recalibrated on data from before 2022 at ZOL and then validated on the included dataset.

Patients were stratified by infection within 30 days of surgery (yes/no) and surgical specialty (neurosurgery, orthopedic, general, urology, vascular).

Data sources/measurement

Observational patient data and cost data were extracted from the ZOL data platform. No additional data were collected as part of this study. Cost data in Belgium's healthcare system reflect actual hospital resource utilization under the all-in DRG reimbursement model, which includes all direct costs associated with hospitalization (personnel, diagnostics, procedures, medications, and overhead)[10]. BLOS represents the actual length of stay, while FLOS ("verantwoorde ligduur") represents the expected reimbursed length of stay based on the patient's diagnosis and procedure codes under Belgian financing rules[11]. The difference (FLOS minus BLOS) indicates whether a patient stayed longer than the financed duration, representing potential financial loss to the hospital under the current reimbursement system.

Bias

To minimize selection bias, all consecutive patients meeting the inclusion criteria over a three-year period were included. Information bias was reduced by using multiple objective criteria to define postoperative infection rather than relying solely on diagnostic codes. Confounding by indication was addressed through stratification by surgical specialty, as infection rates and risk profiles differ substantially across surgical populations. Also patients who underwent day care surgery were excluded as infections occurring in the home setting are more difficult to detect, possibly leading to inclusions of false negatives.

Study size

Study size was determined by including all eligible patients over three calendar years (2022-2024). This sample is expected to be of sufficient size based on annual surgical volume, with an anticipated infection rate of 5% across specialties, providing adequate power to detect clinically meaningful differences in costs and length of stay[9].

Statistical methods

Continuous variables were reported with mean and standard deviation (SD) for normally distributed data or median and interquartile range (IQR) for skewed distributions. These data were compared by Student t-test and Mann-Whitney U test, respectively. Categorical data were represented by percentages and compared by chi square testing.

For interpretation of the clinical effects in relation to costs, a cost tree was built[12,13]. The cost tree was constructed on the PERISCOPE® infection risk allocation (first branch) and established excess cost-generating event, a new post-operative infection (second branch). For each branch, the proportion of the total patient population meeting the branches' clinical criteria, the FLOS-BLOS difference and the mean total and antibiotics healthcare costs per patient were reported.

No adjustment for multiple testing was done. Statistics were generated as specified above in Python version 3.8.

Results

Participants and descriptive data

Between 1-1-2022 and 31-12-2024, 31,735 out of 193,374 surgical procedures were included across five specialties at ZOL Genk. The main reasons for exclusion were procedures performed in other specialties (n=133,960) and day-case admission (n=27,679, Figure 1). The overall 30-day postoperative infection rate was 7.3% (n=2,322), with substantial variation by specialty: vascular surgery 15.3%, general surgery 11.8%, neurosurgery 6.5%, orthopedic surgery 4.4%, and urology 3.8% (Table I). Patients who developed infections were older (mean age 66 vs 62 years, P<.001), more likely male (57% vs 51%, P<.001), and more frequently underwent emergency surgery (46% vs 18%, P<.001). These differences likely reflect underlying variations in surgical case mix and procedure complexity across patient groups and specialties, which may partially confound crude associations between patient characteristics and infection risk. PERISCOPE® stratified the cohort into low-risk (12.2%, n=3,878), medium-risk (33.1%, n=10,515), and high-risk (54.7%, n=17,342) categories, with observed infection rates of 0.7%, 1.4%, and 12.4% (P<.001), respectively. This risk stratification was consistent with the expected gradient of postoperative infection risk across increasingly complex patient and procedural profiles.

Healthcare costs and resource utilization

Patients with postoperative infections incurred substantially higher healthcare costs compared to non-infected patients (Table II): mean total costs €36,196 (SD 94,655) versus €3,768 (SD 6,614), P<.001. The excess cost burden varied by specialty, with neurosurgery showing the highest infection-related costs (€69,136 vs €3,893, P<.001) followed by general surgery (€44,013 vs €3,285, P<.001). Infected patients also demonstrated markedly higher healthcare resource utilization. They experienced prolonged hospital stays (mean BLOS 27.9 days vs 4.0 days, P<.001) and consumed significantly more antibiotic resources (€413 vs €8, P<.001). Both BLOS and FLOS were higher

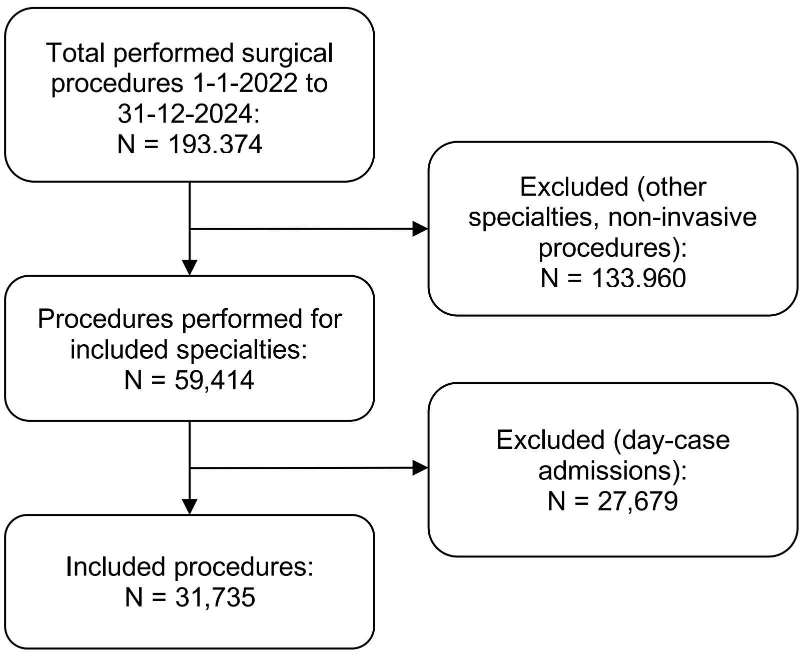

Fig. 1 — STROBE flow diagram.

Table I. — Baseline Characteristics of Study Population.

Characteristic	All patients (N=31,735)	30-day postoperative infection: 7.3% (N=2,322)	No 30-day postoperative infection: 92.7% (N=29,413)
Mean age, years (SD)	62 (16)	66 (16)	62 (16)
Male sex, n (%)	16322 (51%)	1315 (57%)	15007 (51%)
Median ASA score (IQR)	2 (1-3)	2 (2-3)	2 (1 - 3)
Emergency surgery, n (%)	6314 (20%)	1057 (46%)	5257 (18%)
Median surgery duration (IQR)	100 (72-145)	133 (84-215)	98 (71 - 140)
Surgical specialty, n (%)			
General surgery	7580	898 (11.8%)	6682 (88.2%)
Neurosurgery	5391	350 (6.5%)	5041 (93.5%)
Orthopedic surgery	13168	575 (4.4%)	12593 (95.6%)
Urology	3105	118 (3.8%)	2987 (96.2%)
Vascular surgery	2491	381 (15.3%)	2110 (84.7%)
PERISCOPE risk category, n (%)			
Low risk	3878	27 (0.7%)	3851 (99.3%)
Medium risk	10515	148 (1.4%)	10367 (98.6%)
High risk	17342	2147 (12.4%)	15195 (87.6%)

Data presented as mean ± SD, median [IQR], or n (%) as appropriate.

among infected patients, which may partly reflect differences in underlying case mix and surgical complexity. The FLOS-BLOS difference revealed that infected patients generated financial losses for the hospital (mean -2.3 days), while non-infected patients exceeded reimbursed duration by only 0.5 days, P<.001.

PERISCOPE® risk stratification and cost prediction

PERISCOPE®'s risk categories demonstrated clear cost gradients (Figure 2). High-risk patients who developed infections (true positives, n=2,147) incurred mean costs of €38,596 compared to €4,832 for high-risk patients without infection (false positives, n=15,195). Low-risk patients without infection (true negatives, n=3,851) had the lowest resource utilization with mean costs of €2,360 and BLOS of 2.0 days. The 27 false negatives in the low-risk category still generated elevated costs (€10,302) and extended stays (8.6 days), though representing only 0.7% of all low-risk predictions. Medium-risk patients showed intermediate cost profiles, with infected patients (n=148) averaging €6,180 in total costs. The predictive value of PERISCOPE® for identifying excess cost burden was consistent across all five surgical specialties.

Discussion

This study demonstrates that postoperative infections impose a substantial financial burden on Belgian hospitals under DRG-based reimbursement, with patients who contracted a postoperative infection, generating nearly 10-fold higher costs than patients without surgery-related infections. While part of this difference may reflect underlying variations in surgical complexity and case mix - procedures that inherently carry higher risks of complications and resource utilization - the observed cost differentials remain substantial even when considered within the DRG-based reimbursement framework, which is designed to partially adjust for such baseline differences.

Additionally, PERISCOPE®'s AI-based risk predictions prospectively identified which patients incurred these excess costs before infections manifested clinically. The clear cost gradients across PERISCOPE®'s risk categories, from €2,360 for low-risk non-infected patients to €38,596 for high-risk infected patients, may provide an economic foundation for implementing targeted prevention strategies in routine surgical practice.

To further contextualize the relationship between procedure type, infection risk, and healthcare costs, we examined examples of individual procedures in which patients followed different postoperative pathways. Among hospitalized patients undergoing total hip arthroplasty, low-risk patients (n = 285) experienced no infections within 30 days and had a mean baseline length of stay (BLOS) of 1.57 days and financed length of stay (FLOS) of 3.27 days, with mean total costs of €3,637 and minimal

Table II. — Healthcare costs and resource utilization - patients with and without infection.

Outcome	All patients	30-day postoperative infection	No 30-day postoperative infection
All patients (n)	31735	2322	29413
Billed length of stay, days (SD)	5.7 (11.7)	27.9 (29.4)	4.0 (6.3)
Financed length of stay, days (SD)	6.0 (11.0)	25.6 (29.2)	4.5 (5.5)
FLOS-BLOS, days (SD)	0.3 (3.3)	-2.3 (6.9)	0.5 (2.7)
FLOS / BLOS (SD)	1.46 (0.79)	1.0 (0.54)	1.5 (0.79)
Total healthcare costs, € (SD)	6137 (27681)	36196 (94655)	3768 (6614)
Antibiotic costs, € (SD)	42 (410)	413 (1282)	8 (142)
General surgery	7580	898	6682
Billed length of stay, days (SD)	6.8 (14.8)	29.0 (32.1)	3.9 (5.9)
Financed length of stay, days (SD)	7.0 (14.2)	27.3 (32.1)	4.3 (5.4)
FLOS-BLOS, days (SD)	0.2 (3.4)	-1.8 (6.6)	0.5 (2.7)
FLOS / BLOS (SD)	1.44 (0.79)	1.02 (0.55)	1.5 (0.8)
Total healthcare costs, € (SD)	8101 (37975)	44013 (102255)	3285 (6198)
Antibiotic costs, € (SD)	92 (513)	561 (1244)	14 (73)
Neurosurgery	5391	350	5041
Billed length of stay, days (SD)	6.4 (14.2)	37.1 (37.5)	4.3 (7.2)
Financed length of stay, days (SD)	6.8 (13.9)	35.2 (37.9)	4.9 (7.0)
FLOS-BLOS, days (SD)	0.5 (3.0)	-1.8 (6.1)	0.6 (2.6)
FLOS / BLOS (SD)	1.34 (0.64)	0.96 (0.33)	1.37 (0.64)
Total healthcare costs, € (SD)	8119 (43559)	69136 (153791)	3893 (10908)
Antibiotic costs, € (SD)	68 (756)	763 (2428)	12 (325)
Orthopedic surgery	13168	575	12593
Billed length of stay, days (SD)	4.7 (9.0)	26.2 (23.6)	3.7 (6.2)
Financed length of stay, days (SD)	4.9 (7.6)	22.0 (22.8)	4.1 (4.8)
FLOS-BLOS, days (SD)	0.2 (3.3)	-4.2 (7.9)	0.4 (2.8)
FLOS / BLOS (SD)	1.54 (0.83)	0.95 (0.55)	1.56 (0.83)
Total healthcare costs, € (SD)	4228 (6080)	12058 (21089)	3871 (3936)
Antibiotic costs, € (SD)	10 (58)	119 (214)	4 (25)
Urology	3105	118	2987
Billed length of stay, days (SD)	3.3 (7.3)	21.0 (26.6)	2.6 (3.8)
Financed length of stay, days (SD)	3.9 (7.1)	20.3 (26.6)	3.2 (3.6)
FLOS-BLOS, days (SD)	0.6 (2.0)	-0.7 (4.2)	0.6 (1.8)
FLOS / BLOS (SD)	1.48 (0.67)	1.08 (0.49)	1.5 (0.67)
Total healthcare costs, € (SD)	3351 (12143)	22706 (53634)	2586 (5014)
Antibiotic costs, € (SD)	9 (63)	124 (241)	4 (31)
Vascular surgery	2491	381	2110
Billed length of stay, days (SD)	9.1 (11.1)	21.6 (18.5)	6.8 (7.2)
Financed length of stay, days (SD)	9.4 (10.3)	20.1 (17.9)	7.5 (6.6)
FLOS-BLOS, days (SD)	0.3 (4.3)	-1.5 (6.7)	0.6 (3.6)
FLOS / BLOS (SD)	1.36 (0.91)	1.05 (0.63)	1.42 (0.94)
Total healthcare costs, € (SD)	9439 (28815)	28184 (68154)	6053 (8250)

antibiotic expenditures (€1.84). In contrast, high-risk patients undergoing the same procedure (n = 1,606) had a 30-day infection rate of 3.7%, longer hospital stays (BLOS 4.4 days; FLOS 5.32 days), and higher total costs (€4,278), accompanied by increased antibiotic use (€4.19).

A similar pattern was observed among hospitalized patients undergoing laparoscopic gastric bypass surgery. Low-risk patients (n = 117) had a 30-day infection rate of 1.7%, a mean BLOS of 1.43 days and FLOS of 2.33 days, with total costs of €3,456 and minimal antibiotic expenditures (€0.74).

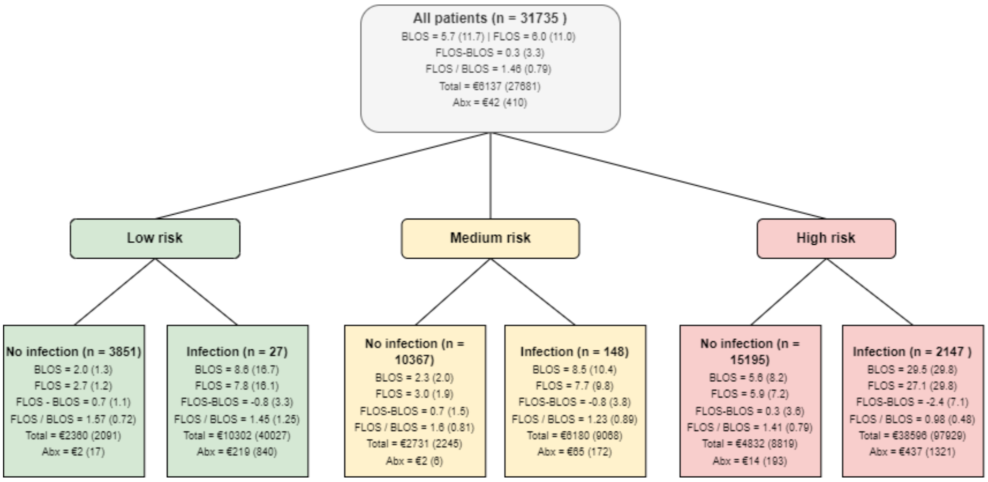

Fig. 2A — Cost tree classified per PERISCOPE® risk group (low, medium or high risk) and patients with and without infection. *Data presented as days ± SD or € ± SD as appropriate.*
- All patients -

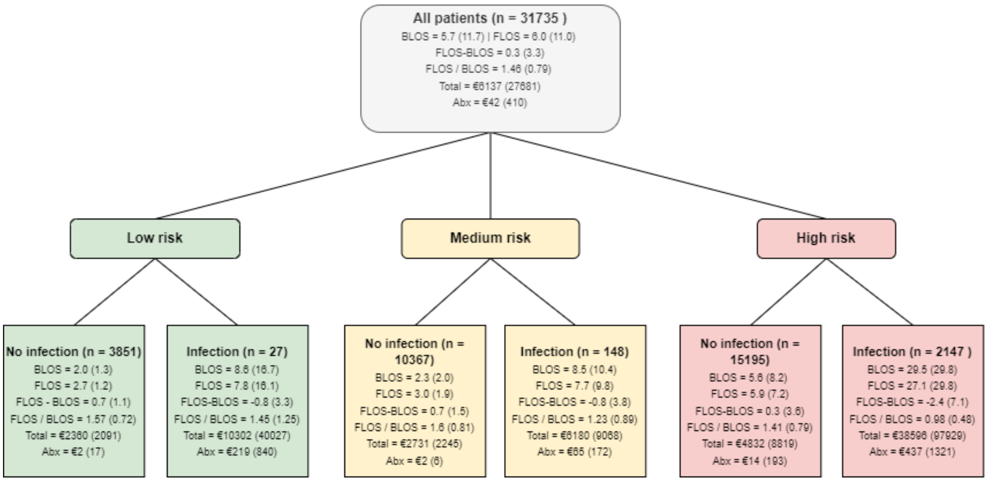

Fig. 2B — Cost tree classified per PERISCOPE® risk group (low, medium or high risk) and patients with and without infection. *Data presented as days ± SD or € ± SD as appropriate.*
- General surgery -

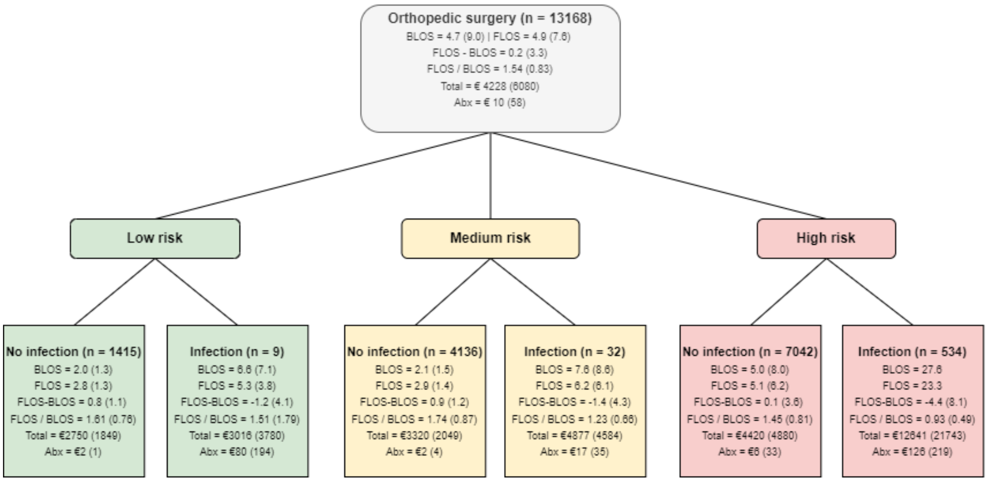

Fig. 2C — Cost tree classified per PERISCOPE® risk group (low, medium or high risk) and patients with and without infection. *Data presented as days ± SD or € ± SD as appropriate.*
- Orthopedic surgery -

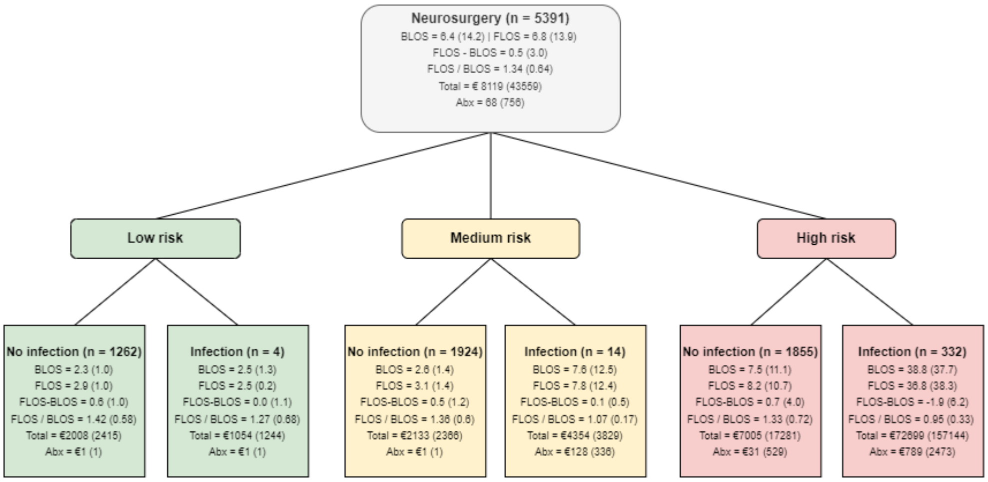

Fig. 2D — Cost tree classified per PERISCOPE® risk group (low, medium or high risk) and patients with and without infection. *Data presented as days ± SD or € ± SD as appropriate.*
- Neurosurgery -

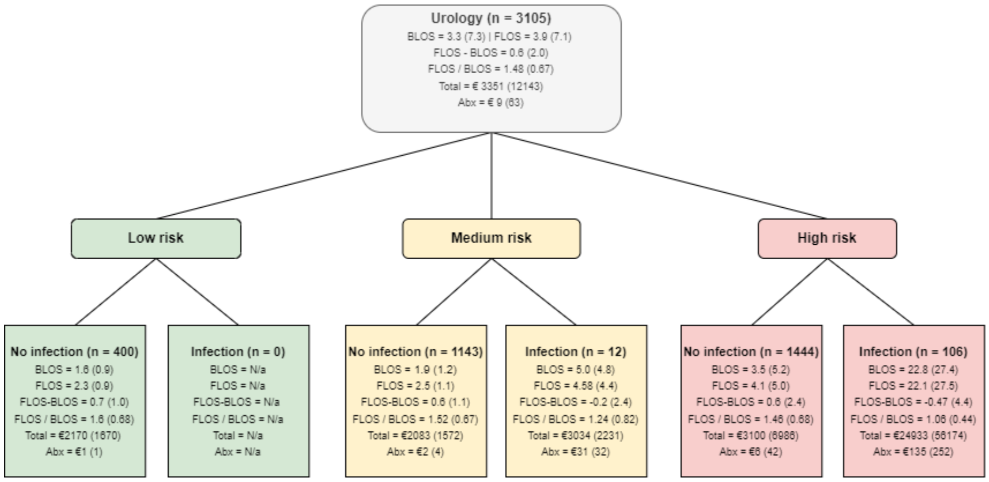

Fig. 2E — Cost tree classified per PERISCOPE® risk group (low, medium or high risk) and patients with and without infection. *Data presented as days ± SD or € ± SD as appropriate.*
- Urology -

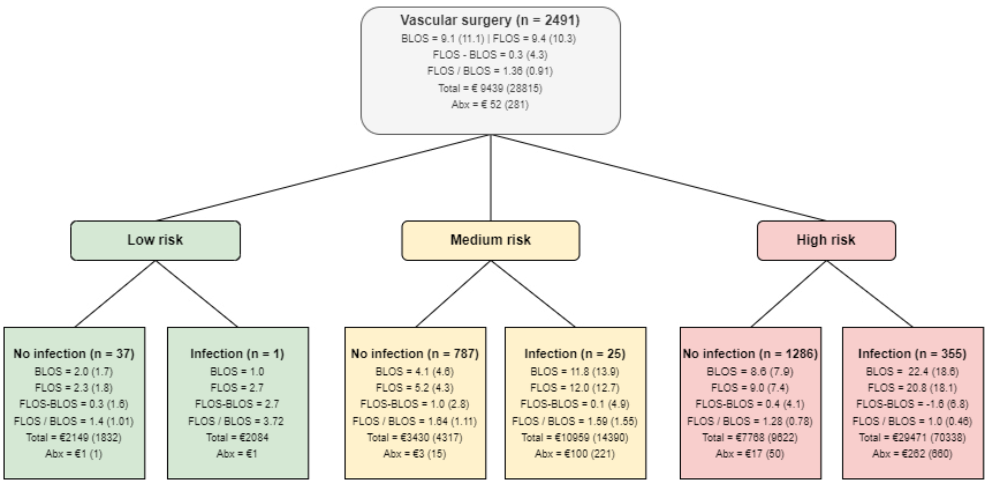

Fig. 2F — Cost tree classified per PERISCOPE® risk group (low, medium or high risk) and patients with and without infection. *Data presented as days ± SD or € ± SD as appropriate.*
- Vascular surgery -

In contrast, high-risk patients (n = 79) had a substantially higher infection rate of 8.9%, longer hospital stays (BLOS 3.16 days; FLOS 3.58 days), and higher total costs (€4,906), accompanied by markedly increased antibiotic use (€10.53).

These examples highlight the wide variation in postoperative trajectories that can occur even among patients undergoing the same surgical procedure. Although the inherent complexity of the surgery influences both infection risk and resource use, the development of complications clearly adds further burden in terms of costs and length of hospital stay.

The financial implications extend beyond direct costs. The negative FLOS-BLOS values for infected patients indicate that hospitals lose reimbursement for extended stays caused by complications, creating direct financial incentives for prevention. Under Belgium's all-in DRG model, where hospitals receive fixed payments per diagnosis regardless of complications, preventing even a subset of infections in high-risk patients could meaningfully improve hospital margins while simultaneously improving patient outcomes[10,11]. The 17,342 high-risk patients in our cohort may represent a targetable population where intensive prevention protocols could be economically justified, while the 3,878 low-risk patients could benefit from de-escalated monitoring and earlier discharge pathways.

Our findings align with previous economic analyses demonstrating the substantial costs of nosocomial infections in Belgium, where infected patients occupy an estimated 900,000 hospital bed-days annually[3,6]. However, this study advances beyond descriptive cost analyses by validating an AI tool that can prospectively identify high-cost patients at the point of care[9]. The strong correlation between PERISCOPE® predictions and actual resource utilization suggests that implementing AI-guided pathways could enable hospitals to allocate prevention resources more efficiently than current one-size-fits-all approaches. This is particularly relevant in surgical specialties like neurosurgery and general surgery, where infection-related costs exceed €40,000 per patient. Given that postoperative infections typically manifest beyond day nine after surgery, early risk stratification enables proactive intervention before clinical deterioration occurs[1,2].

Several limitations warrant consideration. This retrospective, single-center analysis cannot demonstrate causality between PERISCOPE® implementation and cost reduction. Prospective intervention studies are needed to quantify actual savings. Although the study was conducted at a single center, a mitigating factor is that a broad spectrum of surgical procedures is represented and the hospital population is largely representative of the Belgian population. Cost data reflect Belgian DRG reimbursement structures and may not generalize to other healthcare systems, though the principle of targeting prevention to high-risk patients remains applicable. Additionally, the false positive rate in PERISCOPE®'s high-risk category (87.6% of high-risk patients did not develop infections) raises questions about the cost-effectiveness of intensive interventions applied universally to this group, though these patients still demonstrated elevated baseline costs, suggesting underlying complexity.

Future research should focus on prospective cost-utility analyses and long-term economic and quality of life assessment comparing AI-guided stratified care to standard protocols, quantifying both clinical outcomes and economic impact.

Conclusions

PERISCOPE® prospectively identifies surgical patients who will incur excess healthcare costs due to postoperative infections, with clear cost gradients across risk categories (€2,360 for low-risk to €38,596 for high-risk infected patients). Under Belgium's DRG-based reimbursement system, AI-guided risk stratification offers a pathway toward improved patient outcomes and enhanced resource efficiency. The substantial cost differential between infected and non-infected patients provides economic justification for implementing targeted prevention strategies in high-risk populations while enabling safe de-escalation in low-risk patients. Prospective intervention trials are essential to quantify actual cost savings and validate the clinical effectiveness of risk-stratified perioperative care pathways.

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