INPLASY

INPLASY202690028

doi: 10.37766/inplasy2026.9.0028

Received: 7 September 2026

Published: 7 September 2026

Diagnostic Potential of Infrared Thermography in Detecting Post-Operative Wound Complications: A Systematic Review

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ADMINISTRATIVE INFORMATION

Support - This work is supported by the Gold Coast Health Collaborative Research Grant Scheme. The funder has no role in the design, conduct, analysis or reporting of the review.

Review Stage at time of this submission - Data analysis.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY202690028

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 7 September 2026 and was last updated on 7 September 2026.

INTRODUCTION

Review question / Objective This review aims to systematically evaluate the use of infrared thermography (IRT) for detecting post-operative skin wound complications. The primary objective is to appraise and synthesise the evidence on the diagnostic accuracy of IRT, where reported, for identifying post-operative complications at the surgical skin site in humans. Secondary objectives are to summarise reported thermal patterns of normal and complicated wound healing as measured by IRT, to identify gaps warranting further research, and to assess the potential for IRT in clinical practice in this context.

Rationale Post-operative wound complications, particularly surgical site infections, dehiscence and impaired tissue perfusion, remain common, costly and largely preventable when identified early. Current detection relies heavily on subjective clinical assessment, which is operator-dependent and typically recognises complications only once they are visibly apparent, or on fluid and laboratory analyses that are invasive, costly and delayed. This diagnostic uncertainty also drives defensive antibiotic prescribing, contributing to antimicrobial resistance. Infrared thermography (IRT) offers a non-contact, radiation-free and increasingly affordable means of detecting the changes in skin temperature that accompany inflammation, infection and altered perfusion, potentially before these are visible to the naked eye. Although IRT has been systematically reviewed in related fields such as flap monitoring, burns, peripheral vascular disease and diabetic foot ulceration, its evidence base in post-operative wound surveillance is fragmented across heterogeneous designs, devices and outcomes, and has not been synthesised. To our knowledge, no systematic review has evaluated the diagnostic accuracy of IRT for wound complications specifically in the post-surgical setting. A systematic appraisal is

therefore needed to establish what is known about its accuracy and the thermal patterns of normal and complicated healing, to identify gaps for future research, and to inform whether IRT warrants further clinical evaluation. IRT is envisaged as an add-on or triage test alongside routine clinical wound assessment in inpatient, outpatient and community settings, prompting earlier clinical review or investigation rather than replacing clinical or microbiological diagnosis. No minimally acceptable level of accuracy is pre-specified given the exploratory state of the evidence.

Condition being studied Post-operative wound complications are adverse events that disrupt the normal healing of a surgical incision. The most clinically important are surgical site infection (SSI), in which microorganisms colonise the incision or underlying tissue within 30 to 90 days of surgery, typically presenting with erythema, warmth, swelling, pain and purulent discharge; wound dehiscence, the partial or complete separation of previously approximated wound edges; impaired tissue perfusion and necrosis, in which inadequate blood supply leads to ischemia and tissue death at the wound margins; and delayed healing, in which the wound fails to progress through the expected inflammatory, proliferative and remodelling phases. These complications commonly overlap and share an underlying inflammatory and vascular component. They are conventionally identified by clinical examination against criteria such as the CDC definitions or scoring frameworks (e.g. ASEPSIS), supplemented by microbiological cultures, blood tests or imaging where indicated.

METHODS

Search strategy MEDLINE (OVID) search example: ((exp Thermography/ OR infrared.tw. OR "infrared imaging".tw. OR "infrared image".tw. OR "infrared images".tw. OR "infrared camera".tw. OR "thermal imaging".tw. OR "thermal image".tw. OR "thermal images".tw. OR "thermal camera".tw. OR "thermal mapping".tw. OR "thermal map".tw. OR "thermal maps".tw. OR IRT.tw. OR thermog*.tw. OR telethermographic.tw.) AND (exp "Wound Healing"/ OR exp "Surgical Wound"/ OR exp "Postoperative Complications"/ OR exp "Surgical Wound Infection"/ OR exp "Postoperative Period"/ OR exp "Surgical Wound Dehiscence"/ OR exp Seroma/ OR SSI.tw. OR "Surgical Wound".tw. OR "wound assessment".tw. OR periwound.tw. OR "surgical site infection".tw. OR healing.tw. OR "wound evaluation".tw. OR "wound inspection".tw. OR "wound surveillance".tw. OR "wound monitoring".tw. OR "Wound Healing".tw. OR "postoperative healing".tw. OR "surgical site complication".tw. OR "surgical site complications".tw. OR "assessment of wound".tw. OR "wound status".tw.)) NOT (exp animals/ NOT exp humans/). limit 2 to (english language and yr="2005 -Current")

Equivalent strategies for CINAHL (EBSCO), Cochrane Library, Embase and Web of Science are generated with Polyglot. Limits: English language; publication from 1 January 2005 to 31 May 2026.

Participant or population Adult patients (≥18 years) with post-operative wounds on the external integumentary surface (epidermis/dermis) from any surgical specialty. A post-operative wound is defined as a planned surgical incision on the outer skin surface intended to heal by primary (sutured/stapled/glued), secondary (granulating), or delayed primary intention, without an indwelling device traversing the skin during the assessment period, assessed before confirmed complete closure, or after breakdown/failure of closure where healing was not achieved. Deep/subcutaneous implants not breaching the skin (e.g. joint prostheses, pacemakers) were not counted as indwelling devices, as the overlying incision closes by primary intention with no persistent transcutaneous tract.

Intervention Any imaging-based thermal camera using longwave infrared thermography (IRT) producing a surface temperature map (handheld devices, smartphone attachments, high-resolution thermographic cameras); static or dynamic/serial imaging; IRT alone or within multimodal assessment. A visual thermal image must be produced.

Comparator Standard clinical wound assessment and/or a reference standard for infection/complication: clinical diagnosis of surgical site infection, surgeon assessment, microbiological culture or wound swab, standard documentation of complications (dehiscence, necrosis, haematoma, seroma, delayed healing), eventual wound outcome at follow-up.

Study designs to be included Prospective and retrospective cohort studies, randomised controlled trials, case-control studies, cross-sectional studies, longitudinal cohort studies, case series and case reports; conference abstracts where published with sufficient detail.

Eligibility criteria Studies must report at least one of the following: thermal data from the wound or peri-wound region, and/or accuracy or predictive performance for detecting a post-operative wound complication.

Setting: any setting where post-operative wound assessment occurs (inpatient wards, surgical outpatient clinics, community/primary care wound clinics, emergency departments).

Exclusions: paediatric patients (<18 years); chronic wounds (diabetic foot, pressure or venous leg ulcers) unless post-surgical; non-cutaneous surfaces (mucosal, ocular, internal organ); sites with an indwelling device traversing the skin during assessment (external fixator pin sites with frame in situ, tunnelled catheter exits, PEG/tracheostomy stomas, surgical stomas); wounds closed by a pedicled or free flap or skin graft where the primary outcome is flap/graft perfusion or viability; contact-based or spot (non-imaging) infrared thermometry; near-infrared, fluorescence or perfusion-based optical imaging unless thermal data are reported and analysed separately; studies reporting neither thermal outcome data nor accuracy for a wound complication (e.g. thermal images used solely as model input); cadaveric, animal and simulation/modelling studies; systematic reviews and meta-analyses.

Report characteristics: English language; publication from 2005 onwards, reflecting the availability of affordable uncooled longwave infrared cameras; conference abstracts eligible where published with sufficient detail.

Information sources MEDLINE (Ovid), CINAHL (EBSCO), Cochrane Library, Embase (Ovid) and Web of Science, covering 1 January 2005 to 31 May 2026. Supplementary sources: backward citation searching of reference lists and forward citation searching of included studies. The search strategy is peer-reviewed by a health librarian using the PRESS checklist.

Main outcome(s) Primary outcomes: diagnostic accuracy (sensitivity, specificity, PPV, NPV, AUC/ROC, likelihood ratios, diagnostic odds ratio) and predictive/prognostic measures (hazard ratio, relative risk, odds ratio for future complication; thermal threshold performance). The unit of assessment is recorded as reported (per patient, per wound or per image) and tabulated separately where studies differ.

Additional outcome(s) Secondary outcomes: descriptive thermal data (absolute/differential site temperatures post-operatively, reference ranges during normal healing, temporal patterns).

Data management Records are managed in Covidence and Tera Tools, with duplicates removed on import. Titles/abstracts and then full texts are screened independently by two reviewers against the eligibility criteria, with Screenatron used as a screening aid; disagreements are resolved by consensus. Records identified through citation searching are screened in the same way. A standardised extraction form built in Covidence is piloted independently on three included studies before full extraction; data are then extracted independently in duplicate, with discrepancies resolved by discussion. Analysis and figures use the current version of R.

Quality assessment / Risk of bias analysis Quality appraisal is limited to studies that inform the primary objective. Studies reporting diagnostic accuracy or threshold performance are assessed with QUADAS-2 for risk of bias and applicability. Studies that develop or validate a multivariable prediction model or classifier for individual diagnosis or prognosis using regression or machine-learning techniques are additionally assessed with the Prediction Model Risk of Bias Assessment Tool (PROBAST), with reporting appraised against the Transparent Reporting of a multivariable prediction model for Individual Prognosis or Diagnosis statement (TRIPOD). Studies reporting only descriptive thermal data, group comparisons or correlations inform the secondary objective and are not formally appraised; their key methodological features (environmental control, acclimatisation, imager training, internal reference comparator and blinding) are characterised in the evidence tables. Appraisal is undertaken independently by two authors, with disagreements resolved by discussion.

Strategy of data synthesis Considerable heterogeneity between studies is expected in target conditions, devices, imaging time points, thermal metrics and reference standards, and meta-analysis is not undertaken. Findings are synthesised narratively following Synthesis Without Meta-analysis (SWiM) guidance, grouped by whether studies (a) report accuracy statistics or threshold performance, (b) compare thermal values between complicated and uncomplicated wounds, or (c) describe normal post-operative thermal patterns. For analyses reporting accuracy, 2×2 data (TP, FP, FN, TN) are extracted or reconstructed where possible and sensitivity and specificity with 95% CIs presented in tables and paired forest plots without pooling. Each study's definition of the target condition is reported and mapped to surgical site infection, dehiscence, ischaemia/necrosis, haematoma/seroma or delayed healing; all positivity thresholds are reported, distinguishing a priori from post hoc

(ROC-derived) thresholds; results from multiple readers or automated classifiers are reported separately; indeterminate or failed images are tabulated; and reference standards are categorised (clinical diagnosis, CDC/ASEPSIS criteria, microbiology, documented wound outcome). Thermal metrics are classified as absolute temperature, differential to an internal reference (contralateral, adjacent skin or pre-operative baseline), qualitative pattern, or model output. Where reported the interval between imaging and diagnosis of the complication is recorded for each study.

Subgroup analysis No subgroup analyses are pre-specified as meta-analysis is not planned. Narrative results are presented by complication type, imaging time point and device class as exploratory groupings.

Sensitivity analysis Not applicable; meta-analysis is not planned.

Language restriction English only.

Country(ies) involved Australia.

Other relevant information Reporting follows PRISMA 2020, with PRISMA-DTA items applied to the reporting of the subset of studies presenting diagnostic accuracy data. This protocol is registered at the data analysis stage. The eligibility criteria, search strategy (peer-reviewed via PRESS) and data extraction form were finalised before the search was run and are recorded here as pre-specified; the synthesis and quality appraisal plan was formulated after extraction and before any synthesis of results. Any deviations from this protocol are reported in the manuscript. Definitions used in extraction: target conditions as classified in item 22; index test defined by device class (research-grade camera, handheld camera, smartphone attachment), imaging protocol (single time point vs serial) and thermal metric type; reference standards as categorised in item 22.

Keywords Wound Healing; Surgical Wound Infection; Surgical Wound Dehiscence; Postoperative Complications; Skin Temperature.

Dissemination plans Publication in a peer-reviewed journal and presentation at surgical and wound-care conferences.

Contributions of each author

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