Handheld real-time fluorescence imaging of bacteria guides treatment selection and timing of dressing changes in inpatients undergoing negative pressure wound therapy

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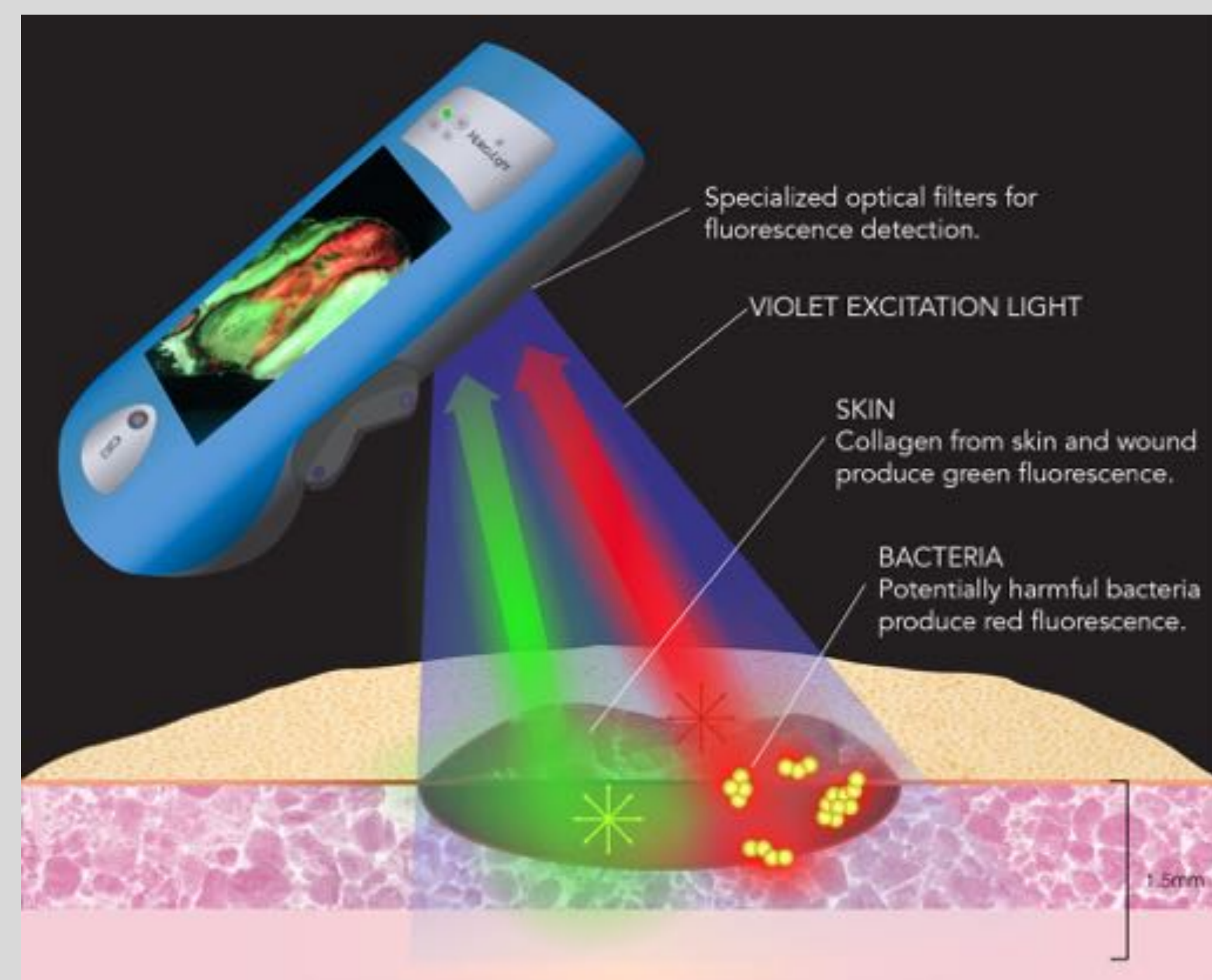Scarborough Rouge Hospital System, Toronto, ON, Canada

INTRODUCTION

- Chronic wounds requiring hospitalization often harbor a high bacterial burden that negatively impacts tissue healing[1].

- Knowledge of wound bioburden can help guide selection of optimal therapies, for example, negative pressure wound therapy devices (NPWT) with instillation of wound cleansers in a heavily contaminated wound.

- Real-time, point-of-care detection of bioburden relies primarily on visual inspection of wounds and subjective and suboptimal clinical signs and symptoms.

- To address this problem, fluorescence imaging has been used to visualize red-fluorescing bacteria in real-time at the bedside using a non-contact device[2].

- Herein, we report the use of this point-of-care imaging device to detect the presence of bacteria in four adult patients undergoing NPWT.

METHODS

Bacterial Fluorescence Imaging

- When excited by 405 nm violet light, tissues fluoresce green while bacteria fluoresce red (porphyrin-producers) or cyan (pyoverdine-producing *Pseudomonas aeruginosa*).

- This enables real-time, point-of-care detection and localization of bioburden ($\geq 10^4$ CFU/g) within and around wounds[2-5].

Specialized optical filters for fluorescence detection.

VIOLET EXCITATION LIGHT

SKIN
Collagen from skin and wound produce green fluorescence.

BACTERIA
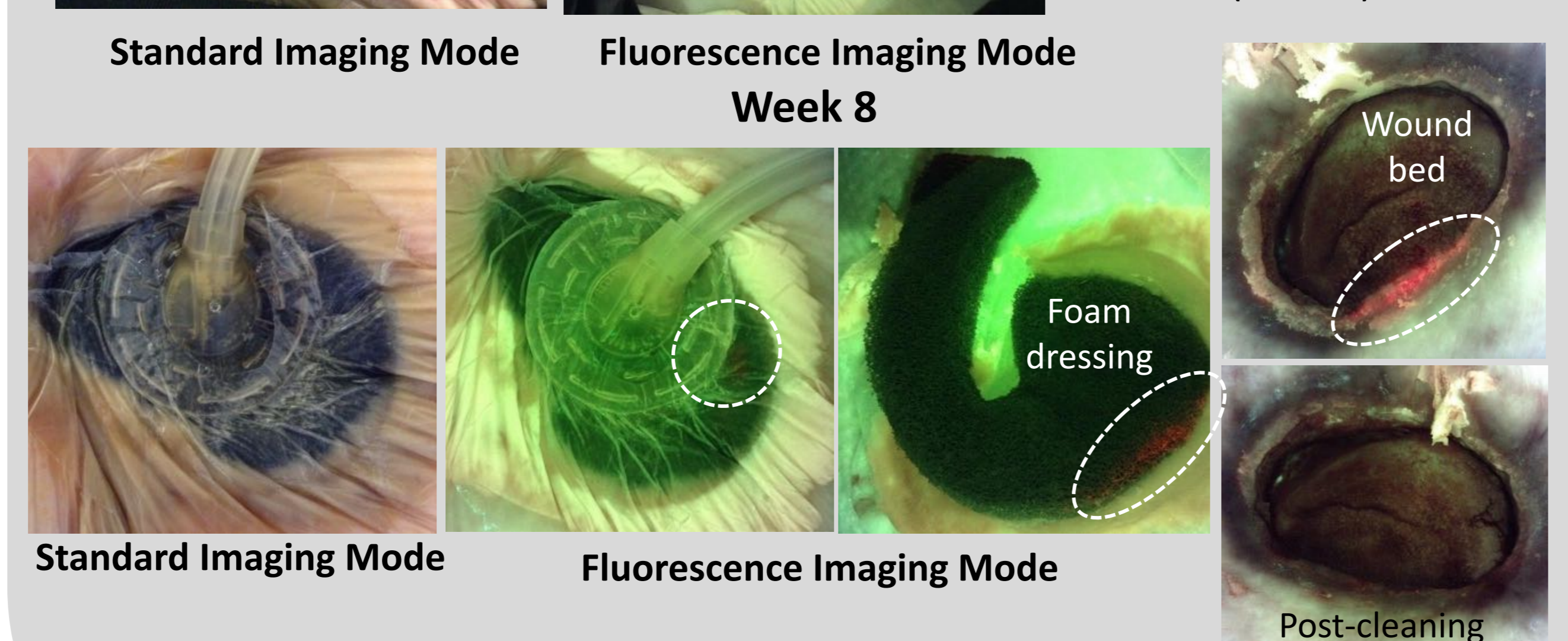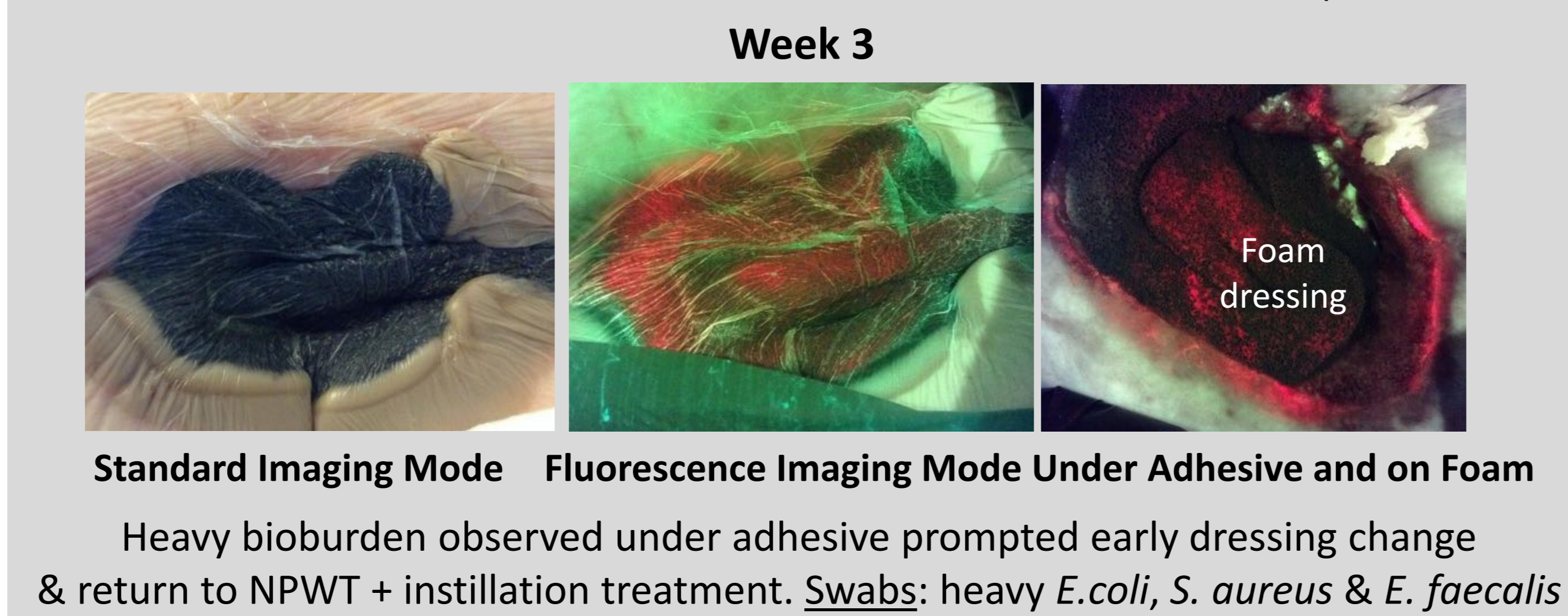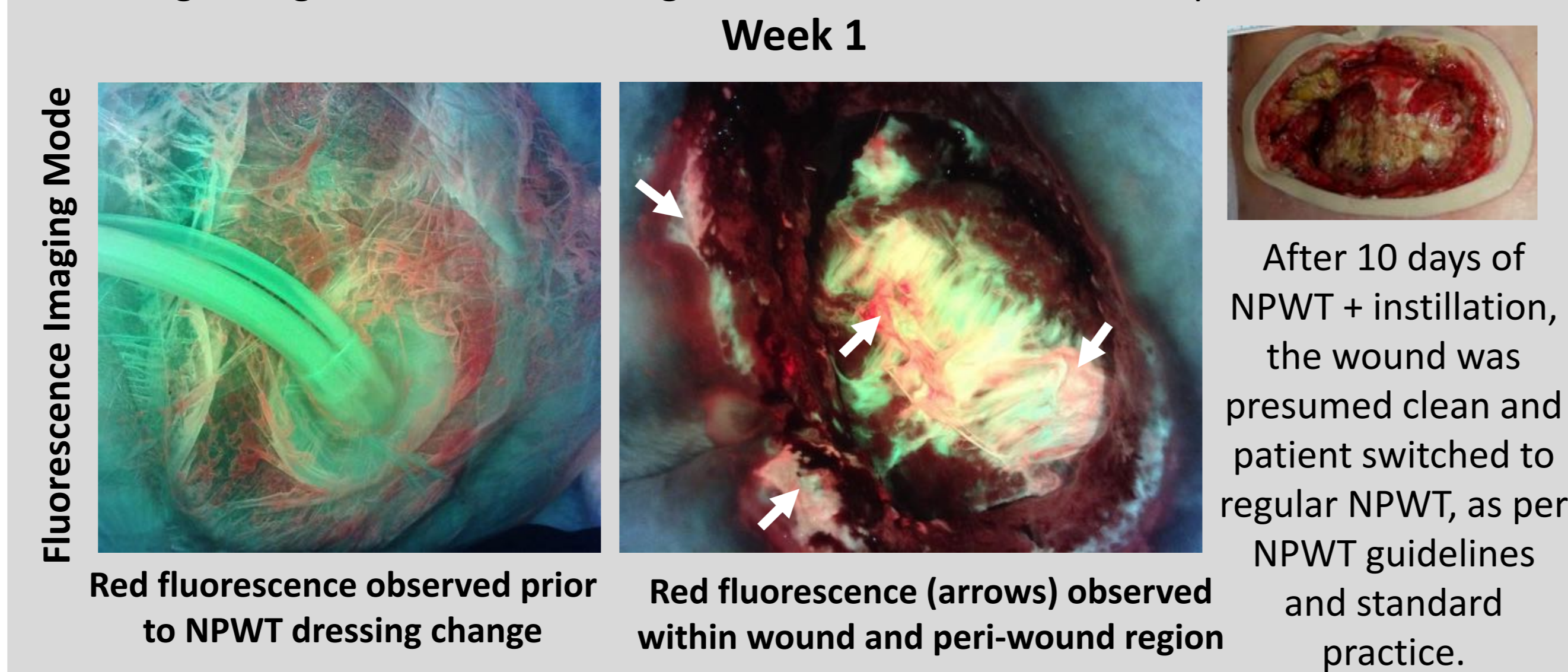Potentially harmful bacteria produce red fluorescence.

Case Series

- Three wounds with diverse etiologies were imaged with the fluorescence imaging device at various stages of the wound healing process.

- Wounds that were positive for red fluorescence signal were considered to be contaminated with bacteria.

RESULTS

Case 1: Detection of Bioburden Under Sealed Adhesive Prompts Change in Treatment Plan and Expedites Dressing Changes

85-year-old female, deep sacral ulcer. Fluorescence imaging enabled detection of bacterial fluorescence under sealed, optically-transparent (routine) adhesive prior to dressing changes, on foam dressings, within the wound, and on peri-wound tissues.

Week 1

Red fluorescence observed prior to NPWT dressing change

Red fluorescence (arrows) observed within wound and peri-wound region

After 10 days of NPWT + instillation, the wound was presumed clean and patient switched to regular NPWT, as per NPWT guidelines and standard practice.

Week 3

Foam dressing

Standard Imaging Mode   Fluorescence Imaging Mode Under Adhesive and on Foam

Heavy bioburden observed under adhesive prompted early dressing change & return to NPWT + instillation treatment. Swabs: heavy *E.coli*, *S. aureus* & *E. faecalis*

Week 4

Standard Imaging Mode   Fluorescence Imaging Mode

Effectiveness of NPWT + instillation demonstrated; only small region of red (bacterial) fluorescence remained (circled).

Week 8

Standard Imaging Mode   Fluorescence Imaging Mode
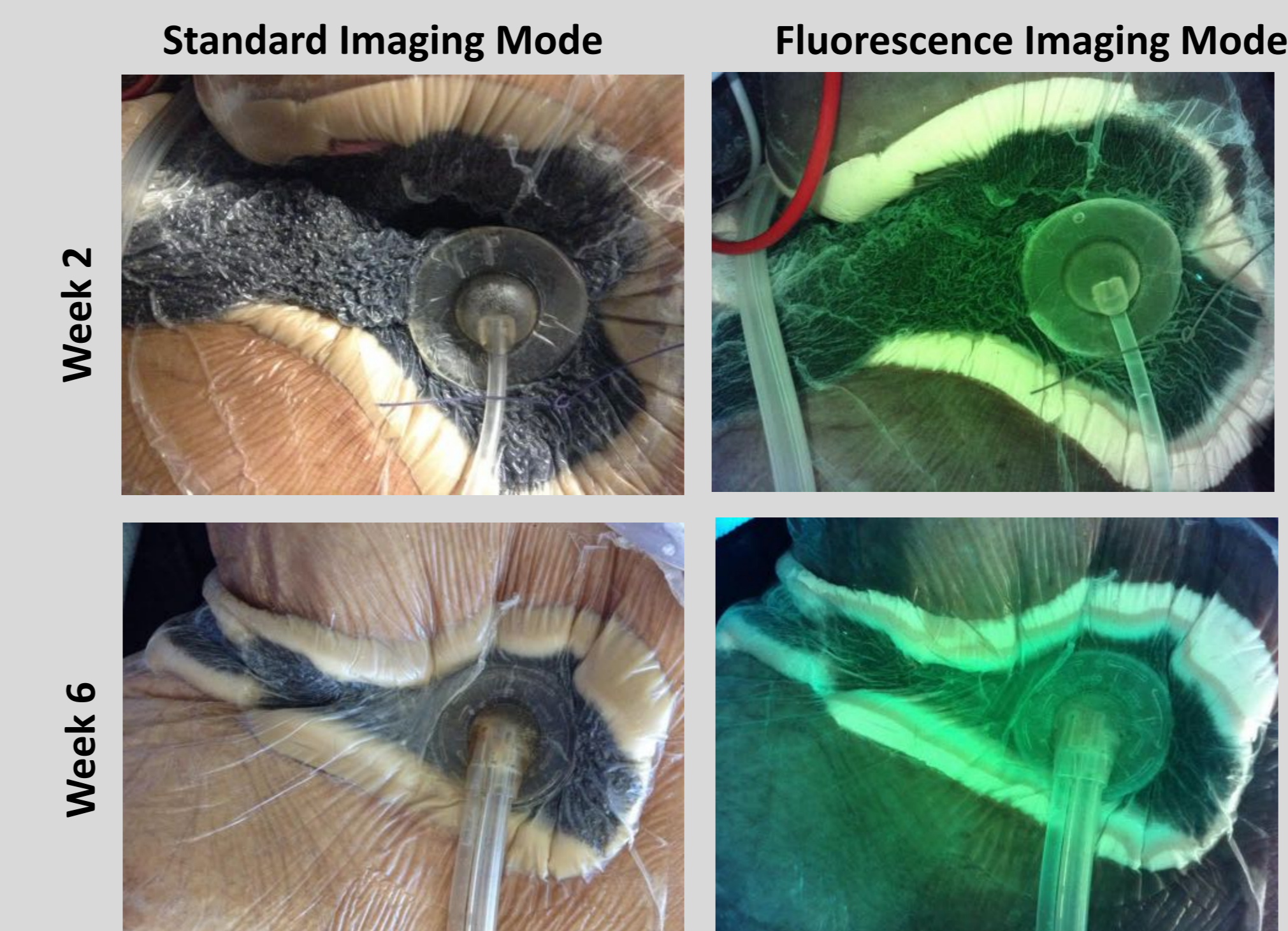
Wound bed

Post-cleaning

Red fluorescence (circles) prompted additional cleaning of peri-wound region and maintenance of this patient on NPWT + instillation, rather than the planned return to standard NPWT.

RESULTS

Case 2: Fluorescence Images Provide Confidence to Delay Dressing Changes, Avoiding Disturbance of Wound Bed

45-year-old female with large, pectoral necrotizing fasciitis wound undergoing NPWT. Images taken over 6 weeks were consistently free of red fluorescence, (confirmed by swab results). Based on images, clinician delayed several dressing changes by 24 hours, leaving the wound bed undisturbed for better healing and saving clinician time and resources.

Standard Imaging Mode   **Fluorescence Imaging Mode**

Week 2

Week 6

Below, images taken of wound bed and foam dressing during dressing change (week 6) were also negative for red fluorescence.

Foam dressing
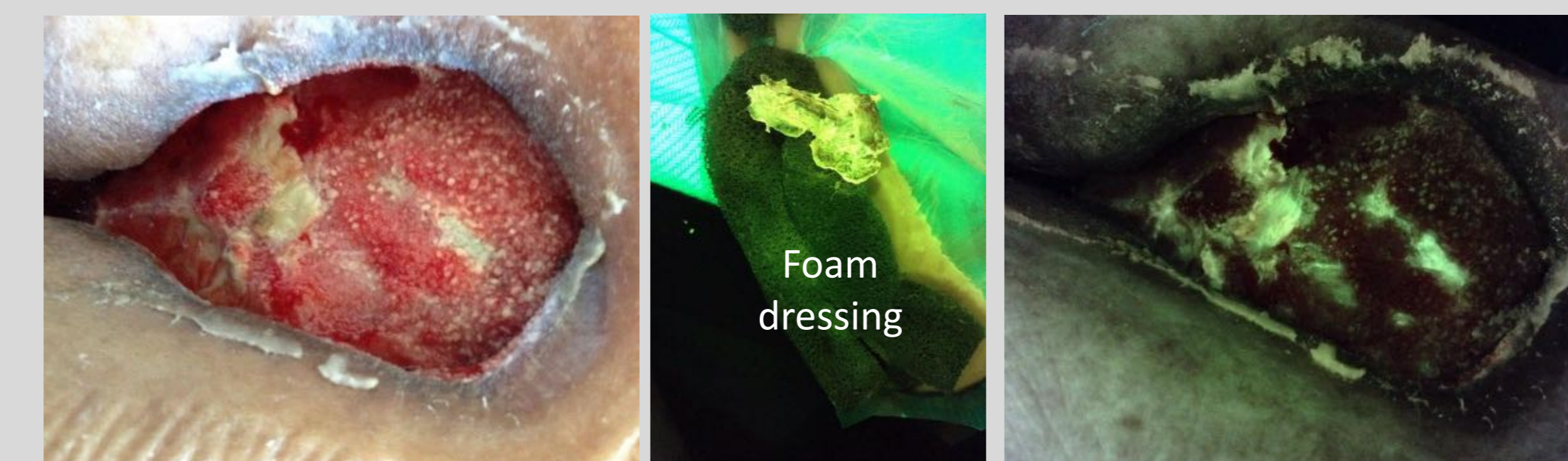
### Case 3: Real-time Bacterial Fluorescence Detection Guides Selection of NPWT with Instillation of Wound Cleansers

Standard Imaging Mode   Fluorescence Imaging Mode

65-year-old male with abdominal surgical wound (6.30 cm²). Fluorescence images taken prior to initiation of NPWT revealed significant bioburden, guiding the clinician's selection of NPWT + instillation of wound cleaning fluids.

RESULTS

Case 4: Fluorescence Images Guide Extent and Location of Wound Cleaning at Scheduled NPWT Dressing Change

Pre-cleaning   Post-cleaning

Standard Imaging Mode   Fluorescence Imaging Mode Before and During Dressing Change
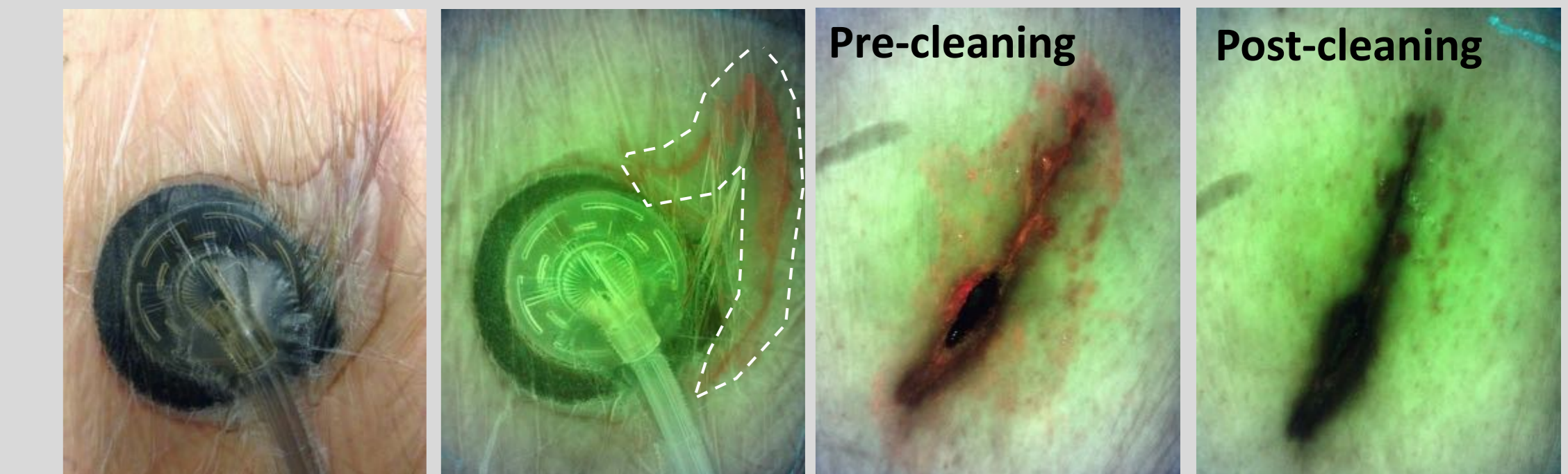
58-year-old male with appendectomy abscess undergoing NPWT. Red fluorescence observed under adhesive (circled) and on wound. Fluorescence guided the extent and location of wound cleaning at this dressing change.

CONCLUSIONS

- Bacterial visualization in real-time helped to guide:
  - bioburden-based, personalized treatment regimens,
  - clinician selection of NPWT with or without instillation of wound cleansers, and
  - the extent and location of wound cleaning during dressing changes.

- Visualization of bacteria prior to removal of adhesive and dressings led to expedited dressing changes when heavy bioburden was detected and postponement of dressing changes for 24 hours when red fluorescence was not observed, avoiding unnecessary disturbance of the wound bed.

- Fluorescence imaging of bacteria helped guide selection of the appropriate and most cost-effective NPWT (standard vs. instillation), demonstrating its potential to effect health economics.

- These results highlight the ability of bacterial fluorescence imaging to provide invaluable, real-time information on a wound's bioburden, contributing to clinician treatment decisions in cases where bacterial contamination could impede wound healing.

REFERENCES

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5. Rennie MY et al. Point-of-care fluorescence imaging positively predicts the presence of pathogenic bacteria in wounds at loads $\geq 10^4$ CFU/g: a clinical study. J Wound Care (submitted)