Bacterial fluorescence images detecting asymptomatic bacterial loads prevented an unwarranted graft procedure and its associated costs

Lt Col SLA Jeffery, RAMC[1,2,3,4]

[1]Queen Elizabeth Hospital (Birmingham, United Kingdom), [2]The Royal Centre for Defence Medicine (United Kingdom), [3]Birmingham City University and [4]NIHR WoundTec Healthcare Technology Cooperative

INTRODUCTION

- Infection is a major potential complication in all wounds, however the highest rate of surgical site infection is associated with lower limb amputations [1], adding to increased healthcare costs and patient quality of life degradation in this population.

- Diagnosing high levels of bacteria or infection based on traditional clinical signs and symptoms is difficult as bacteria are invisible to the unaided eye.

- Bacterial fluorescence imaging can be used to visualize concerning levels of bacteria in real-time at the bedside using a non-contact handheld device [3-5].

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].
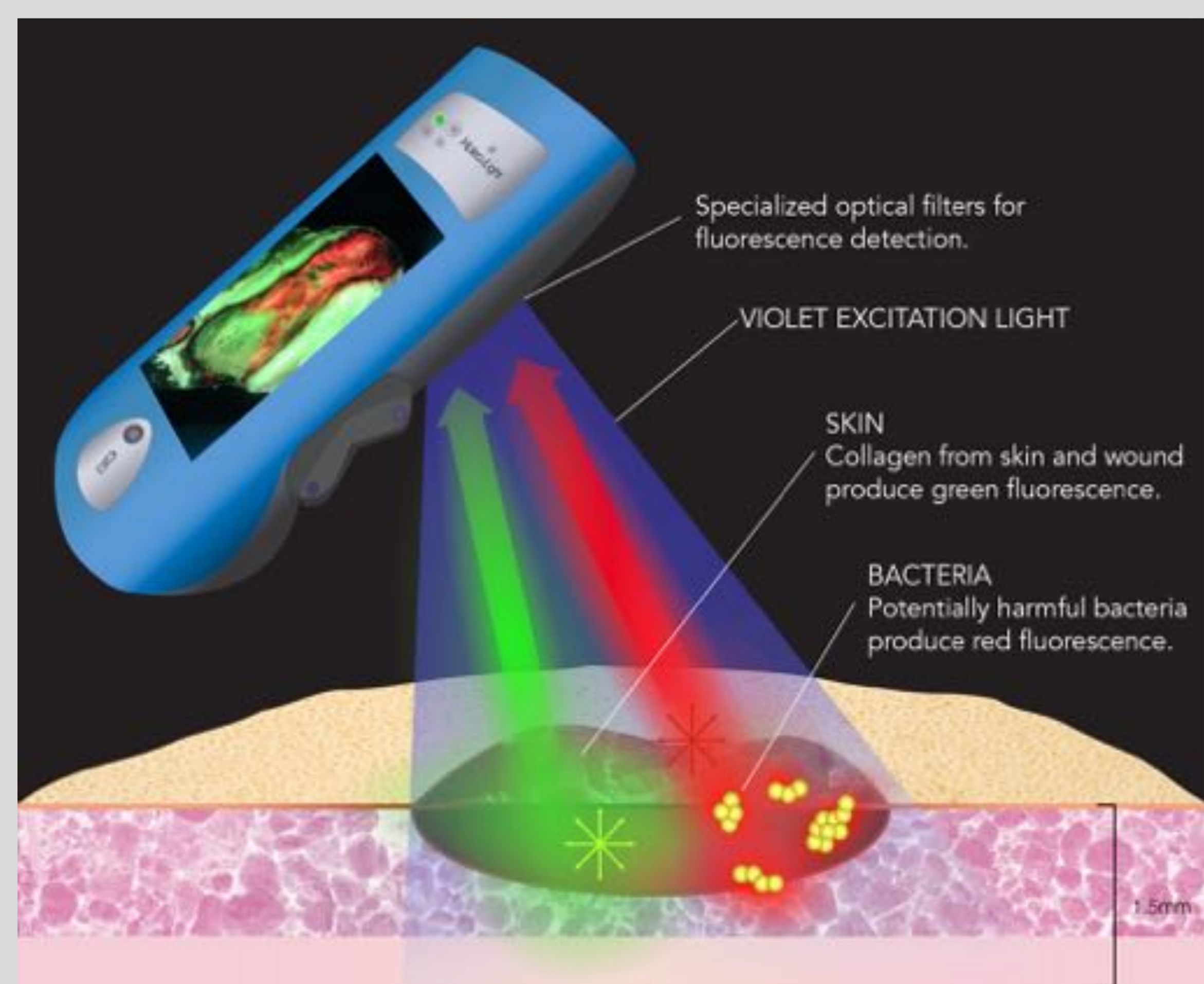
CASE STUDY

- 47-year-old male patient had an above knee amputation after severe traumatic injury.

- His wound was monitored as per standard of care and also imaged for bacterial fluorescence with the MolecuLight *i:X* Imaging Device.

- Post amputation, the stump became infected, therefore was evacuated, washed out and left open with a plan for subsequent delayed closure.

RESULTS

- Clinical assessment suggested the wound was granulating well and had no current contraindications for grafting (e.g. bacterial contamination).
- The patient was deemed ready for operating theatre for limb closure with a graft. However, MolecuLight *i:X* fluorescence images taken prior to theatre revealed asymptomatic bacterial burden in the lower edge of the wound. Probing of this area revealed the presence of pus, which was later confirmed to be *E. coli* and *P. mirabilis*.
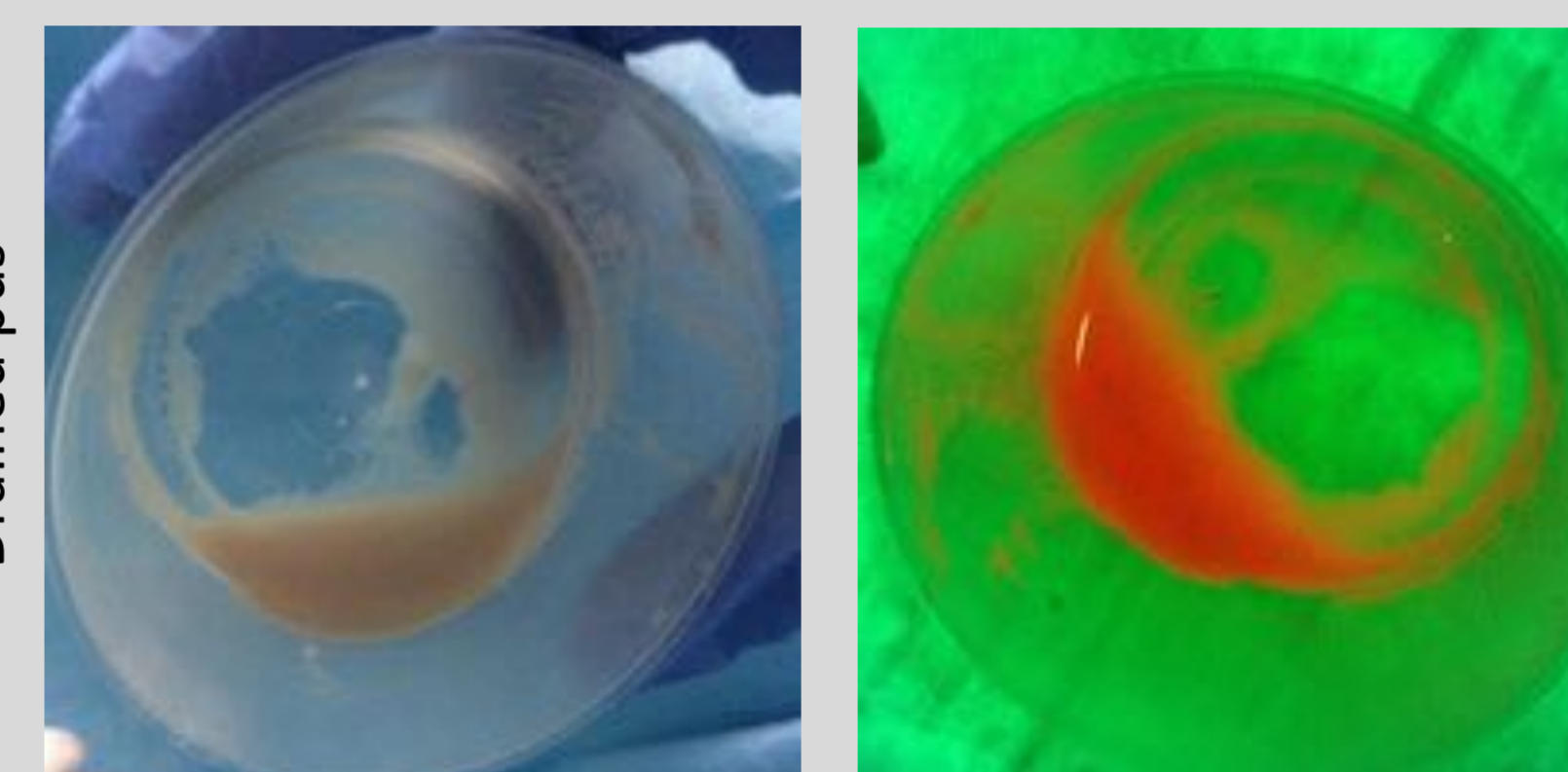

Standard Imaging Mode | Fluorescence Imaging Mode™ (Bacteria appear red) | Standard Imaging Mode | Fluorescence Imaging Mode™ (Bacteria appear red)

- Based on the red fluorescence in the image, the clinician decided to delay the skin graft operation, which would not have been successful if pursued.
- A graft was performed at a later date when evidence of bacterial load was no longer present, and the stump healed successfully.

COST SAVINGS

Deciding when a wound is ready for grafting presents a clinical challenge, as grafts are contraindicated when bacteria are present, costly to the healthcare institutions, and very likely to fail in the event that significant bacterial burden was present in the wound [6,7].

In this particular patient, MolecuLight *i:X* images prevented an unnecessary surgery and saved the hospital approximately £3500. This figure does not include the additional health care costs of treating a failed infected skin graft, which would almost certainly have developed in this stump had a graft been performed.

Potential Cost Savings (estimated in £)[1]	
Operating Theatre and Staff (1 hour)	£1500[8]
Five Day Hospital Stay	£400/day = £2000
Total Cost Savings	**£3500**

CONCLUSIONS

- This case highlights the potential for this imaging tool to provide invaluable information regarding the pathogenic state of wounds prior to grafting, leading to more effective cost management and assuring that the patient has the best chance of healing.

- Using the bacterial fluorescence imaging device is simple and easy to use, similar to any smart touchscreen technology.

- By detecting bacteria at the point of care, decisions can be made regarding the effective use of resources to reduce burden on healthcare systems and patients.

- Early intervention could reduce the likelihood of graft failure, while fluorescence guided sampling to determine the precise bacterial species present will enable targeted antibiotic therapy.

- In summary, bacterial fluorescence imaging provides guidance for clinicians in regards to:
  - Immediate information on bacterial presence or absence
  - Pinpointing the location of bacterial presence for more accurate sampling
  - Antimicrobial and antibiotic decision making and monitoring of treatment effectiveness

REFERENCES

1. J Harker, Wound healing complications associated with lower limb amputation, World Wide Wound, 2006.

2. DaCosta RS et al. Point-of-Care Auto-fluorescence Imaging for Real-Time Sampling and Treatment Guidance of Bioburden in Chronic Wounds: First-in-Human Results, PLoS ONE, 2015.

3. Wu YC et al. Handheld fluorescence imaging device detects subclinical wound infection in an asymptomatic patient with chronic diabetic foot ulcer: a case report. International Wound Journal, 2015.

4. Ottolino-Perry et al. Improved detection of wound bacteria using autofluorescence image-guided wound sampling in diabetic foot ulcers. International Wound Journal, 2017.

5. Rennie MY et al. Point-of-care fluorescence imaging positively predicts the presence of pathogenic bacteria in wounds at loads ≥ 104 CFU/g: a clinical study. J Wound Care, 2017.

6. Snyder RJ et al. Applying Split-Thickness Skin Grafts: A Step-by-Step Clinical Guide and Nursing Implications. Ostomy Wound Manage, 2001.

7. Wu SC, et al. Wound care: The role of advanced wound healing technologies, 2010.

8. Ang WW et al. The cost of trauma operating theatre inefficiency. Ann Med Surg., 2016.