24.

PREDICTION OF SURGICAL SITE INFECTIONS USING SPECTROPHOTOMETRY: PRELIMINARY RESULTS

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1. INTRODUCTION

Wound infections occur in approximately 5% of operations[1]. These infections cost the U.K. National Health Service up to £65 million per year and lower patient quality of life[2].

If wound infections could be predicted there would be potential for prevention and a reduction in cost and morbidity would ensue. Work has previously been carried out to predict when these infections will occur, and attempts have been made to create scoring systems for patients undergoing operations. The most simple of these is to classify the type of operation into one of the four following groups:

- Clean surgery (no inflammation present, respiratory, alimentary and genitourinary system are not breached) carries a 1-2% risk.
- Clean-contaminated surgery (above systems are entered, but there is not significant spillage of contents) – risk of <10%.
- Contaminated surgery (where inflammation is present, and there is spillage of contents) carries a risk of 15-20%.
- Dirty surgery is classified as that carried out where there is an abscess present or there has been spillage of contents for more than 4 hours. This carries a risk of around 40% of developing a wound infection.

Although in a broad sense this can be applied, some series report higher infection rates than should be encountered for the surgery type[3]. More sophisticated scoring systems are available which can be used to predict infections with higher accuracy. The best known is the SENIC score (Study on the Effect of Nosocomial Infection Control)

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which was evaluated in the US between 1975 and 1985[4]. This scoring system gave a point for each of the following:

- Abdominal operation
- Notable wound contamination
- Operation lasting for longer than 2 hours
- 3 or more diagnoses on discharge from hospital

The wound infection risk was from 1% for 0 points to 27% for 4 points. Comparing this again to the work by Israelsson[3] the infection rate for patients in the high risk group may underestimate the actual surgical site infections (SSI). However, it has been shown that the use of scoring systems per se does not reduce wound infection rates[5]. The NNIS (National Nosocomial Infection Score) was developed after this[6], and is similar to the SENIC score. However it instead measures the ASA (American Society of Anaesthetists) grade of the patient, the length of operation and the type of operation. Again it has not been found to be useful for all types of operation.

The problem with these scoring systems is that they can be time consuming, are often subjective and are not accurate. The ideal tool for prediction of SSI would be one that is easy to use, is objective, reproducible and gives the clinician an accurate risk of wound infection in a time scale where there is opportunity for intervention. Measuring oxygen saturation in the tissues may fit these criteria. It is easy to measure in a non-invasive way and is objective.

Determining oxygen levels in the tissues is logically a sound marker for risk of wound infection. Factors which increase the risk of wound infection are related to the oxygenation (or perfusion) of the tissues. For example a longer operation will lead to wound ischemia or a patient with other morbidities, such as chest disease, may be hypoxic. Furthermore it is well known that oxygen is the most important substrate needed for wound healing. Among some of its actions it provides a nutrient for the dividing cells, it encourages collagen accumulation[7] and acts as a substrate in the oxidation of bacteria by macrophages[8].

Hopf et al.[9] measured wound pO_2 (partial pressure of oxygen) with subcutaneous probes in specially created wounds in the upper arm. They recorded data on 130 patients undergoing general elective surgery and found pO_2 was more accurate in predicting wound infections than the SENIC score of the patient. They also found that the pO_2 could be manipulated clinically, and so shows a potential for prevention of wound infections. However their technique has the drawbacks of being invasive as a wound is created in the upper arm and the probe needs time to calibrate. It would also be beneficial to find a method that could measure oxygen at the actual site of surgical insult. Oxygen saturation (SO_2) can be measured with spectrophotometry. This method uses probes that are placed onto the skin at the surgical site and no time is needed for calibration when in use. It has been shown that oxygen saturation can predict wound healing in amputation stumps[10] and can assess degree of peripheral vascular disease[11-14].

Wavelengths of light in the visible range are used to measure skin oxygen saturation (SSO_2) as they only penetrate the first few millimetres of tissue, whereas the absorptive properties of tissue are such that wavelengths in the near-infrared range can penetrate a few centimetres and measure muscle oxygen saturation (MSO_2).