INTERNATIONAL SURGICAL WOUND COMPLICATIONS ADVISORY PANEL (ISWCAP)

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OPTIMISING PREVENTION OF SURGICAL WOUND COMPLICATIONS: DETECTION, DIAGNOSIS, SURVEILLANCE AND PREDICTION

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ISWCAP EXPERT PANEL

FOREWORD

While most contemporary surgical procedures are relatively safe, from time to time, complications related to the incisional wound occur. Despite advances in surgical technique, intraoperative technique and a plethora of wound dressings, surgical wound complications such as surgical site infection (SSI) and surgical wound dehiscence have a considerable impact on the patient and the wider healthcare setting. Consequently it is critical to raise awareness and improve early detection, diagnosis and prevention of these unwelcome wound types. Surgical wound complication (SWC) is a term that includes, but is not limited to:

- Surgical wound dehiscence (SWD)
- Hypergranulation
- Peri-wound maceration
- Scarring
- Medical adhesive-related skin injury (MARSI)
- Seroma and haematoma
- SSI (Sandy-Hodgetts et al, 2020).

SWCs remain a significant challenge for clinicians around the globe, representing one of the leading global causes of morbidity following surgery. Evidence suggests that SWCs are the most commonly managed wound type in some clinical care settings (Sandy-Hodgetts et al, 2016; Guest et al, 2018).

The International Surgical Wound Complications Advisory Panel (ISWCAP) has been dedicated to raising awareness on the early detection, predicticion, prevention and management of surgical wound complications since 2017. ISWCAP also serves to provide guidance on preventing and managing all SWCs, moving away from a traditionally narrow focus on SSI. Building on the ISWCAP International Best Practice Recommendations (Sandy-Hodgetts et al, 2020), early detection and prevention is the key area of focus, in order to optimise outcomes and maintain healthcare cost efficiency.

The President of ISWCAP convened a group of experts from Europe, North America, Asia, and the United Arab Emirates for an online meeting in September 2020 to develop this international consensus document, focusing on the early detection, diagnosis and prediction of SWCs, in order to optimise incisional wound healing outcomes for patients. This consensus document aims to:

- Provide an update on the current landscape and potential advances in prevention and management of SWCs
- Clarify the role of diagnostic technology and advanced therapies
- Provide specific guidance for low- and middle-resource countries
- Facilitate use of the WUWHS Sandy Grading System for SWCs in practice
- Provide a self-care pathway/algorithm for patients.

As always, the emphasis is on optimising care for patients, improving quality of life and outcomes. As such, early identification of an SWC may allow for early intervention and halt the escalation of a wound complication to more serious consequences. It is important that all clinicians are aware of the importance of early intervention and how to detect, diagnose and predict development of SWCs, especially SSI and surgical wound dehiscence. This document is live document with links to relevant information and resources for your use.

Dr Kylie Sandy-Hodgetts, ISWCAP President

Models of pre-operative risk assessment

SWCs have been shown to delay healing and result in significant morbidity, mortality and related socioeconomic costs (Leaper et al, 2013; Sandy-Hodgetts et al, 2013). For the most part, predictive models for preoperative assessment have focused upon SSI, with the incidence and economic burden of SSI receiving global attention; however, there is limited understanding of other SWCs such as surgical wound dehiscence (SWD; Sandy-Hodgetts et al, 2020). Tools currently used in clinical practice are specific to the surgical domain (e.g. cardiothoracic surgery), with some disparities of prediction models in other domains. Therefore, preoperative risk assessment for SWC may be absent from the clinical armamentarium for some surgical domains.

To mitigate the impact of all SWCs on patients, clinicians and healthcare systems, the focus must be on prevention and, where this is not possible, on early identification, to prevent any SWC from escalating into a more serious issue. Early intervention, conducted in a cost-effective way, also reduces use of resources and results in overall cost savings. Early detection can be facilitated in a number of ways: through preoperative and intraoperative risk assessment, and monitoring of the patient's wound in the post-discharge period (Figure 1).

It is important to note, the risk of SWC development encompasses the patient's full surgical journey and factors related to SWCs span the preoperative, intraoperative and postoperative phases of this journey, including post-discharge from acute care (Sandy-Hodgetts et al, 2020).

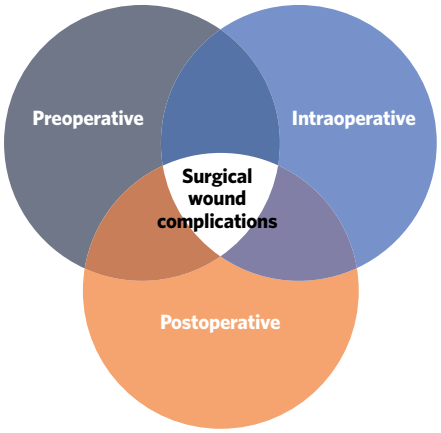

FIGURE 1 | The patient's surgical journey (Sandy-Hodgetts et al, 2018)

Preoperative risk assessment

Preventative measures must involve the risk assessment of a patient, which can be assessed during several phases of their surgical journey. The most common risk assessments for postoperative complications, morbidity and mortality available for clinical use focus on the operative phase of the patient journey (Sandy-Hodgetts et al, 2020; see Table 1).

With the exception of Sandy-Hodgetts et al (2019), which focuses on SWD, there is generally a narrow window for the use of these tools and they are dependent upon the specific discipline, not necessarily focusing upon the entire surgical journey. There is some overlap in patient factors that may be more likely to result in SWCs of all kinds, but there is a need for further focus on the synergistic risk factors and to widen the scope of these to explicitly include all types of SWCs, not just SSI.

It is also clear from the expert group's experience that use of pre-surgical risk assessment and screening tools vary significantly between different to geographical locations and healthcare systems.

Table 1. Current risk models for surgical wound complications		
Risk model/index/system	**Type of complication**	**Clinical setting use and surgical domain**
CeDAR (Augenstein et al, 2015)	SSI	Preoperative colorectal surgery
NNIS (Russo & Spelman, 2002)	SSI	Intraoperative, retrospective
Perth Surgical Wound Dehiscence Risk Assessment Tool (Sandy-Hodgetts et al, 2019)	SWD	Preoperative colorectal surgery, predictive
Fowler Risk Index (Fowler et al, 2005)	SSI	Intraoperative cardiothoracic surgery
P-POSSUM (Prytherch, 2003)	Morbidity and mortality	Intraoperative, general surgery
ASA Classification (Dripps, 1963)	SSI	Intraoperative All surgical domains
EuROSCORE (Nashef et al, 2002)	SSI	Preoperative cardiothoracic surgery
BRA Score (Mlodinow et al, 2017)	SSI	Preoperative breast cancer reconstruction
SSIRS (van Walraven and Musselman, 2013)	SSI	Broad range of surgery types, predictive

The ISWCAP expert group recommend incorporating patient risk assessment as part of a comprehensive pre-surgical process in tandem with other validated risk assessment systems.

Who carries out risk assessment?

In many healthcare systems, it is primarily surgeons or anaesthetists, or both, who may assess the patient prior to surgery, assessing the risk (generally high/moderate/low) and planning medical intervention accordingly. In the case of elective surgeries, the risk assessment may determine whether surgery is undertaken. The nurse-led focus on patient and carer education around hygiene and engagement occurs through managing the patient in the postoperative setting.

There is a recognised need for interdisciplinary working and for effective communication between clinicians from the beginning of the patient's surgical journey, in order to reduce risk and optimise outcomes from the beginning of the process from beginning and through into the community setting, post-discharge.

The current landscape has seen a move towards risk assessment and optimisation of the patient in the pre-operative phase of treatment wherever possible to reduce patient morbidity and mortality. If the patient's risk can be determined preoperatively, decisions can be made accordingly such as:

- Delaying or avoiding surgery where possible, if the risk of SWC is unacceptably high
- Adapting patient factors before surgery takes place, where possible; this may also help to engage the patient and improve their overall health status (i.e. Enhanced Recovery After Surgery [ERAS®] protocols; Ljungqvist et al, 2017)
- Selecting prophylactic products to manage risk post-surgery (such as specialist dressings) and reduce the risk of a SWC developing
- Determining a personalised care pathway that mitigates the level of risk through modification of known risk factors.

While many surgical wounds are likely to heal well, there are a multitude of risk factors that may assist in predicting those that may develop complications. Risk factors may relate to the patient (intrinsic risk factors), the environment (extrinsic risk factors) or to the surgery itself, such as the

type and duration of surgery (Sandy-Hodgetts et al, 2020). Most notably, complications are often associated with known factors that contribute to delayed wound healing (Table 2).

Patients that may be at most risk of a complication are those with pre-existing comorbidities, chronic disease, poor nutrition, advanced age and lifestyle factors such as smoking. These comorbidities include known factors related to delayed wound healing. Some of these risk factors may be modifiable (such as improved nutrition and smoking cessation) and others may not be (such as age and some comorbidities). Where risk factors are modifiable, addressing these with the patient prior to surgery may help to improve their outcomes and overall health status (Levett and Grimmett, 2019; Ripolles-Melchor et al, 2020). In recent times it has been shown that preoperative hydration and nutrition management, blood glucose management and early mobilisation after surgery has reduced the occurrence of postoperative complications (Levett and Grimmett, 2019; Ripollés-Melchor et al, 2020).

Table 2. Examples of factors and conditions associated with delayed/impaired wound healing (From ISWCAP Best Practice Recommendations, 2020; adapted from Hodgetts et al, 2013)

Local factors	Hypoxia/ischaemia Devitalised tissue Infection/contamination Inflammatory conditions Larger initial incision Ongoing mechanical stress or trauma
Systemic factors	Age Psychological stress Chronic disease/comorbidities Medication/polypharmacy Radiotherapy Smoking, alcohol/substance dependency Malnutrition Connective tissue disorders Poor compliance with treatment plans
Extrinsic factors	Poor post-acute surveillance Poor education about wound healing after surgery Lack of use of technology to connect patients and care givers

Enhanced Recovery After Surgery (ERAS®) initiative

Enhanced recovery after surgery (ERAS®) protocols, founded in the 1990s by Professor Henrik Kehlet, are multimodal perioperative care pathways designed to achieve early recovery after surgical procedures by maintaining pre-operative organ function and reducing the profound stress response following surgery (Melnyk et al, 2011). The key elements of ERAS® protocols include preoperative counselling, nutritional optimisation, standardised analgesic and anaesthetic regimens and early mobilisation (Wilmore and Kehlet, 2001; Kehlet and Wilmore, 2002; Kehlet and Dahl, 2003; Arumainayagam et al, 2008; Wainwright et al, 2019).

There is a significant body of evidence indicating that ERAS® protocols lead to improved outcomes (Eskicioglu et al, 2009; Lassen et al, 2009); however, their implementation has been slow (Melnyk et al, 2011). Although much of the data arise from colorectal surgery, the evidence is applicable to other types of surgery. More recently, ERAS® protocols have been developed to encompass colorectal, orthopaedic and gynaecological surgery. Currently there are over 15 protocols to guide perioperative patient care to maximise surgical outcome (Moorthy and Halliday, 2021).

With recent adaptations of ERAS® protocol, patients are able to recover and return to their daily living activities. This, however, may cause over-exertion and result in the patient conducting activities that disrupt the tissue healing process. Guidelines regarding certain restraints of activities are important upon patients discharge from surgery to avoid potential complications, such as seroma, haematoma, and wound dehiscence.

Managing operative risk factors

The 19-item World Health Organization Surgical Safety Checklist (2009) and its implementation has shown significant reduction in both morbidity and mortality and is now used by a majority of surgical providers around the world (NHS, 2019; WHO, 2021).

The WHO Surgical Safety Checklist includes measures throughout the patient's intraoperative stages and divides risk factors into three categories based on the stage:

- Sign in (before induction of anaesthesia)
- Time out (before skin incision)
- Sign out (before patient leaves the operating room).

See Table 3 for more information about the WHO Surgical Safety Checklist.

Table 3. WHO Surgical Safety Checklist (WHO, 2009)

Sign in (before induction of anaesthesia)	Patient has confirmed identity, site, procedure, consent
	Site marked/not applicable
	Anaesthesia safety check completed
	Pulse oximeter on patient and functioning
	Does patient have: ■ Known allergy? ■ Difficult airway/aspiration risk (equipment/assistance available? ■ Risk of over 500ml blood loss (7ml/kg in children)? ■ Adequate intravenous access and fluids planned?
Time out (before skin incision)	Confirm all team members have introduced themselves by name and role
	Surgeon, anaesthesia professional and nurse verbally confirm patient, site, procedure
	Anticipated critical events: ■ Surgeon reviews: what are the critical or unexpected steps, operative duration, anticipated blood loss? ■ Anaesthesia team reviews: are there any patient-specific concerns? ■ Nursing team reviews: has sterility (including indicator results) been confirmed? Are there equipment issues or concerns?
	Has antibiotic prophylaxis been given within the last 60 minutes?
	Is essential imaging displayed?
Sign out (before the patient leaves the operating room)	Nurse verbally confirms with the team: ■ The name of the procedure recorded ■ Instrument, sponge and needle counts are correct ■ How the specimen is labelled ■ Any equipment problems to be addressed
	Surgeon, anaesthesia professional and nurse review key concerns for recovery and management of this patient

In addition to the WHO Surgical Safety checklist, several SWC risk classification systems are in use (see Table 1, page 5), but these are generally used retrospectively for surveillance purposes and, according to NICE, are not used to guide clinical decision-making (NICE, 2020). They are generally not utilised in the identification of high-risk patients prior to a surgical procedure (Sandy-Hodgetts et al, 2020).

The role of diagnostic technology

Early identification and intervention can be facilitated by the use of accurate clinical assessment and novel diagnostic technology, such as fluorescence imaging and digital technologies, which can provide objective tools to assess risk and identify SWCs at the earliest possible stage.

The ISWCAP expert group noted that the role of diagnostic technology is of particular importance in identification of SWCs as it provides an objective means of detecting infection or another SWC without having to rely on clinician judgement – i.e. it helps to remove the subjective 'human factor' from identification and diagnosis. This may be of particular relevance in post-surgical surveillance, where diagnosis of complications spans an interdisciplinary approach (see page 17 for more information on post-surgical surveillance).

Clinical investigations and assessments for diagnosis of SWCs

SWCs such as SSI are often the result of the host's immune response to microbial burden and potential biofilm activity. The microbial burden may be caused by one of two or both vehicles of contamination of the incision site: endogenous or exogenous infection. Endogenous infections arise from contamination from the patient's skin flora or internal organs (Debreuve-Theresette et al, 2015). Exogenous infections occur when external microorganisms contaminate the operative site during the procedure: i.e. contaminated surgical instruments or theatre environment or from another vector (Sendi et al, 2011).

SSI may manifest as an excessive inflammatory response, delayed collagen deposition, inhibited or excessive epithelisation, and may proceed beyond a normal healing timeframe. Therefore, accurate and timely assessment to monitor progress is key to early detection. Clinical assessments must involve vital signs that may indicate early onset of infection, which include but are not limited to:

- Presence of tachycardia
- Elevated body temperature
- Discharge or pus
- Malodour
- General malaise
- Test for and identify causative agent (microbiology, DNA sequencing)
- Determine appropriate patient centric treatment plan with specified goals
- Apply principles of antimicrobial stewardship prior to initiating antibiotic therapy (refer to local guidelines) that is targeted to the identified pathogen(s).

The ISWACP group agreed that appropriate holistic patient assessment and skin inspection using a predefined assessment checklist will aid in determining the extent and severity of the complication. Patient surgical wound assessment must adhere to local and national standards; ISWCAP recommends referring to local guidelines.

There are a number of validated assessment tools for use in the clinical setting that are relevant to the specific surgical domain (Table 4).

Table 4. Surgical wound assessment tools

Surgical wound assessment tool	Surgical domain
ASEPSIS	All
Southampton Wound Score	All
Clavien-Dindo Classification of Surgical Complications	General surgery
WUWHS Sandy SWD Grading System	All
SMArt Wounds Assessment Tool	Orthopaedics

Fluorescence imaging

Point-of-care fluorescence imaging is increasingly used to detect critical bacterial burden in wounds, a new diagnostic technology that is becoming recognised and adopted by clinicians across the globe as an accepted and added component of wound assessment protocol (Oropallo et al, 2021). A Delphi consensus found a high level of agreement among experts on the utility and value of this diagnostic technology, improving patient outcomes and with high potential to reduce the overuse of antimicrobials and reduce costs for both patients and healthcare systems (Oropallo et al, 2021). Use of this imaging procedure was agreed to enable healthcare providers to rapidly detect elevated levels of bacteria and develop an effective treatment plan, while at the same time avoiding the use of advanced therapies when they are contradicted.

Fluorescence technology works by detecting the presence of red or cyan fluorescence signals, which are indicative of elevated bacteria loads (>104 CFU/g; Raizman et al, 2021). Red fluorescence is emitted from porphyrins, endogenous fluorophores produced by bacterial species; while cyan fluorescence signal is attributed to pyoverdines, which are uniquely produced by *Pseudomonas aeruginosa* (Jones et al 2020). These signals are produced from bacteria both in planktonic state and bacteria encased in biofilm. The colour of red fluorescence is dependent on the depth of bacteria; blush and pink are a result of subsurface bacteria.

The efficacy and potential of this diagnostic imaging technology was primarily discussed in chronic wounds; describing their clinical experiences of imaging impact, >80% reported changes in treatment plans, 96% reported that imaging-informed treatment plans led to improved wound healing, 78% reported reduced rates of amputations, and 83% reported reduced rates of microbiological sampling (Oropallo et al, 2021). A post-hoc analysis of these findings has described the potential of fluorescence imaging in the detection of wound infection in surgical wounds (Sandy-Hodgetts et al, 2022). The findings of the study reported an 11.3-fold higher detection of SSI compared to using clinical signs and symptoms alone ($p < 0.0001$; Sandy-Hodgetts et al, 2022).

Often by the time a patient has reached the stage of referral to a wound specialist, they frequently harbour asymptomatic high bacterial loads that delay healing and increase infection risk. Advanced imaging of pathological bacterial burden may improve surgical site monitoring and may potentially reduce the rate of SSIs. More research is needed in a variety of wound types and tracking longer-term outcomes.

The ISWCAP expert group agreed that point-of-care fluorescence imaging is a diagnostic technology that could be of significant benefit in early identification of SSI and may be a useful tool for early detection of other SWCs.

Intraoperative fluorescence and tissue oximeter technology have been adapted to assess tissue perfusion and viability during surgery, wound closure and reconstruction. In addition, these technologies have been extended in their use to evaluate on immediate postoperative course of tissue oxygenation and viability.

Changes on the monitoring parameters may reflect on early development of complication, which can be reversed with immediate intervention (Ozturk et al, 2015; Lohman et al, 2014; Lohman et al, 2013).

The COVID-19 pandemic has increased usage and knowledge around telemedicine and digital platforms to aid patient care (Fletcher et al, 2021). Using telemedicine to facilitate improved post-discharge surveillance has potential to enable early intervention and to improve communication between patient and clinician if the patient has concerns about their wound, decreasing delays in seeking help and managing issues, which is beneficial for patient safety.

Patient education and self-management

Empowering patients through education, so that they are engaged in their own care and feel comfortable to inform their clinician if there is an issue, improves outcomes (WUWHS, 2020) and may be of particular value in early detection of SWCs. Educating the patient in identifying early on the signs and symptoms of a potential complication may be key to the prevention of escalation of the incisional wound to something more sinister. Moreover, education and strong therapeutic relationships with the patient often allay fear and anxiety around self-care of the patient's acute wound in the home care setting (Goh and Zhu, 2018). Telemedicine and use of digital technologies may be of particular benefit in rural areas , where patients may have long distances to travel to see a clinician in person. Such geographical factors, plus the resources and support available in their home environment, require care and communication to be tailored to the individual patient's needs (Castillo et al, 2017; Morgan-Jones et al, 2019; Morgan-Jones et al, 2021; Sandy-Hodgetts et al, 2021, McIssac and Bolton 2020). Moreover, the use of telemedicine and smartphones may become part of routine practice for the assessment of management of surgical wound complications such as SSI in a pandemic era, and may be here to stay for the foreseeable future (McLean et al, 2021; Totty et al, 2018; Sandy-Hodgetts et al, 2022; Oliveria et al, 2022).

Developing therapeutic relationships with patients enables the HCP to develop surgical wound management goals that encompass the cultural and environmental factors that are part of the patient's healing environment (Figure 2). It further allows for post-discharge planning and providing the patient with the appropriate level of education in regards to their incisional wound, how to manage their surgical wound at home and what to do in the event of a suspected complication. Box 1 is guide for clinicians in asking questions prior to discharge, to understand the context of the patient environment following discharge. Several studies have found that both practical and theoretical sessions from clinicians are essential to successful self-management in the home care setting (Gho and Zhu, 2018; Welch et al, 2014; Walker et al, 2015). Moreover, certain patient-related characteristics such as confidence, being alert and responsible and willingness to learn are key for being able to self-care (Gho and Zhu, 2018). Assessing the patient-related characteristics, environmental factors and support network must be considered if the wound management plan incorporates the element of self-management.

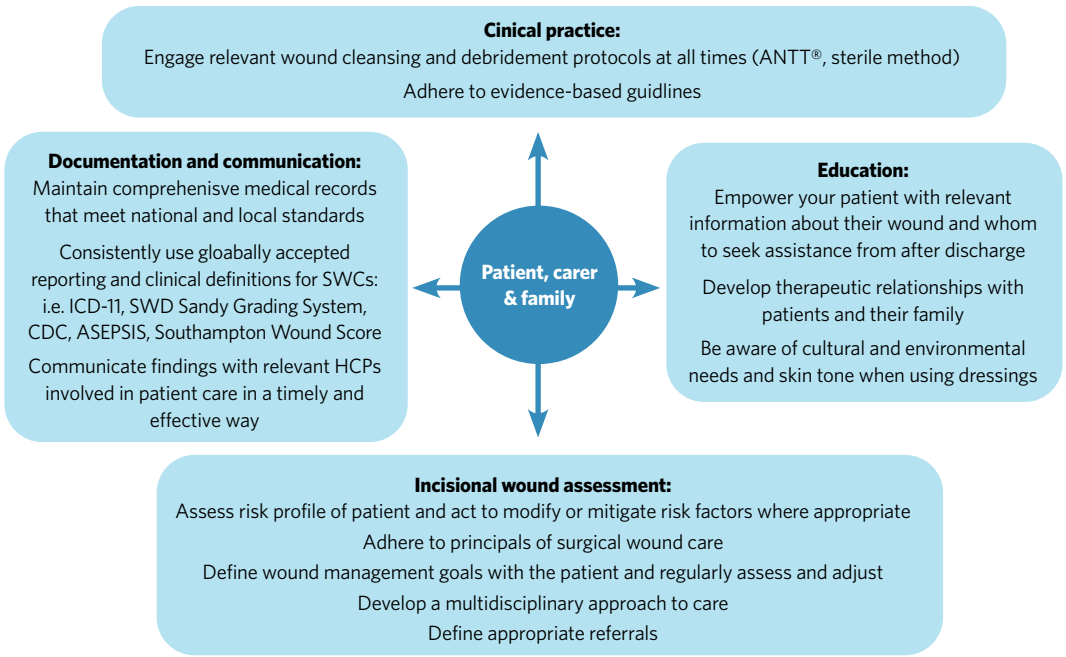

FIGURE 2 | Patient-centered framework for surgical wound management

Box 1. Checklist for patient self-care

- ☐ Do you understand how to look after your own wound at home?
- ☐ Do you have support from carer/family members?
- ☐ Have you been given all the information you need about your wound?
- ☐ Have you been informed about the signs and symptoms of your wound not healing and what to look out for?
- ☐ Do you know when/how to contact your healthcare professional if you have concerns?
- ☐ Have you been given guidelines on your activity level?
- ☐ Have you been informed about nutrition and lifestyle factors in regards to your wound healing?

The ISWCAP group agreed that developing therapeutic relationships with the patient, family and carers enables the opportunity to educate and empower the patient to self-management of their wound. The use of a patient-centric checklist when assessing the patient's home environment, access to health resources and the ability to manage their own care will guide the wound care management plan for the patient.

The role of dressings and advanced wound therapies

Dressing selection in surgical wound management protocols plays a key role in post-surgical incision care (WUWHS, 2016). Evidence suggests that dressing choice and protocols can vary significantly based on individual clinicians, healthcare systems and surgery types, with the individual patient's needs and preferences also playing a key role in dressing selection and the resulting dressing change protocol (Morgan-Jones et al, 2019; Sandy-Hodgetts et al, 2021). There is also disparity between geographical areas regarding access to dressings and other therapies (see page 22 for further guidance for care in low- and middle-resource areas). Additionally, in some areas, advanced therapies are only available privately.

Dressings used in practice vary, including dry gauze, which is simple to use if advanced options are not available. When selecting a post-operative dressing, there are certain criteria a dressing must meet in order to reduce risk of contamination and ensure an optimal healing outcome. A suggested list of the seven requirements of the ideal post-surgical dressing based on expert global consensus (Morgan-Jones et al, 2021) includes:

- Flexibility (not impede the patient's movement), providing elasticity to avoid pulling the skin or blistering (e.g. particularly over knee joints in orthopaedic surgery)
- Good fixation to the skin on application, even if the wound has been disinfected shortly before
- Absorbency, ability to handle exudate
- Skin protection (e.g. reduce the risk of blistering or irritation, not excessively adhesive)
- Water-resistance, providing a good seal/barrier function and enabling the patient to shower
- Elimination of dead space where necessary (not leaving a gap between the dressing and the incision bed where blood/exudate can pool, potentially causing maceration and increasing infection risk)
- Patient comfort and atraumatic removal, reducing the risk of compromising skin integrity
- Application of negative pressure wound therapy (NPWT), which may reduce tension on the incision with close exudative management (Galiano et al, 2018).

The ISWCAP expert group agreed that the most important fundamental factors in selecting a post-operative dressing are to keep the wound occluded, with the correct moisture balance, and ensure that the patient is comfortable with their dressing. The dressing should be able to allow range of movement for normal daily activities, be waterproof and able to stay in situ beyond 48 hours. The dressing must be easy to apply and be atraumatic upon removal. Protection of the periwound skin must also be considered with minimising blistering.

Dressing selection for post-surgical wounds should be considered as carefully as possible, particularly in the presence of any patient risk factors for SWCs that have been detected. Moreover a full holistic assessment of the patient's needs, including the home care setting, should be conducted in order to determine the most appropriate dressing for that patient. Cultural considerations, skin tone (Dhoonmoon et al, 2021) and other related factors such as the ability of the patient to manage their own incisional care if they are unable to access a health care professional due to remote location must also be considered. Inappropriate dressings can also add to the risk of other SWCs such as MARSI, therefore care needs to be taken regarding dressing materials and properties such as adhesion (Le Blanc et al, 2021; Fletcher et al, 2020).

Visibility of the wound: to see or not to see?

Transparent dressings that enable the clinician and the patient to see the wound for monitoring purposes are being increasingly used, with some studies yielding interesting findings on the clinical utility of this approach. A randomised control trial assessing the impact of transparent

semipermeable dressing procedure on the rate of SSI in comparison with a conventional occlusive gauze dressing found that the transparent semipermeable dressings were effective in reducing SSI rates in clean and clean-contaminated operations as well as reducing length of hospital stay and additional costs associated with the occurrence of infection (Ezzelarab et al, 2019). The authors agreed that the use of a semipermeable transparent dressing seemed more comfortable for the patient compared to the occlusive gauze dressing. The semipermeable film dressing allowed the patient to move about freely and shower when necessary with early postoperative mobilisation facilitated (Ezzelarab et al, 2019). The clinical utility of a transparent hydropolymer dressing after TKA or THA was investigated to determine whether extended wear time is suitable for Class I/II procedures. The study revealed a wear time to 14 days without removal and full visibility to allow for early detection of incision line breakdown (Rousseau et al, 2021). Another study is investigating the clinical utility of an advanced transparent hydropolymer dressing for early detection of complications in the home care setting with the use of smartphone technology that allows image capture and rapid communication and wound assessment without the need to attend a clinic or the emergency department for management (Sandy-Hodgetts et al, 2022).

In practice, anecdotal evidence suggests that patient attitudes towards visibility of the wound vary depending on individual factors: some patients would prefer not to see their own wound, whereas some patients prefer to have increased visibility. This may be preferable for patients who are either well informed about their own care or anxious about their wound; in both cases, patients may prefer to be able to monitor the progress and state of the wound themselves. For patients, feeling involved in their own care can have a significant impact on wound healing and optimising treatment, including overall wellbeing and mental health (WUWHS, 2020).

As undisturbed wound healing is generally encouraged (Morgan-Jones et al, 2019), it should be noted that if wound visibility creates an environment that means any unnecessary dressing change is avoided, selecting a transparent dressing can be considered worthwhile (Sandy-Hodgetts et al, 2020).

Negative pressure wound therapy

Use of NPWT in surgical wounds is increasing, particularly in wounds where heavy exudate/leakage may be an issue or where risk of infection is high (Morgan-Jones et al, 2019). NPWT is well established in the management of chronic wounds and surgical wounds healing by secondary intention (Xie et al, 2010; WUWHS, 2016), and has shown early promise in being able to reduce the incidence of SWCs (WUWHS, 2016)

The evidence is conflicting around the use of NPWT on closed surgical incisions for the prevention of SWCs, with studies producing a range of conclusions on clinical outcomes. Some studies report that use of NPWT results in reduction in occurrence of SSIs and seroma (Hyldig et al, 2016; Sandy-Hodgetts et al, 2015), reduced lengths of stay and readmission rates (Pappala et al, 2015) and improved quality of scar tissue (Galiano et al, 2014). Other studies report inconclusive evidence in outcomes for prevention of SSI; there is also some evidence in improvements in scar tissue quality. A Cochrane systematic review has indicated no clear difference in primary or secondary outcomes for the prevention of SSI when using NPWT over incisions (Norman et al, 2020). Likewise other reviews of varying metholodiges have yielded similar findings, and have low-grade clinical recommendations, primarily due to study related factors which render clinical grading difficult, such as limited research design, sample bias and imprecision and that further powered studies are required.

Advances in dressing technology

Advances are continually being made in the development of new dressings, increasing the range of options for patients and clinicians. Trials are currently in progress on 'smart' dressings such as a border dressing with a colour change sensor to monitor bacterial load.

Fluorescence imaging (see page 10) is also being used to guide detection of pathogenic activity and is providing useful insights and potentially changing how current clinical assessment and diagnosis paradigms.

Point-of-care handheld fluorescing devices detect bacterial activity under a safe violet excitation light (405 nm) on a wound. This causes the wound components (skin, slough, blood, bacteria, etc) to fluoresce (or emit light) in different colours (Rennie et al, 2017; 2019). Red and cyan fluorescence are associated with regions of bacterial at loads of >104 CFU/g, which is typically moderate-to-heavy growth (Rennie et al, 2017; 2019; Hurley et al, 2019; Serena et al, 2019).

Several studies have established the role of this diagnostic technology in chronic wounds (Le et al, 2020; Price, 2020). The use of this technology in detection of SSI is an emerging field showing promising results: an 11-fold sensitivity in detection of infection compared to clinical signs and symptoms alone (Sandy-Hodgetts et al, 2021). Further studies are underway to validate this advanced diagnostic tool for surgical wound management.

Post-operative surveillance

At present, most SSI surveillance is completed in the acute care setting, and hospital infection control programs do not always include a standardised methodology for post-discharge surveillance. However, approximately 60% of SSIs occur following discharge and, therefore, the true rate of SSI is likely underreported (Andersen, 2018). Moreover, the lack of standardisation for post-discharge data collection has resulted in a limited understanding of SSIs in the post-acute and home care areas.

The majority of SWCs develop in the community setting post-discharge (McIsaac and Bolton, 2020; Sandy-Hodgetts et al, 2015). There is some discrepancy in post-operative monitoring and surveillance between geographical locations and healthcare systems. In some settings, lack of interdisciplinary communication between teams means that surveillance isn't as effective or accurate as it could be. This means that exact figures around prevalence of all SWCs remain somewhat unclear.

Some advances in treatment in fact mean that patients are likely to be seen less by a clinician so this may mean that SWCs can develop as they are not being monitored as effectively. For example, in some areas where dissolvable stitches are used, this means that a patient may have developed a SWC before they are seen again by a clinician.

The transition from hospital to home can be a complex and confusing time for patients (Hesselink et al, 2013). Uncoordinated discharge planning and inconsistent organisation of care can lead to decreased patient satisfaction, harmful incidents and a higher number of hospital readmissions due to complications (Allaudeen et al, 2011). Studies have shown that up to 20% of medical patients experience a harmful incident within 5 weeks of hospital discharge (Kripalani et al, 2007). A Pan-Canadian study found that the second-most common adverse event in the home care setting was wound infections (14% of all adverse events; Blais et al, 2013). There is a clear need for a standardised monitoring program to bridge the care continuum from hospital to home care.

Therefore, it is imperative that all relevant clinicians are knowledgeable about the potential signs and symptoms of SWCs and how these might present in practice. Clinicians need to be vigilant to ensure early identification and intervention whenever possible, in order to improve outcomes regarding all SWCs. It should be noted again that a narrow focus on SSI must not mean that other SWCs are neglected or not spotted early enough.

Post-discharge surveillance of SSI has been incomplete, problematic and unstandardised (Koek et al, 2015), making it very difficult to calculate and understand true SSI rates. This research was the first to assess the feasibility of a web-based tool (how2trak), which uses the CDC guidelines as a standardised methodology for post-operative discharge surveillance of SSI. Overall, it was found that the how2trak software application (with the CDC surgical assessment guidelines embedded) was feasible in assisting nurses to identify post-acute care SSIs among study participants (McIsaac and Bolton, 2020).

See Table 5 for an overview of possible signs and symptoms of common SWCs.

Table 5. Signs and symptoms of surgical wound complication or infection (adapted from WUWHS, 2018)	
Local signs and symptoms	Warmth
	Erythema
	Swelling/inflammation
	Unexpected pain or tenderness
	Pus or excess exudate
	Malodour
	Dehiscence (areas of separation from the wound margins)
	Crepitus (crackling feeling/sound detected on palpation, due to gas in the soft tissues)
	Collection of fluid under some or all of the incision (seroma, haematoma or abscess)
Systemic signs and symptoms	Malaise
	Loss of appetite
	Pyrexia or hypothermia
	Tachycardia
	Tachypnoea
	Elevated C-reactive protein (CRP)
	Elevated or suppressed white blood cell count
	Sepsis
	Septic shock

Proactive surgical wound surveillance

'No matter how skilled a cardiac surgeon or how successful a surgery, when an SSI sets in, patients can find themselves fighting for their lives' (Emanuel, 2021). SSIs are a leading cause of re-operation, hospital readmission and surgical sepsis, and are an important source of antimicrobial resistance (WHO, 2016).

Sustained surveillance with stakeholder feedback is an evidence-based strategy, which can help to reduce SSI (Abbas et al, 2019). However, surveillance is costly and time-consuming, and some programmes focus only on inpatient detection (Australian Commission on Safety and Quality in Health Care, 2017). This introduces something of a paradox in SSI surveillance: the majority of SSIs occur after the patient leaves hospital, but many hospitals do not conduct surveillance during this critical period, which in turn, leads to the loss of opportunity to introduce measures to improve patient safety (see Figure 3).

Proactive surgical wound surveillance (PSWS) is a novel approach using a consistent multidisciplinary approach to reviewing wounds before more serious problems develop (CASSIS project group, 2022; see Table 6). PSWS is front-line initiative using Islacare, a health technology start-up, which has created the world's first visual medical record to create and deliver a personalised, real-time wound monitoring system for acute and community use. This may be distinguished from other work to date using digital images in SSI surveillance, which cover only patient use (i.e. patient as the photographer; Macefield, 2020). Hospital staff use Isla for wound assessments and the 'Photo at Discharge' personalised wound assessment and care plan (Rochon et al, 2018). Once home, patients continue to use Isla to submit images and information into the same collection as the clinician. Patients can respond to scheduled MS text requests or emails and can also initiate submissions if they become concerned about their wound.

FIGURE 3 | SSI Burden, based on SSI surveillance data in England

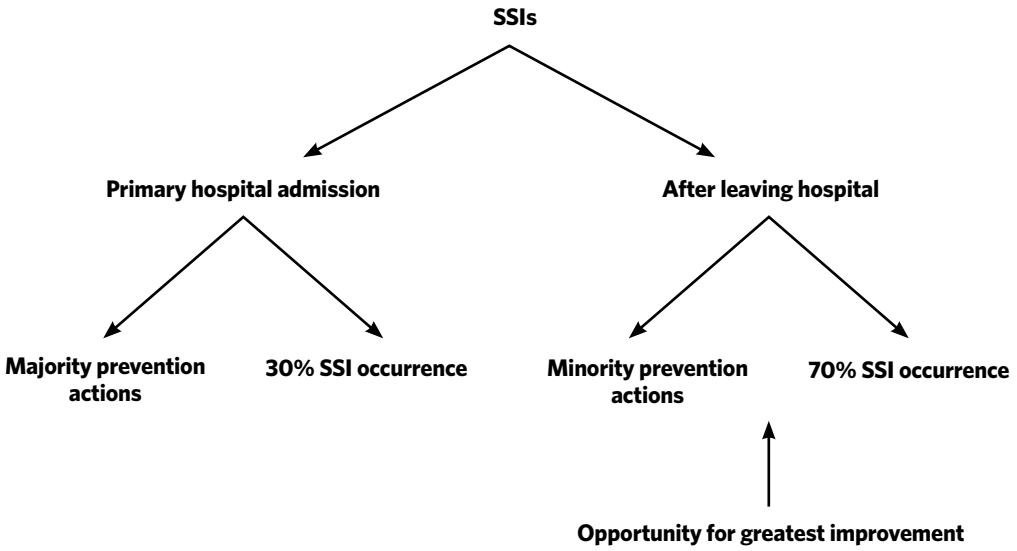

Table 6. Comparison of the traditional and proactive surveillance

Traditional Surveillance Model	Proactive Surveillance Model
Often silo-approach, separate to or duplicating existing data	Real-time opportunity to detect problems early and work within the MDT to improve care directly
Focuses on data collection for SSI benchmarking	Focuses on patient-centred approach and wound healing outcomes, including SSI and SWD
Documents presence or absence of criterion	Embeds an image along with surgical assessment (70-90% of SSI are incisional so a visual element may assist review)
Post-discharge surveillance is frequently retrospective, point-in-time activity, relying on patient's ability to self-identify SSI and cross-referenced with healthcare records	Provides a low-friction way to collect information across the patient pathway to improve care locally

Along with data on SSI, proactive surveillance provides information on the early detection rate of wound concerns, mostly commonly surgical wound dehiscence. As the evidence for using of digital images in surveillance starts to emerge in the United Kingdom (McLean et al, 2021), this scaled and sustained 'real-world' new form of surveillance ensures wounds are reviewed at the right time and in the right place to improve patient experience and outcomes (NHS England, 2019).

WUWHS Sandy Grading System: a diagnostic tool

Structured assessment and classification helps to guide and standardise practice, optimising patient outcomes. Diagnostic tools assist in classifying the type and severity of a clinical issue and can be used to guide practice. The WUWHS Sandy Grading System was originally developed as a grading system for SWD, an area where a classification system was previously lacking (Sandy-Hodgetts, 2017; WUWHS, 2018).

The WUWHS Sandy Grading System relates to the incisional wound dehiscence characteristics and is determined by the visible anatomical features at the incision site (Sandy-Hodgetts et al, 2020). It is intended that this grading system can provide a suitable diagnostic tool for enhanced decision-making for clinical diagnosis and management of SWD (Sandy-Hodgetts, 2017; WUWHS, 2018).

The aim is for this system to be further validated and adopted in clinical practice, in order for standardised classification that informs bedside management. Furthermore, this system provides a standardised system to aid documentation and reporting of SWD, which can assist in describing and determining the prevalence of SWD. This model can be used to guide practice in other form of SWC.

See Figure 4 for details of the WUWHS Sandy Grading System (Sandy-Hodgetts, 2017).

The patient's overall health and wellbeing should be monitored, including any feelings regarding their wound; for example, in patients with abdominal or sternal stitches, an incident of coughing or vomiting may result in a feeling of pulling or ripping that may indicate SWD (WUWHS, 2018).

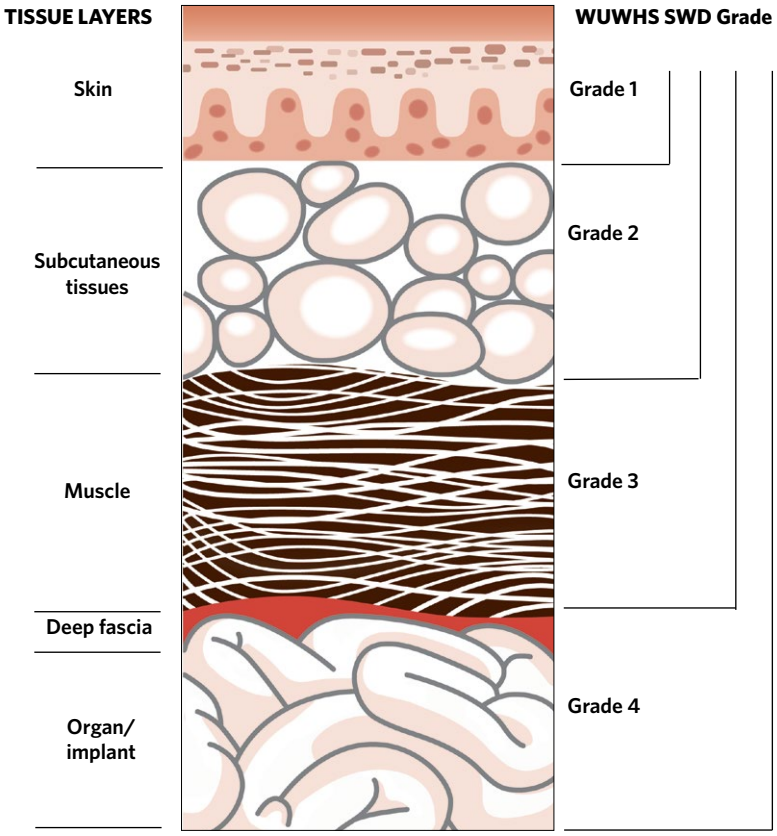

FIGURE 4 | WUWHS SWD Grading system (WUWHS, 2018)

Table 7. WUWHS SWD Sandy Grading System (adapted from Sandy SWD Grading System; WUWHS, 2018)

Definition: Surgical wound dehiscence (SWD) is the separation of the margins of a closed surgical incision that has been made in skin, with or without exposure or protrusion of underlying tissue, organs or implants. Separation may occur at single or multiple regions, or involve the full length of the incision, and may affect some or all tissue layers. A dehisced incision may, or may not, display clinical signs and symptoms of infection.

WUWHS SWD Grade*		Descriptors
Increasing severity; Single/multiple regions† or full-length separation of the margins of a closed surgical incision; occurring up to 30 days after the procedure‡	**1** Figure 4a, page 20	**Epidermis only, no visible subcutaneous tissue** ■ No clinical signs or symptoms of infection
	1a Figure 4b, page 20	As Grade 1 plus clinical signs and symptoms of infection
	2 Figure 4c, page 20	**Subcutaneous layer exposed, fascia not visible** ■ No clinical signs or symptoms of infection
	2a Figure 4d, page 20	As Grade 2 plus clinical signs and symptoms of infection
	3 Figure 4e, page 20	**Subcutaneous layers and fascia exposed** ■ No clinical signs and symptoms of infection
	3a Figure 4f, page 20	As Grade 3 plus clinical signs and symptoms of infection
	4^ Figure 4g, page 20	**Any area of fascial dehiscence with organ space, vicera, implant or bone exposed** ■ No clinical signs or symptoms of infection
	4a^ Figure 4h, page 20	As Grade 4 plus clinical signs and symptoms of infection= (e.g. organ/space SSI§)

**Grading should take place after full assessment including probing or exploration of the affected area as appropriate by a clinician with suitable competency*
†Where this is >1 region of separation of the wound margins, SWD should be graded according to the deepest point of separation
‡Where day 1 = the day of the procedure
§See WUWHS document (2018) Appendix 1, page 38, for the CDC definitions of the different types of SSI
^Grade 4/4a dehiscence of an abdominal incision may be called 'burst abdomen'

Management of SWCs in low- and middle-resource countries (LMICs)

Patients in LMICs are affected by disproportionately higher incidence rates of SSI when compared to high income countries. Protocols and access to resources often vary between geographical locations and healthcare systems. Some regions of the world have both high prevalence and incidence of chronic and acute wounds, coupled with significant disadvantages with respect to healthcare, including wound prevention and treatment (Macdonald and Asiedu, 2010). These regions experience a range of factors that reduce their ability to achieve positive wound outcomes. This includes limited supplies of physical resources, fewer skilled wound professionals and reduced access to formal health services (WHO, 2006; 2010; Builders and Builders, 2016). A number of programmes are attempting to address some of these inequities with a focus upon intraoperative procedures, addressing the shortage of trained personnel and material resources. There are a number of global initiatives underway that are addressing issues related to SWCs such as antimicrobial resistance and safer surgery practices:

- The Global Antibiotic Resistance Partnership (GARP): a collaborative initiative between middle-and-low resource countries to develop policies addressing AMR
- The Global Surgery Foundation working with key stakeholders WHO and UN to improve access to safe and affordable surgery in LMICs
- The G4 Alliance for surgical, obstetric, trauma and anaesthetic care.

It is necessary to consider cultural acceptability, transferability and adaptability, cost-effectiveness, and positive and negative experiences associated with interventions when making recommendations on wound care interventions used in low- and middle-resource communities (Haesler and Rice, 2020). More important is the engagement of local clinicians and researchers to ensure the issues are understood and programmes are grounded and relative to the region.

Some studies have reviewed the use of local wound care remedies and their respective efficacy, such as aloe vera, potato peel dressings, banana leaf dressings, chlorhexidine, tea tree oil, citric acid, green tea, hypochlorites and turmeric; much of the research focuses on burns (Haesler and Rice, 2020), as such guidance is needed for prevention and management of SWCs in low- and middle-resource areas.

Fundamental guidance should focus on issues such as hygiene and dressing selection, with an emphasis on prevention of complications and ongoing monitoring to facilitate early identification and intervention if necessary. It is also important to acknowledge that in some areas there is disparity between urban and rural regions, with patients having to travel long distances to be seen by a clinician and a potential lack of access to resources, especially advanced wound dressings.

Assessment

Thorough and accurate assessment is a key element of care that can be carried out in any setting. While diagnostic technologies are not available in all areas, assessment can be carried out that uses all of the senses and can effectively identify the development of any SWCs. The focus should be on any signs and symptoms and on listening to the patient about their health and experience.

In areas where geographical distance is an issue, telemedicine can play an important role in patient assessment – using phones/apps to stay in touch with the patient can make significant improvements to care.

Education

Care can be improved and the risk of SWCs reduced if the patient (or their carer/family) can be educated about the signs and symptoms to look out for relating to SWCs and when to contact their clinician if there are concerns about the wound. All patients should receive full information (appropriate to their capacity) about their wound and how to manage and observe its progress post-discharge. Involving the patient in their own care whenever possible also helps to engage and empower the patient and, as a result, may improve outcomes (WUWHS, 2020).

As well as the importance of patient education, there is also an ongoing need to educate clinicians – including surgeons, doctors and nurses – on the importance of wound healing.

An interdisciplinary approach is needed, sharing knowledge and best practice between disciplines and departments, as well as within teams.

Box 2. Checklist for incisional wound care in low- and middle-resource areas

- ☐ Are fundamental hygiene measures being followed (basic infection control, use of sanitisers if access to water is unavailable)?
- ☐ Has an appropriate dressing been selected (gauze if other options are not available)?
- ☐ Have you made a plan of care with the patient for post-discharge?
- ☐ If you are unable to see the patient in person, can telemedicine be used?
- ☐ Has the patient/carer been educated about signs and symptoms to look out for, and when to contact their clinician if there are any concerns about the wound?
- ☐ Has the patient been informed about activity level in the home care setting?

The Future

SWCs remain a challenge in clinical practice, with more awareness and education required to facilitate early intervention to improve patient outcomes. An interdisciplinary approach is needed to ensure that known risk factors for all SWCs are optimised during all phases of the patient's surgical jouney.

The development of novel diagnostic technologies represents a considerable advance in prevention and management of SWCs, and should be incorporated into practice where possible. Telemedicine also represents an important option in care, particularly in remote geographical areas where distance is an issue, or in metropolitan areas where access to onsite consultation is limited due to pandemic or other constraints.

Clarity is needed regarding prevalence of SWCs; therefore, implementation of post-surgical surveillance programmes should be viewed as priority – both in terms of data-gathering and improving patient experiences and outcomes. The value of patient reported outcomes provides considerable information and should be incorporated into post-discharge surveillance programs.

Involving the patient in their own care – where possible and tailored to the individual patient and their capacity – has been found to improve their engagement and sense of empowerment about the care they are receiving, ultimately improving outcomes (WUWHS, 2020). Education of the patient, carer and provider is fundamental to improving a patient's healing outcomes. Programmes that are fit for purpose and educate the clinician and the layperson are required to improve wound healing outcomes after surgery. An interprofessional approach is required that is reflective of the patient's surgical journey. The approach must include surgeons, nurses, allied health professionals, primary and community care services in order to reduce variation in practice and provide continuity and consistency of care.

Finally, we must continue to view SWCs – their early detecetion and prevention - as a key topic in surgery and wound care.

References

Allaudeen N, Vidyarthi A, Maselli J, Auerbach A (2011) Redefining readmission risk factors for general medicine patients. *J Hosp Med* 6(2): 54-60

Andersen BM (2018) Prevention of postoperative wound infections. *Prevention and Control of Infections in Hospitals* 25: 377-437

Arumainayagam N, McGrath J, Jefferson KP et al (2008) Introduction of an enhanced recovery protocol for radical cystectomy. *BJU Int* 101: 698-701

Augenstein VA, Colavita PD, Wormer BA (2015) CeDAR: Carolinas Equation for Determining Associated Risks. *Journal of the American College of Surgeons* 221(4): S65-6

Baygin O, Kararmaz A (2018) Sepsis and tachycardia: Etiological factors and effects on prognosis. *Journal of Anesthesia and Therapeutics* 1(1): 1-6

Bjarnsholt T, Kirketerp-Moller K, Jensen PO et al (2008) Why chronic wounds will not heal: a novel hypothesis. *Wound Repair Regen* 16: 2–10

Blais R, Sears NA, Doran D et al (2013) Assessing adverse events among home care clients in three Canadian provinces using chart review. *BMJ Quality and Safety* 22(12)

Builders PF, Builders MI (2016.) Wound care: traditional African medicine approach. In: Fonseca C (Ed.) *Worldwide Wound Healing – Innovation in Natural and Conventional Methods*. Rijecka, Croatia: InTechOpen

Castillo E, McIsaac C, MacDougall B et al (2017) Post-Caesarean Section Surgical Site Infection Surveillance Using an Online Database and Mobile Phone Technology. *Journal of Obstetrics and Gynaecology Canada* 39(8), 645-51

Clavien PA, Barkun J, de Oliveira ML (2009) The Clavien-Dindo classification of surgical complications five-year experience. *Annals of Surgery* 250(2): 187-96

Davies CE, Wilson M, Hill KE et al (2001) Use of molecular techniques to study microbial diversity in the skin: chronic wounds reevaluated. *Wound Repair Regen* 9: 332–40

Debreuve-Theresette A, Diallo S, Siboni R, Ohl X, Dehoux E, Bajolet O (2015) Infections in total hip and total knee arthroplasty: Development of a score to assess endogenous risk of surgical site infections. *Surg Infect* 16(6): 794-8

Dhoonmoon L, Fletcher J, Atkin L et al (2021) Best Practice Statement: Addressing skin tone bias in wound care: assessing signs and symptoms in people with dark skin tones. *Wounds UK*

Dripps RD (1963) New classification of physical status. *Anesthesiol* 24: 111

Eskicioglu C, Forbes SS, Aarts MA et al (2009). Enhanced recovery after surgery (ERAS) programs for patients having colorectal surgery: a meta-analysis of randomized trials. *J Gastrointest Surg* 13: 2321-9

Ezzelarab MH, Nouh O, Ahmed AN et al (2019) A randomized control trial comparing transparent film dressings and conventional occlusive dressings for elective surgical procedures. *Open Access Maced J Med Sci* 7(17): 2844-50

Fletcher J, Atkin L, Murphy N et al (2021) Lessons learned from COVID-19: Building a 'new normal' in tissue viability. *Wounds UK* 17(3): 99-103

Fletcher J, Beeckman D, Boyles A et al (2020) International Best Practice Recommendations: Prevention and management of moisture-associated skin damage (MASD). *Wounds International*

Fowler VG Jr, O'Brien SM, Muhlbaier LH et al (2005) Clinical predictors of major infections after cardiac surgery. *Circulation* 30(112):358-65

Galiano R, Djohan R, Shin J et al (2014) *The effects of single use canister-free negative pressure wound therapy (NPWT) system on the prevention of post-surgical wound complications in patients undergoing bilateral breast reduction surgery.* Poster presented at: 30th Annual Scientific Meeting of the British Association of Aesthetic Plastic Surgeons, London, September 2014

Galiano R, Hudson D, Shin J, Hulst R et al (2018) Incisional Negative Pressure Wound Therapy for Prevention of Wound Healing Complications Following Reduction Mammaplasty. *Plast Reconstr Surg Glob Open* 12:6(1): e1560

Goh LJ, Zhu XMN (2018) Exploring Patient and Caregiver Perceptions of Primary Healthcare Sector Home Care for Simple Acute Wounds, Advances in Skin & Wound Care: August 2018 - Volume 31 - Issue 8 - p 348-360

Guest J, Fuller GW, Vowden P, Vowden KR (2018) Cohort study evaluating pressure ulcer management in clinical practice in the UK following initial presentation in the community: costs and outcomes. *BMJ Open* 8(7): e021769

Haesler E, Rice J (2020) Wound management in communities with limited resources: our mission and achievements of the world Alliance for Wound and Lymphedema Care. *Wounds International* 11(2): 18-21

Hessselink G, Schoonhoven L, Plas M et al (2013) Quality and safety of hospital discharge: a study on experiences and perceptions of patients, relatives and care providers. *Int J Qual Health Care* 25(1): 66-74

Hyldig N, Birke-Sorensen H, Kruse M et al (2016) Meta-analysis of negative-pressure wound therapy for closed surgical incisions. *Br J Surg* 103; 477-86

International Wound Infection Institute (2016) Wound Infection in Clinical Practice: Principles of Best Practice. *Wounds International*

Jones LM, Dunham D, Rennie MY et al (2020) In vitro detection of porphyrin-producing wound bacteria with real-time fluorescence imaging. *Future Microbiol* 15(5): 319-32

Kehlet H, Dahl JB (2003) Anaesthesia, surgery, and challenges in postoperative recovery. *Lancet* 362: 1921-8

Kehlet H, Wilmore DW (2002) Multimodal strategies to improve surgical outcome. *Am J Surg* 183: 630-41

Koek MB, Wille JC, Isken MR et al (2015) Post-discharge surveillance (PDS) for surgical site infections: a good method is more important than a long duration. *Eurosurveillance* 20(8): 26

Kripalani S, LeFevre F, Phillips CO et al (2007) Deficits in communication and information transfer between hospital-based and primary care physicians: implications for patient safety and continuity of care. *JAMA* 297(8): 831-41

Lassen K, Soop M, Nygren J et al (2009). Consensus review of optimal perioperative care in colorectal surgery: Enhanced Recovery After Surgery (ERAS) Group recommendations. *Arch Surg* 144: 961-9

Le L, Baer M, Briggs P et al (2021) Diagnostic accuracy of point-of-care fluorescence imaging for the detection of bacterial burden in wounds: results from the 350-patient fluorescence imaging assessment and guidance trial. *Adv Wound Care* 10(3): 123-36

Leaper D, Tanner J, Kiernan M (2013) Surveillance of surgical site infection. *Journal of Hospital Infection* 83(2): 83-6

LeBlanc K, Beeckman D, Campbell K et al (2021) Best practice recommendations for prevention and management of periwound skin complications. *Wounds International*

Leid JG, Willson CJ, Shirtliff ME et al (2005) The exopolysaccharide alginate protects Pseudomonas aeruginosa biofilm bacteria from IFN-c-mediated macrophage killing. *J Immunol* 175: 7512–8

Levett DZH, Grimmett C (2019) Psychological factors, prehabilitation and surgical outcomes: evidence and future directions. *Anaesthesia* 74(S1): 36-42

Ljungqvist O, Scott M, Fearon KC (2017) Enhanced recovery after surgery: a review. *JAMA Surg* 152(3): 292-8

Lohman RF, Langevin CJ, Bozkurt M et al (2013) A Prospective Analysis of Free Flap Monitoring Techniques: Physical Examination, The External Doppler, The implantable Doppler, and Tissue Oximetry. *J Reconstr Microsurg* 29: 51-6

Lohman R, Ozturk C, Djohan R et al (2014) Predicting Skin Flap Viability Using a New Intraoperative Tissue Oximetry Sensor: A Feasibility Study in Pigs. *J Reconstr Microsurg* 30: 405-12

Macdonald J, Asiedu K (2010) WAWLC: World Alliance for Wound and Lymphedema Care. *Wounds* 22(3): 55-9

McIsaac C, Bolton LL (2020) Reliability and feasibility of registered nurses conducting web-based surgical site infection surveillance in the community: A prospective cohort study. *International Wound Journal* 17(6): 1750-63

McLean KA, Mountain KE, Shaw CA (2021) Remote diagnosis of surgical-site infection using a mobile digital intervention: a randomised controlled trial in emergency surgery patients. *Digital Medicine* 4:160

Melnyk M, Casey RG, Black P, Koupparis AJ (2011) Enhanced recovery after surgery (ERAS) protocols: Time to change practice? *Can Urol Assoc J* 5(5): 342-8

Meyer JM, Neely A, Stintzi A et al (1996) Pyoverdin is essential for virulence of Pseudomonas aeruginosa. *Infect Immun* 64(2): 518-23

Mlodinow AS, Lanier ST, Galiano RD, Kim JYS (2017) Using the Breast Reconstruction Risk Assessment (BRA) Score: An Individualized Risk Calculator to Assist Expectation Management and Reconstructive Decision Making in the Mastectomy Patient. In: Harness J, Willey S (Eds.) *Operative Approaches to Nipple-Sparing Mastectomy.* Springer, Cham.

Moorthy K, Halliday L (2021) Guide to Enhanced Recovery for Cancer Patients Undergoing Surgery: ERAs and oesophagectomy. *Ann Surg Oncol* doi: 10.1245/s10434-021-10384-5

Morgan-Jones R, Bishay M, Hernández-Hermosa JA et al (2019) Incision care and dressing selection in surgical wounds: Findings from an international meeting of surgeons. *Wounds International*

Morgan-Jones R, Cao L, Daozhang C et al (2021) Incision care and dressing selection in surgical wounds: Findings from an international meeting in the APAC region. *Wounds International*

Nashef S, Roques F, Hammill B et al (2002) Validation of European System for Cardiac Operative Risk Evaluation (EuroSCORE) in North American cardiac surgery. *European Journal of Cardiothoracic Surgery* 22(1): 101-5

National Health Service UK (2019) Decade of improved outcomes for patients thanks to Surgical Safety Checklist. Available at: www.england.nhs.uk/2019/01/surgical-safety-checklist/ (accessed 24.11.2021)

National Institute for Health and Care Excellence (2020) Surgical site infections: Prevention and treatment (NG125). Available at: https://www.nice.org.uk/guidance/ng125 (accessed 6.10.2021)

Norman G, Goh EL, Dumville JC et al (2020) Negative pressure wound therapy for surgical wounds healing by primary closure. *Coch Sys Rev* 5: 1465-858

Oliveira LP, Lucato ALS, Fernandes DR et al (2022) Use of technology for self-care in surgical wound infection surveillance: integrative review. *Rev Bras Enferm* 75(3): e20210208

Oropallo AR, Andersen CA, Abdo R et al (2021) Guidelines for point-of-care fluorescence imaging for detection of wound bacterial burden based on Delphi consensus. *Diagnostics* 11(7): 1219

Ozturk CN, Ozturk C, Ledinh W et al (2015) Variables Affecting Postoperative Tissue Perfusion Monitoring in Free Flap Breast Reconstruction. *Microsurg* 35(2):123-8

Pappala S, Mitchell B, Riley J, Katakam N (2015) Reducing caesarean section (CS) surgical site infection (SSI) rate with PICO negative pressure wound therapy (NPWT) in high-risk pregnancies. *Br J Obs Gynaecol* 122: 82

Percival SL, Bowler PG (2004) Biofilms and their potential role in wound healing. *Wounds* 16 234–40

Percival SL, Rogers AA (2005) The significance and role of biofilms in chronic wounds. In: *Biofilms: Persistence and Ubiquity*. McBain A, Allison A, Pratten J et al (Eds.). Manchester, UK: The Biofilm Club, University of Manchester

Prytherch DR, Whiteley MS, Higgins B et al (1998) POSSUM and Portsmouth POSSUM for predicting mortality. *Br J Surg* 85(9): 1217-20

Raizman R, Little W, Smith AC (2021) Rapid diagnosis of Pseudomonas aeruginosa in wounds with point-of-care fluorescence Imaging. *Diagnostics* 11(2): 280

Rennie MY, Lindvere-Teene L, Tapang K, Linden R (2017) Point-of-care fluorescence imaging predicts the presence of pathogenic bacteria in wounds: a clinical study. *J Wound Care* 26(8): 452-60

Ripollés-Melchor J, Abad-Motos A, Díez-Remesal Y et al (2020) Postoperative outcomes within Enhanced Recovery After Surgery protocol in elective total hip and knee arthroplasty (POWER2) Study Investigators Group for the Spanish Perioperative Audit and Research Network (REDGERM). *JAMA Surg* 155(4): e196024

Russo P, Spelman D (2002) A new surgical-site infection risk index using risk factors identified by multivariate analysis for patients undergoing coronary artery bypass graft surgery. *Infect Control Hosp Epidemiol* 23(7), 372-6

Sandy-Hodgetts K (2017) The Sandy Grading System for Surgical Wound Dehiscence Classification: a new taxonomy. *Wounds International* 8(4): 6-11

Sandy-Hodgetts K, Andersen CA, Al-Jalodi O et al (2021) Uncovering the high prevalence of bacterial burden in surgical site wounds with point-of-care fluorescence imaging. *Int Wound J* e1-11

Sandy-Hodgetts K, Carville K, Leslie GD, Lewin G (2013) Determining risk factors for surgical wound dehiscence: A review of the literature. *Int Wound J* doi:10.1111/iwj.12088

Sandy-Hodgetts K, Carville K, Santamaria N et al (2019) The Perth Surgical Wound Dehiscence Risk Assessment Tool (PSWDRAT). *J Wound Care* 28(6): 332-44

Sandy-Hodgetts K, Lewin G, Carville K (2016) Surgical wound dehiscence in patients referred to a Western Australian community nursing service during 2010: Time and cost to healing. *J Wound Care* 25(7): 377-83

Sandy-Hodgetts K, Norman R, Edmondston S et al (2022) A non-randomized pragmatic trial for the Early Detection and prevention of surgical wound complications using an advanced hydropolymer wound dressIng and SmartphONe technology: the EDISON trial protocol. *IWJ*

Sandy-Hodgetts K, Ousey K, Conway B et al (2020) International Best Practice Recommendations for the early identification and prevention of surgical wound complications. *Wounds International*

Sendi P, Banderet F, Graber P, Zimmerli W (2011) Clinical comparison between exogenous and haematogenous periprosthetic joint infections caused by Staphylococcus aureus. Research Note Mycology 17(7): 1098-100

Serralta VW, Harrison-Balestra C, Cazzaniga AL et al (2001) Lifestyles of bacteria in wounds: presence of biofilms? *Wounds* 13: 29–34

Sigmund AE, Fang Y, Chin M et al (2017) Postoperative tachycardia: Clinically meaningful or benign consequence of orthopedic surgery? *Mayo Clin Proc* 92(1): 98-105

Singh Kooner S, Sheehan B, Kendal JK, Johal H (2018) Development of a simple multidisciplinary arthroplasty wound-assessment instrument: the SMArt Wound Tool. *J Can Chir* 61(5): 326-31

Totty J, Harwood AE, Wallace T et al (2018) Use of photograph-based telemedicine in postoperative wound assessment to diagnose or exclude surgical site infection. *J Wound Care* 27: 128–35

Van Walraven C, Musselman R (2013) The Surgical Site Infection Risk Score (SSIRS): A Model to Predict the Risk of Surgical Site Infections. *PLoS One* 8(6): e67167

Wainwright TW, Gill M, McDonald DA et al (2020) Consensus statement for perioperative care in total hip replacement and total knee replacement surgery: Enhanced Recovery After Surgery (ERAS®) Society recommendations. *Acta Orthopaedica* 91(1): 3-19

Walker RC, Hanson CS, Palmer SC et al (2015) Patient and caregiver perspectives on home hemodialysis: a systematic review. *Am J Kidney Dis* 65(3): 451-63

Walter EJ, Hanna-Jumma S, Carretto M et al (2016) The pathophysiological basis and consequences of fever. *Crit Care* 20: 200

Welch JL, Thomas-Hawkins C, Bakas T et al (2014) Needs, concerns, strategies, and advice of daily home hemodialysis caregivers. *Clin Nurs Res* 23(6): 644-63

Wilmore DW, Kehlet H (2001) Management of patients in fast track surgery. *BMJ* 322: 473-6

Wilson AP, Treasure T, Sturridge MF, Grüneberg RN (1986) A scoring method (ASEPSIS) for postoperative wound infections for use in clinical trials of antibiotic prophylaxis. *Lancet* 1(8476): 311-3

Wilson APR, C Gibbons C, B C Reeves BC (2004) Surgical wound infection as a performance indicator: agreement of common definitions of wound infection in 4773 patients. *BMJ* 329(7468): 720

Woods EJ, Davis P, Barnett J, Percival SL et al (2010) Wound healing, immunology and biofilms. In: *Microbiology of Wounds*. Percival SL and Cutting K (Eds). CRC Press

World Health Organization (2006) The World Health Report 2006: Working Together for Health. Available at: https://www.who.int/whr/2006/en (accessed 13.10.2021)

World Health Organization (2009) WHO Guidelines for safe surgery: Safe surgery saves lives. Available at: http://apps.who.int/iris/bitstream/handle/10665/44186/9789241598590_eng_Checklist.pdf;jsessionid=C35422016E3B442A67E72C5511D833D8?sequence=2 (accessed 6.10.2021)

World Health Organization (2010) Wound and Lymphoedema Management. Available at: https://apps.who.int/iris/bitstream/handle/10665/44279/9789241599139_eng.pdf (accessed 13.10.2021)

World Health Organization (2021) WHO Surgical Safety Checklist. Available at: https://www.who.int/teams/integrated-health-services/patient-safety/research/safe-surgery/tool-and-resources (accessed 6.10.2021)

World Union of Wound Healing Societies (2016) Closed surgical incision management: Understanding the role of NPWT. *Wounds International*

World Union of Wound Healing Societies (2018) Surgical wound dehiscence: Improving prevention and outcomes. *Wounds International*

World Union of Wound Healing Societies (2020) Optimising wound care through patient engagement. *Wounds International*

Xie X, McGregor M, Dendukuri N (2010) The clinical effectiveness of negative pressure wound therapy: a systematic review. *J Wound Care* 19(11): 490-5

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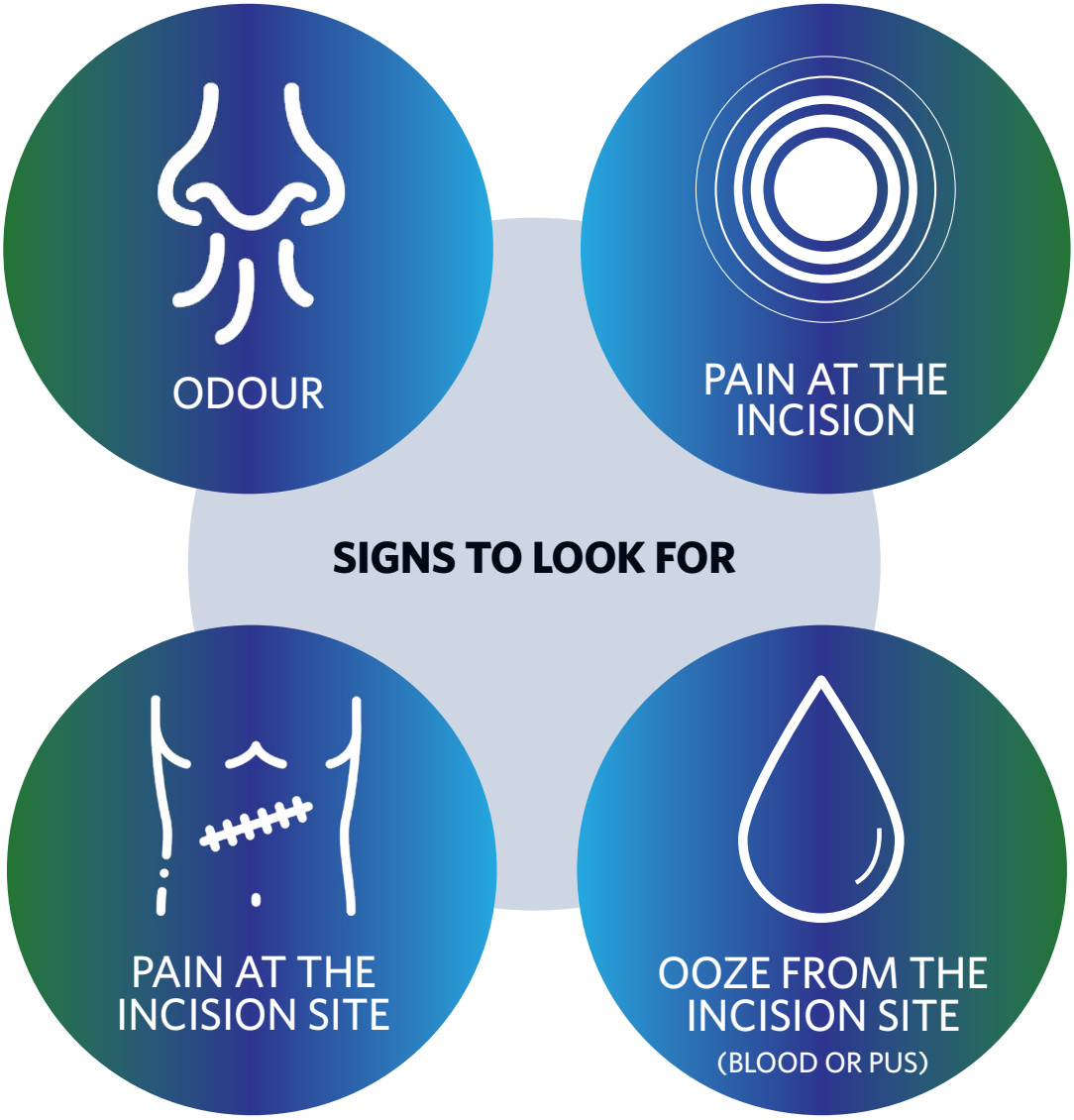

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