

Frugal innovation in wound management within a low resource inpatient setting: A case series

Abstract:

Objective This article seeks to discuss the challenges of wound care in low resource settings, considering opportunities for frugal innovation and the authors' experiences whilst creating virtual wound care clinics across two global communities. In addition, the authors will discuss four real cases presented within the virtual clinics. An adaptation of the widely accepted tissues, infection, moisture, edge, regeneration and repair of tissue, and social factors (TIMERS) wound assessment is also proposed with considerations for low-resource settings.

Method: From March to December 2021 the University of Salford engaged in a virtual wound clinic initiative with colleagues in Fort Portal Regional Referral Hospital.

Results: The clinics provided opportunities for professional and academic development of students on postgraduate tissue viability module in Salford, empowered nurses and midwives in Uganda in taking their place at the centre of multidisciplinary teams in care delivery and created links between the university and clinicians in Uganda to develop the delivery of evidence based wound management. Throughout this period, challenges associated with low resources were highlighted and, in some cases, innovative approaches to managing wound care were adopted to account for this.

Conclusions: The development and delivery of the virtual wound care clinics between the University of Salford and Fort Portal Regional Referral Hospital provided an opportunity for reflection on practice which led to development of a Fit4purpose® wound dressing, revision of evidence-based guidelines, deeper understanding of the scarcity of essential items and frugal practice, and examination of skin tone bias in the signs and symptoms of wound infection in patients with darker skin tones.

Key words: case series, dressings, frugal innovation, low resource, Uganda, wounds.

Introduction:

Background to the virtual wound clinic initiative

In 2019 Knowledge For Change (K4C), together with the University of Salford, Kabarole Health District, Fort Portal Regional Referral Hospital (FPRRH) and the Pharmaceutical Society of Uganda established the importance of wound care to reductions in maternal mortality from sepsis and effective anti-microbial stewardship in Uganda (Ackers, Ackers-Johnson, Seekles et al., 2020). From this work it was identified that nurses and midwives had to be at the heart of any multi-disciplinary approach to future care delivery.

Capitalising on the impact of *'knowledge clusters'* (UK professionals working alongside K4C and local health workers) and the utility of virtual international experiences in undergraduate programmes (Stephens & Hennefer, 2013), three midwives from Uganda were supported in applying for Commonwealth Fellowships to Salford in 2021. Their fellowships would be used for knowledge and skill development in wound and acute illness management; and on return the Commonwealth Fellows would lead the development and delivery of six virtual wound care clinics from September to December 2021. The purpose of the virtual clinics was to influence current practice in FPRRH enabling the midwives to conduct a review of wound management processes, examine the current evidence base and use the case studies from the clinics to develop guidance based on the resources and services available. The clinics would also provide students studying on the Tissue Viability Module at the University of Salford an opportunity to experience wound management in both a global and interprofessional context, as the cases presented at the clinics exposed them to varying patient populations which were discussed by

members of the interprofessional team. The experience could be considered to be similar to that of an international elective for a pre-registration student (Addis, Dean, Setterfield et al. 2022).

Six virtual wound clinics were developed and delivered by the Fellows and clinicians in FPRRH between September 2021 and December 2021. Preparation of these were guided by academic colleagues in the University of Salford. An interprofessional team at FPRRH comprising of nurses, midwives, pharmacists, doctors, clinical officers, and healthcare volunteers joined with lecturers on the Tissue Viability module, and their students, in a virtual bi-weekly forum.

The format of the virtual clinics was refined following two early pilot 'live-stream' clinics during the Fellows' time in the Salford (March – July 2021), which identified ethical and logistical issues relating to showing the live ward environment and to enable more FPRRH staff to join without disrupting clinical work.

At each clinic a case (adult or child with a wound) was presented by the Fellows and FPRRH team. Wound and care management was discussed in depth and across professions and countries, for example wound assessment and aetiology, wound bioburden, surgical techniques, dressing choice and purchase, pharmacology, biochemistry, IV fluids, nutrition, and emotional care.

In order for the University of Salford students to have an awareness of the economic, social and environmental factors affecting healthcare and wound management in Uganda background information regarding the hospital and its services were shared on the module virtual learning platform. The students were directed to this information during the clinics when considering

their clinical reasoning and decision-making processes. FPRRH is a public internship hospital in the town of Kabarole District, Western Uganda. The Ugandan Ministry of Health fund general care in the hospital. Services within the hospital include maternity, paediatrics, burns, high dependency, medicine and surgery. Wound care products available include normal saline, water, hydrogen peroxide, savlon, iodine, honey, sugar, cotton wool, non-woven gauze and sleek. Some products are provided by the hospital and others' patients purchase. The types of wounds seen in FPRRH include pressure ulcers, diabetic foot ulcers, surgical wounds (dehiscid and evisceration), burns and maternity wounds. Many patients must travel long distances to attend the hospital and during their stay have attendants who sleep on the floor and provide support, food, and routine care. This can create congestion, increase the risk of hospital acquired infections (HAIs), and make it harder to clean the clinical areas (Ackers, Ackers-Johnson, Seekles et al., 2020).

Opportunities for exposure to frugal innovation in wound care

There is increasing interest in frugal innovation to address healthcare challenges in low resource settings. In some cases, these innovations have been demonstrated to be preferable to more expensive alternatives (Tran, & Ravaud, 2016) To aid the dissemination and adoption of potential frugal innovations, a digital compendium of frugal medical innovations was recently created by researchers from France (<http://frugal-innovation-medicine.com/index.php>) however to date this only contains one innovation related to wound care and refers to an article published in 1925 describing the use of ant mandibles as an alternative to sutures, a

technique also used by ancient physicians (Majno, 1975). There has so far been little reported specifically on frugal innovation in wound care however, the authors believe that there are many opportunities for innovation within this field.

Frugal innovations are considered to fall into four discrete categories: lean tools and techniques, opportunistic solutions, contextualised adaptations, bottom-up innovations. These were described by Tran and Ravaud (2016) as follows.

Lean tools and techniques, the simplification of existing technologies to reflect lower availability of resources. These technologies are not simply low-cost versions of more expensive technologies but may be technologies with minimised functions to reduce costs. Examples of this in wound care may include:

- Negative pressure wound therapy devices with limited therapy functions to reduce manufacturing costs (Gopal & Solomon, 2016).
- The use of free range instead of bagged larvae.
- Development of the World Alliance for Wound and Lymphoedema Care Wound Care Kit for less resourced countries, which contains sufficient material to produce up to 100 dressings (Vuagnat & Comte, 2016).

Opportunistic solutions, these are when contemporary technologies are used to address 'old' clinical problems. Examples:

- The use of patients' smartphone cameras to document wound healing as an alternative to the acquisition and maintenance of expensive technologies by healthcare providers.

- Video conferencing software to facilitate international consultation on clinical cases to obtain second opinions.

Contextualised adaptations, this is the diversion of existing tools for different purposes.

Examples:

- Construction of negative pressure wound therapy from readily available hospital supplies (Vuagnat & Comte, 2016).
- The use of nappies as superabsorbent dressings.
- The use of sterilised banana leaves or boiled potato peels as dressings
- Use of green tea bags for wound odour management (Bolton, 2016)
- Polyvinylidene food wraps as wound dressings and
- Papaya pulp for enzymatic debridement (Benskin, 2013).

The practice of contextualised adaptations in LMIC's may make practitioners in high income countries (HICs) concerned over the apparent lack of sterility or application of moist wound healing principles when utilising these methods. However, these practices are for conditions when contemporary dressings are unavailable due to costs and access to materials. For example the World Alliance for Wound and Lymphoedema Care (WAWLC) dressing kit was developed from a DELPHI consensus study of experts and is based upon quality wound care in an emergency situation or in a situation with limited resources in health centres or district hospitals. These guidelines make reference to using products that provide '*judicious infection control practices*' (Vuagnat & Comte, 2016). The Joanna Briggs Institute WHAM Node Low Resource Setting section also provides useful insights about the properties of frugal wound care

innovations and for balance, the evidence summaries provide practical recommendations for their readers for example there is no published evidence on the use of potato peel dressings in chronic wounds (Haesler, Robin Watts, Ned, Solomons et al., 2022).

Bottom-up innovations, the use of simple technologies to improve outcomes. Examples: Boiling or salination of water for use during wound cleansing or irrigation.

To support low-resource healthcare settings achieve optimal clinical outcomes it is necessary for further investigation of frugal innovations to be conducted (Benskin, 2013). Ideally, approaches already common in these settings should be investigated using robust methodologies to identify opportunities to maximise the efficiency and efficacy of care and measure the efficacy of the adaptations.

Demonstrating frugal management and innovation through a virtual wound clinic experience; examples of the case studies

In HICs evidence-based practice drives high quality wound care (National Wound Care Strategy Programme, 2022), whereas in LICs wound care practice is based on affordability and accessibility of products (Gupta, Sagar, Maheshwari, Kisaka, et al., 2021). Despite these different approaches, the purpose of the virtual wound care clinics was to examine the global management of wounds and critically discuss practices to assist in reducing the impact wounds have on mortality, morbidity and healthcare resources. The clinics allowed the students to consider the impact frugal innovation (FI) can have on serving the needs of underserved populations which is to offer 'low-cost and efficacious, new or adapted products (or services),

mostly emerging from contexts of institutional voids and resource constraints, involving the creative use of existing resources’ (Sarkar & Mateus, 2022. p.2). The clinics also allowed staff in Uganda, to examine the current evidence base used to support care delivery, service provision and the role each member of the interprofessional team has to offer in the holistic management of patients with acute and chronic wounds. We will now describe four of the cases that were presented during the virtual wound clinics, showing comparisons in practices (see table 1) and highlighting the changes the midwives had instigated to deliver FI.

Wound	Background	HIC wound management	LMIC wound management
Dehisced abdomen	17-year-old female, post c-section	<i>Conservative management</i> with Negative Pressure Wound Therapy or a Wound manager/ fistula bag. <i>Surgical closure with mesh.</i>	<i>Conservative management</i> with daily dressings of dry gauze and sleek to secure the dressing in place. <i>Surgical closure with no mesh</i>
Diabetic Foot Ulcer	50-year-old female – 2-week history of swelling of the right big toe and dorsum of the foot	Incision, drainage of pus, debridement of necrosis and irrigation with saline. Dress with antimicrobials and absorbent dressing, secured with stockinette, wool and crepe.	Incision, drainage of pus, debridement of necrosis and irrigation with hydrogen peroxide. Dressed with honey-soaked gauze, gauze secondary dressing and sleek to secure.

Burns	3-year-old burns injury from cooking oil	Low adherent wound contact layer, antimicrobial ointment, foam, or alginate dressing, secured with tubular bandage or wool and crepe.	Silver sulfadiazine and Vaseline/petroleum-soaked gauze.
Pressure ulcer	52-year-old female with paraplegia of unknown cause	Negative pressure wound therapy or cavity wound dressing such as hydrofibre, alginate, secondary foam dressing.	Sugar paste, dry sterile gauze and sleek.

Table 1: Types of wounds from the virtual case studies

Case Study 1 – Management of a patient with a dehisced abdomen and sepsis

A dehisced or burst abdomen (BA) is a serious complication of intra-abdominal surgery where abdominal muscles separate exposing the abdominal contents, carrying significant morbidity and mortality. Wound infection, coughing, malnutrition, emergency surgery and anaemia increase the risk of BA (Soni, Haripriya, Haripriya & Dutt, 2015). There are no prevalence rates of BA in Uganda, but it is seen regularly in gynaecology in FPRRH. This case describes the care of a girl presenting with a BA.

A 17-year-old female presented with obstructed labour and proceeded to emergency caesarean section. She was discharged the following day to care for her baby who was

admitted to neonatal intensive care. On readmission three days later, the patient presented with pain around the wound, febrile, hypotensive, and tachycardic. Her abdomen was distended and tender, with pus discharging from the wound. Vaginal examination showed foul smelling lochia rubra. She was commenced on antibiotics and stitches were removed to open the caesarean section wound. During the next few days, she began spiking high fevers, and presented with a distended and tender abdomen, offensive, green discharge was oozing from the wound. A laparotomy was performed, and profuse pus and necrotic tissue were discovered within the peritoneal cavity. The uterus was also necrotic. Pus was drained, uterine debridement performed and repaired, and the abdomen closed. Three days later she developed a BA with profuse pus and was rescheduled for a laparotomy. However, she developed Covid-19 and the surgeons were unable to operate. Instead, she was monitored for deterioration and had daily wound dressings, using an aseptic non touch technique (ANTT), daily irrigation with saline and the wound dressed with sterile dry gauze. Two weeks later the wound had granulated, with a gaped rectus sheath and therefore abdominal wall closure was performed. She was discharged home soon after.

During the virtual wound care clinic students and staff were asked questions to stimulate bilateral learning regarding how they would describe the type of wound presented in this case and the underlying aetiology (BA versus surgical dehiscence), what the clinical signs of infection are both locally (erythema, heat, malodour, purulent discharge, pain, oedema, delayed healing, loss of function) in an acute wound, how the wound and patient should be managed (based on local resources and then comparisons globally) and closure of the wound versus closure of the rectus sheath and healing by secondary intention. Interestingly the clinical signs of infection led

to discussion of the term erythema as both countries reported this as a clinical sign of infection at the wound bed. Pictures of the patient's wound were then examined and those present were asked to describe what they saw. It was agreed that erythema was not visible, but instead differences in skin colour were noted between the peri-wound area and surrounding skin. This led to a discussion regarding the latest Best Practice Statement in the UK (Wounds UK, 2021) that examined skin tone bias in wound care. Those present also discussed the use of sterilised mosquito nets for abdominal wall repair, which is common practice in LMIC's for hernia repairs (Tongaonkar, Reddy, Mehta, Singh et al., 2013). A recent clinical review by Skopec et al. (2021) found that mosquito net mesh more closely resembles the biological and mechanical properties of the abdominal wall and therefore is more suitable for use in hernia mesh repair and call for a clinical trial to provide grade 1 evidence for its cost-effectiveness and efficiency of use in the UK.

Case study 2 - Management of a patient with an infected diabetic foot ulcer

Diabetes Mellitus is a chronic, progressive condition with many complications. Diabetic foot ulcers (DFU) occur following poor glycaemic control, secondary to neuropathy and ischaemia (Yazdanpanah, Shahbazian, Nazari, Arti, et al. 2018) and carry significant morbidity and mortality. A meta-analysis found 14.2% of patients across nineteen African countries died during hospitalization with DFU (Rigato, Pizzol, Tiago, Putoto et al., 2018). Prevalence of diabetes across Uganda may range from 1.4% to 9% (Bahendeka, Wesonga, Mutungi, Muwonge et al., 2016; Mondo, Otim, Akol, Musoke et al., 2013), with rates as high as 16% in rural areas

(Chiwanga, Njelekela, Diamond, Bajunirwe et al., 2016). Most patients with diabetes have never been diagnosed (Rigato, Pizzol, Tiago, Putoto et al., 2018), but even with a known diagnosis there is suboptimal control in 42.8% of patients, with 31.2% having diabetic neuropathy (Kibirige, Atuhe, Sebunya & Mwebaze, 2014).

A fifty-year-old female diagnosed with Diabetes Mellitus type II (four months before admission), treated with Metformin and Glibenclamide, presented with a diabetic foot ulcer. She had a two-week history of swelling of the right big toe and dorsum of the foot, associated with excessive urination, blurred vision, and numbness of the lower limbs. Her physiological observations were normal, but a random blood sugar was high at 20mmol/l. Her right foot was swollen with oedema to the knee. The distal toe was darkened and dry. The dorsum of the foot appeared yellowish, covering an area of 10cm x8 cm with a sinus discharging pus. An incision was made across the DFU, allowing pus to drain. Necrotic and gangrenous tissue were removed, then cleaned using hydrogen peroxide. She was treated with IV antibiotics, and subcutaneous insulin for diabetic control. Her insulin was adjusted according to her blood glucose but remained high. She underwent daily dressings using ANTT. The wound was cleaned using diluted hydrogen peroxide. Remaining necrotic tissue was removed on the ward, then irrigated with sterile saline. It was packed with honey gauze and dressed with dry sterile gauze. Debridement was repeated after five days as the wound continued to produce exudate. Pus was drained and the edges and base were thoroughly cleaned. The wound was dressed using sterile gauze soaked in iodine. The patient was discharged the following day on oral antibiotics and encouraged to seek dressing changes at her local health centre.

During this clinic those present were asked to examine how they would define what a DFU was, what the causative factors were for the presenting case, what assessment tools could be used to aid diagnosis and management including the dressing type and footwear. Significant discussions took place on the merits of hydrogen peroxide as a wound cleansing agent, as practice in the UK has declined due to the toxic effects on healthy tissue and fibroblasts (Rueda-Fernández, Melguizo-Rodríguez, Costela-Ruiz, de Luna-Bertos et al., 2022). This assisted the Commonwealth Fellows in challenging current practices within FPRRH as they tried to move to normal saline being the only option for the cleansing of wounds.

Case study 3 – Management of a child with a burn injury

Paediatric burn injuries are the third most frequent cause of injury and death globally in children (Chikwanha, Chinhengo & Chadambuka, 2013). Those injuries can be devastating especially in LMICs due to increased risk factors such as unattended children at home, crowding, and using the kitchen as a room to sleep; in addition to few trained burn specialists and burn centres available (Chalya, Mabula, Dass, Giiti et al., 2011).

Patients suffering from grease burns such as cooking oil are at higher risk of developing deep wounds due to the heat (higher boiling point) and thick, sticky and semi-fluid consistency (Klein, Gibran, Emerson, Sullivan et al., 2005). Grease burns have a much higher rate of requiring excision and grafting.

Minimal data indicates children constitute the highest proportion of the burn victims in Kampala (Nakitto & Lett, 2010). FPRRH is observed to have weekly admissions on the paediatric ward for accidental burns.

A three-year-old girl presented to the ward with burns to multiple body parts caused by accidentally falling into hot cooking oil. On examination, approximately 20% total body surface area (TBSA) was affected with blisters and peeling skin involving trunk, full length of both upper limbs, and face. Initial observations did not indicate an infection and child appeared in stable condition. The diagnosis was 20% mixed thickness burns. The typical management plan for this condition included IV fluids, pre-emptive IV antibiotics and administrations of Tetanus toxoid. Pain was managed with rectal paracetamol. Within 24 hours, the patient had wound debridement under general anaesthetic. The wounds were cleaned with normal saline and silver sulfadiazine (SSD) was applied. Wounds were then dressed in Vaseline/petroleum gauze. Grafting was not performed as this is not available in this setting. The dressing was changed every four days until the wound improved, and no bleeding was noted. After 17 days, the patient was discharged on oral antibiotics for five days and continued with dressing changes at the nearest health centre.

Prompt intervention of paediatric burns caused by cooking oil is needed and whilst this patient presented the day after the injury, this is considered quick as commonly patients present days or weeks later. Surgery within 24 hours was efficient as frequent delays occur due to lack of staff. Studies show that early intervention in burn management is vital due to the risk of developing septicaemia (Rowan, Cancio, Elster, Burmeister et al., 2015). This case raises the

question if IV antibiotics throughout their admission was necessary (Stewart, Gyedu, Agbenorku, Amankwa et al., 2015) creating an opportunity for more research.

Discussions during this virtual wound clinic centred around the use of SSD and Vaseline impregnated gauze. A systematic review and meta-analysis (Nimia, Carvalho, Isaac, Souza, et al. 2019) compared the effect of Silver Sulfadiazine (SSD) with other new dressings, with or without silver, on healing and infection prevention in burns. The authors concluded that *'new dressings with and without silver show better results than SSD for wound healing, and burns treated with dressings without silver are less likely to become infected than burns with SSD. No differences between SSD and new silver materials were observed in relation to infection prevention'* (p.282). Whilst this assists in delivery of EBP in HICs, in LMICs many modern dressings are unavailable, studies that evaluate the use of impregnated tulle gras on time to wound healing would be of clinical use (Sahin, Kaplan, Ozturk, Alpar et al., 2019).

Case study 4 – Management of a patient with a pressure ulcer

Pressure ulcers are areas of damaged skin and underlying tissue following constant, prolonged pressure causing cessation of oxygen and nutrition leading to tissue ischaemia (Bhattacharya & Mishra, 2015). A recent meta-analysis estimated the prevalence of pressure ulcers throughout Africa to be 11% (Anthony, Alosaimi, Shiferaw, Korsah et al., 2021). Many factors increase the risk of pressure ulcers including hypertension, malnutrition, increasing age, and immobility (Agan, 2018).

A 52-year-old female was admitted with extensive category 4 gluteal pressure ulcer (European Pressure Ulcer Advisory Panel, National Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance, 2016) and other smaller wounds following four-months in bed, secondary to paraplegia of unknown cause. There was major skin and tissue loss which involved the muscle, bone and tendon (Zaidi & Sharma, 2021). There were signs of infection tracking surrounding the wound. On examination she appeared malnourished with bilateral lower limb oedema. She was hypertensive. Lower limbs had a power of 1/5, were hypertonic and without reflexes. She has no relevant past medical history. A culture and sensitivity swab isolated E-coli, Acinobacter, proteus mirabilis and enterococcus spp. Her liver function, complete blood count and renal function tests were normal. She had a chest and lumbosacral x-rays to investigate the cause of her paraplegia, which were normal. Ultimately no cause was found. She required a blood transfusion on admission and was treated with antibiotics.

She underwent daily dressings using ANTT with normal saline and gauze. Sugar paste was applied making sure the cavities were filled then dry sterile gauze applied followed by strapping.

Unfortunately, despite all efforts using a multidisciplinary team approach, this patient died of septic shock.

During this virtual wound clinic discussions took place across those present on the direct and indirect causes of pressure ulcers, categorisation of pressure ulcers, wound swabbing and reporting processes, the over prescription of antibiotics and the use of sugar paste. The therapeutic benefits of sugar for the management of wounds is noted to include a decrease in

malodour by inhibiting bacterial growth, reduction in oedema, a change to the wound pH, thus increasing the bacteriostatic effect, stimulation of granulation tissue from local irritation, and growth of epithelial tissue (Kilic, 2001). However in a review of animal studies of sugar based compounds on wound healing suggests topical applications are '*safe and promote wound healing by their antibacterial, immunomodulatory and wound contraction effects*' (Oryan, Alemzadeh, & Moshiri, 2019. p.13). The authors also noted that sugar-based compounds only have value on the initial stages of wound healing and certain types of wounds.

Applying TIME in frugal wound management

Wound healing by activating the endogenous healing process along with effective therapeutic measures is an approach to wound bed preparation (Schultz, Barillo, Mozingo , Chin, 2004). The TIME framework was initially proposed to have T-Tissue, I- Infection, M-Moisture and E- Epithelial migration. Epithelial migration was later modified to include E- Edges of wound. Then in 2019 this was updated to TIMERS to include R-Regeneration and S- Social Factors (Atkin, Bućko, Montero, Cutting et al., 2019) In FPRRH the original framework was recently adopted to enhance wound healing using innovative strategies to encourage normal wound healing with minimal interventions and locally available resources.

Tissue- Debridement of non-viable tissue is the one of the first steps in wound bed preparation. Muhammad Ch (2014) highlighted that clinical experience favoured a combination of surgical

debridement followed by enzymatic debridement. Sharp or surgical debridement is carried out at the bedside or in the operating theatre in FPRRH.

Mechanical debridement, hydrogen peroxide and honey were used to debride the wound in the DFU case study. Hydrogen peroxide has fallen out of favour in many countries following concerns with local toxicity (Wilkins & Unverdorben, 2013). However, it remains common in LMIC setting where few alternative wound debriding agents are available. Hydrogen peroxide may improve healing of chronic wounds, but more research is required (Wilkins & Unverdorben, 2013). Clinically honey is found to be beneficial for DFU, which is supported by multiple studies (Zhu, Wang, Lu, Niu, 2017). Honey reduces wound debridement time, and bacterial clearance time (Wang, Guo, Zhang, & Wang, 2019). Honey is readily available in our low resource setting making it a sustainable wound management option.

Infection- Wound Infections delay healing, therefore, are a key point of the TIME framework for wound bed preparation. Addressing local wound infection using appropriate dressings and topical antimicrobials can decrease bacterial load and promote healing.

In the management of the paediatric burn wounds sugar was used. Sugar has an osmotic effect reducing the moisture in the wound, which promotes granulation tissue formation and inhibits bacterial growth (Haynes & Callaghan, 2011). Sugar is beneficial in infected wounds (Murandu, Webber, Simms, Dealey, 2011; Biswas, Bharara, Hurst, Gruessner et al., 2010) and is cheap and readily available. However, more recently sugar is no longer used at FPRRH because of concerns on sterility (people used ward sugar supplies for domestic purposes). However, if this issue is overcome, sugar could be used in wound management. In future, honey could be an effective

alternative because it is more effective and easier to maintain sterility (Mphande, Killowe, Phalira, Wynn Jones et al., 2007).

Moisture- Moisture balance is key in creating a moist wound environment for healing to occur. Petroleum jelly used in diaper rash decreases epidermal water loss (Alonso, Larburu, Bon, González et al., 2013), and is known for its moisturising properties, when used for minor surgical procedures (Czarnowicki, Malajian, Khattri, da Rosa et al., 2016). Hanna and Giacomelli (1997) state the use of gauze impregnated with petroleum for surgical or traumatic wounds such as burns showed an increase in patient comfort and disruption to wound sites during dressing change. The secondary dressing of gauze provides some absorptive properties, although the risk of strikethrough is common with gauze dressings over more modern ones such as foams. Strikethrough breaches the dressing barrier, creating a pathway for bacteria to reach the wound bed. Furthermore, in the UK and America, the use of petroleum jelly is prescribed with caution in wounds, alternative moisturisers/dressings should be prescribed if a patient is on oxygen therapy or who smokes. A small number of cases of burns to faces, scalp and hands have been reported in patients who have accidentally ignited themselves and/or their dressings (Bauters, Van Schandevyl, & Laureys, 2016).

Edges of Wound- To assist with epithelial edge advancement surgical closure was an option for the patient with the BA. There is limited evidence for guidance, particularly in low-income settings on the management of BA. The European Hernia Society offers guidelines recommending the use of mesh but cannot comment on alternative methods due to lack of evidence, with management decided clinically due to heterogenicity of BA (López-Cano, García-Alamino, Antoniou, Bennet et al., 2018). Management options of primary closure with or

without mesh, temporary closure, or conservative management with regular wound dressings with wet sterile gauze, or negative pressure dressings have been described (van Ramshorst, Eker, Harlaar, Nijens et al., 2010). Conservative management may have increased morbidity with a longer healing time, therefore primary closure with mesh is often recommended (Denys, Monbailliu, Allaey, Berrevoet et al., 2021; Hermawan, Wibisono, Nembo, 2021; Jaiswal & Shekhar, 2018). However, all studies report a lack of good quality evidence. FPRRH clinicians prefer primary closure, without mesh as this is unavailable, despite understanding of the long-term risks of herniation (Bosanquet, Ansell, Abdelrahman, Cornish et al., 2015) and only a few patients with incisional hernias seeking medical care (Ogbuanya & Ugwu, 2022). However, due to Covid-19 this patient was managed conservatively. Dry gauze was used in this instance due to the level of exudate and pus, however wet gauze potentially with honey as an adjuvant could be used as described in the literature (Jaiswal & Shekhar, 2018).

Reflections on frugal management and innovation on future practice

Frugal management and innovation have been central to the project, two wound dressing companies attended a pilot virtual clinic sparking an interest in the development of a wound dressing for LMICs (Fit4Purpose®). With support of a UK microbiology volunteer, K4C has developed a 'honey gauze' dressing using locally made medical grade honey, reducing reliance on antibiotics and antiseptics on the ward. An improvement in rates of sepsis and a reduction in sepsis deaths have been observed in the findings of an action research intervention (Ackers, Acker-Johnson, Seekles et al., 2020). Discussions with Joint Medical Stores, the primary supplier

of medical supplies in Uganda, to enable distribution for honey gauze nationwide is now underway.

The volunteers and University of Salford students identified that they learnt about frugal practice, whilst gaining a deeper understanding of the scarcity of essential items. This gives a renewed appreciation of the National Health Service (NHS) and its resources. The evidence base for many aspects of frugal practice is rooted in low-resource settings, and knowledge sharing through virtual clinics provides understanding of its application, including use in the NHS. For example, the workshops highlighted evidence-based practice such as the use of water for wound cleansing and honey for the antimicrobial, antioxidant, and anti-inflammatory properties.

The clinics have also impacted the development and/or revision of guidelines both in the UK and Uganda and allowed the examination of skin tone bias and signs and symptoms of wound infection in patients with darker skin tones. Reflecting on our experiences within the virtual wound clinics, it is apparent that further visual learning materials in the form of wound images showing clinical signs related to colour are needed to support learning in this area. The Wounds UK (2021) best practice document on skin tone bias does not provide images like this across the skin tone spectrum currently. This is important to ensure timely identification of common wound complications including infection and vascular disease. The international relevance of health education curricula and virtual learning alliances such as this, play a role in dismantling Eurocentric healthcare curricula (Liyanage, 2021), and increase accessibility, diversity, and inclusivity, and creating a global workforce for the NHS and beyond.

Conclusion:

The challenge of delivering wound care in low resource settings directly impacts patient outcomes, however opportunities can arise from frugal innovation and a multidisciplinary approach to wound care delivery. The creation of virtual wound care clinics across two global communities provided learning for professional and academic development of students on a postgraduate tissue viability module in Salford created links between the university and clinicians in Uganda to develop delivery of evidence based wound management using minimal resources. Unexpected learning included the development of a honey wound dressing, revision of evidence-based guidelines, and examination of skin tone bias in the signs and symptoms of wound infection in patients with darker skin tones.

References:

Ackers, L., Ackers-Johnson, G., Seekles, M., Odur, J. and Opio, S., (2020). Opportunities and challenges for improving anti-microbial stewardship in low-and middle-income countries; lessons learnt from the maternal sepsis intervention in Western Uganda. *Antibiotics*, 9(6), p.315.

Addis, B., Dean, K., Setterfield, M., Nott, S., Hunter, A. and Webster, E., (2022). Virtual elective placements for medical students during COVID-19. *Medical Education*, 56(5), p.576.

Agan, A. (2018). Factors Contributing to Pressure Ulcer among admitted patients in Moroto Regional Referral Hospital in Moroto District. Retrieved from

<https://ir.kiu.ac.ug/jspui/bitstream/20.500.12306/5165/1/Agan%20Adam.pdf>

Alonso, C., Larburu, I., Bon, E., González, M.M., Iglesias, M.T., Urreta, I. and Emparanza, J.I., (2013). Efficacy of petrolatum jelly for the prevention of diaper rash: a randomized clinical trial. *Journal for Specialists in Pediatric Nursing*, 18(2), pp.123-132.

Anthony, D., Alosaimi, D., Shiferaw, W.S., Korsah, K. and Safari, R., (2021). Prevalence of pressure ulcers in Africa: A systematic review and meta-analysis. *Journal of Tissue Viability*, 30(1), pp.137-145.

Atkin, L., Bućko, Z., Montero, E.C., Cutting, K., Moffatt, C., Probst, A., Romanelli, M., Schultz, G.S. and Tettelbach, W., (2019). Implementing TIMERS: the race against hard-to-heal wounds. *Journal of wound care*, 28(Sup3a), pp.S1-S50.

Bahendeka, S., Wesonga, R., Mutungi, G., Muwonge, J., Neema, S. and Guwatudde, D., (2016). Prevalence and correlates of diabetes mellitus in Uganda: a population-based national survey. *Tropical Medicine & International Health*, 21(3), pp.405-416.

Bauters, T., Van Schandevyl, G. and Laureys, G., (2016). Safety in the use of vaseline during oxygen therapy: the pharmacist's perspective. *International journal of clinical pharmacy*, 38, pp.1032-1034.

Benskin, L.L. (2013) A review of the literature informing affordable, available wound management choices for rural areas of tropical developing countries. *Ostomy Wound Management*, 59(10), 20-41.

Bhattacharya, S. and Mishra, R.K., (2015). Pressure ulcers: current understanding and newer modalities of treatment. *Indian Journal of plastic surgery*, 48(01), pp.004-016.

Biswas, A., Bharara, M., Hurst, C., Gruessner, R., Armstrong, D. and Rilo, H., (2010). Use of sugar on the healing of diabetic ulcers: a review. *Journal of Diabetes Science and Technology*, 4(5), pp.1139-1145.

Bolton, L. (2017). Resources for optimising wound outcomes in low-resource settings. *Wound Practice and Research*, 25(3): 127-132.

Bosanquet, D.C., Ansell, J., Abdelrahman, T., Cornish, J., Harries, R., Stimpson, A., Davies, L., Glasbey, J.C., Frewer, K.A., Frewer, N.C. and Russell, D., (2015). Systematic review and meta-regression of factors affecting midline incisional hernia rates: analysis of 14 618 patients. *PLoS One*, 10(9), p.e0138745.

Chalya, P.L., Mabula, J.B., Dass, R.M., Giiti, G., Chandika, A.B., Kanumba, E.S. and Gilyoma, J.M., (2011). Pattern of childhood burn injuries and their management outcome at Bugando Medical Centre in Northwestern Tanzania. *BMC research notes*, 4, pp.1-10.

Chiwanga, F.S., Njelekela, M.A., Diamond, M.B., Bajunirwe, F., Guwatudde, D., Nankya-Mutyoba, J., Kalyesubula, R., Adebamowo, C., Ajayi, I., Reid, T.G. and Volmink, J., (2016). Urban and rural prevalence of diabetes and pre-diabetes and risk factors associated with diabetes in Tanzania and Uganda. *Global health action*, 9(1), p.31440.

Chikwanha, T., Chinhengo, T., & Chadambuka, A.B. (2013). Factors associated with accidental burn injuries in children twelve years and below admitted at Chitungwiza and Harare central hospitals in Zimbabwe. *International Journal of Child Health and Human Development*. 6(3): 297-303.

Czarnowicki, T., Malajian, D., Khattri, S., da Rosa, J.C., Dutt, R., Finney, R., Dhingra, N., Xiangyu, P., Xu, H., Estrada, Y.D. and Zheng, X., (2016). Petrolatum: barrier repair and antimicrobial responses underlying this “inert” moisturizer. *Journal of Allergy and Clinical Immunology*, 137(4), pp.1091-1102.

Denys, A., Monbailliu, T., Allaey, M., Berrevoet, F. and van Ramshorst, G.H., (2021). Management of abdominal wound dehiscence: update of the literature and meta-analysis. *Hernia*, 25, pp.449-462.

European Pressure Ulcer Advisory Panel, National Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance. (2016). Prevention and Treatment of Pressure Ulcers: Quick Reference Guide. Retrieved from <https://www.epuap.org/wp-content/uploads/2016/10/quick-reference-guide-digital-npuap-epuap-pppia-jan2016.pdf>

Gopal, S.V, & Solomon, A. (2019). An inexpensive method of negative pressure wound therapy for extremities. *International Wound Journal*, 16(1): 131-133. doi:10.1111/iwj.13002

Gupta, S., Sagar, S., Maheshwari, G., Kisaka, T. and Tripathi, S., (2021). Chronic wounds: Magnitude, socioeconomic burden and consequences. *Wounds Asia*, 4(1), pp.8-14.

Haesler, E., BN, F.W.A., Robin Watts, A.M., Ned, D., and Solomons, T., (2022). WHAM evidence summary: Potato Peel Dressings. *studies*, 5, p.6.

Hanna, J.R., and Giacobelli, J.A. (1997). A review of wound healing and wound dressing products. *The Journal of foot and ankle surgery*. 36(1):2-14.

Haynes, J.S., and Callaghan, R. (2011). Properties of honey: its mode of action and clinical outcomes. *Wounds UK*. 7(1), 50-7.

Hermawan, G.N., Wibisono, J.J. and Nembo, L.F., (2021). Abdominal Wound Dehiscence: A Review of Risk Factors, Prevention and Management in Obstetrics and Gynecology Practice. *Medicinus*, 8(3), pp.102-110.

Jaiswal, N.K. and Shekhar, S., (2018). Study of burst abdomen: it's causes and management. *International Surgery Journal*, 5(3), pp.1035-1040.

Kibirige, D., Atuhe, D., Sebunya, R. and Mwebaze, R., (2014). Suboptimal glycaemic and blood pressure control and screening for diabetic complications in adult ambulatory diabetic patients in Uganda: a retrospective study from a developing country. *Journal of Diabetes & Metabolic Disorders*, 13, pp.1-7.

Kilic, A. (2001). Healing of diabetic ulcers with granulated sugar. *Plastic and Reconstructive Surgery*. Aug 1;108(2):585.

Klein, M.B., Gibran, N.S., Emerson, D., Sullivan, S.R., Honari, S., Engrav, L.H. and Heimbach, D.M., (2005). Patterns of grease burn injury: development of a classification system. *Burns*, 31(6), pp.765-767.

Liyanage, M., (2020). *Miseducation: decolonising curricula, culture and pedagogy in UK universities* (Vol. 23, pp. 1-59). Oxford: Higher Education Policy Institute.

López-Cano, M., García-Alamino, J.M., Antoniou, S.A., Bennet, D., Dietz, U.A., Ferreira, F., Fortelny, R.H., Hernandez-Granados, P., Miserez, M., Montgomery, A. and Morales-Conde, S.,

(2018). EHS clinical guidelines on the management of the abdominal wall in the context of the open or burst abdomen. *Hernia*, 22, pp.921-939.

Majno G. (1975). *The Healing Hand: Man and Wound in the Ancient World*. Cambridge, Massachusetts: Harvard University Press.

Mondo, C.K., Otim, M.A., Akol, G., Musoke, R., and Orem, J., (2013). The prevalence and distribution of non-communicable diseases and their risk factors in Kasese district, Uganda: cardiovascular topics. *Cardiovascular Journal of Africa*, 24(3), pp.52-57.

Mphande, A.N.G., Killowe, C., Phalira, S., Wynn Jones, H. and Harrison, W.J., (2007). Effects of honey and sugar dressings on wound healing. *Journal of wound care*, 16(7), pp.317-319.

Muhammad Ch, I.M. (2014). Role of papaya dressings in the management of diabetic foot ulcers. *Journal of Rawalpindi Medical College*. Jun 30;18(1):87-9.

Murandu, M., Webber, M.A. and Simms, M.H., (2011). Use of granulated sugar therapy in the management of sloughy or necrotic wounds: a pilot study. *Journal of wound care*, 20(5), pp.206-216.

Nakitto, M. and Lett, R., (2010). Paediatric burn injuries: a hospital based study in Uganda. *Injury prevention*, 16(Suppl 1), pp.A46-A47.

National Wound Care Strategy Programme. (2022). About the programme.

<https://www.nationalwoundcarestrategy.net/about-the-nwcsp/>

Nimia, H.H., Carvalho, V.F., Isaac, C., Souza, F.A., Gemperli, R. and Paggiaro, A.O., (2019). Comparative study of Silver Sulfadiazine with other materials for healing and infection prevention in burns: A systematic review and meta-analysis. *Burns*, 45(2), pp.282-292.

Ogbuanya, A.U.O. and Ugwu, N.B., (2022). Surgical repair of abdominal wall hernias in rural southeast Nigeria: Barriers, outcomes, and opportunities for change. *International Journal of Abdominal Wall and Hernia Surgery*, 5(2), p.59.

Oryan, A., Alemzadeh, E. and Moshiri, A., (2019). Role of sugar-based compounds on cutaneous wound healing: what is the evidence?. *Journal of Wound Care*, 28(Sup3b), pp.s13-s24.

Rigato, M., Pizzol, D., Tiago, A., Putoto, G., Avogaro, A. and Fadini, G.P., (2018). Characteristics, prevalence, and outcomes of diabetic foot ulcers in Africa. A systemic review and meta-analysis. *Diabetes research and clinical practice*, 142, pp.63-73.

Rowan, M.P., Cancio, L.C., Elster, E.A., Burmeister, D.M., Rose, L.F., Natesan, S., Chan, R.K., Christy, R.J. and Chung, K.K., (2015). Burn wound healing and treatment: review and advancements. *Critical care*, 19, pp.1-12.

Rueda-Fernández, M., Melguizo-Rodríguez, L., Costela-Ruiz, V.J., de Luna-Bertos, E., Ruiz, C., Ramos-Torrecillas, J. and Illescas-Montes, R., (2022). Effect of the most common wound antiseptics on human skin fibroblasts. *Clinical and Experimental Dermatology*, 47(8), pp.1543-1549.

Sahin, C., Kaplan, P., Ozturk, S., Alpar, S. and Karagoz, H., (2019). Treatment of partial-thickness burns with a tulle-gras dressing and a hydrophilic polyurethane membrane: a comparative study. *Journal of Wound Care*, 28(1), pp.24-28.

Sarkar, S. and Mateus, S., (2022). Doing more with less-How frugal innovations can contribute to improving healthcare systems. *Social Science & Medicine*, p.115127.

Schultz, G.S., Barillo, D.J., Mazingo, D.W. and Chin, G.A., (2004). Wound bed preparation and a brief history of TIME. *International wound journal*, 1(1), pp.19-32.

Skopec, M., Grillo, A., Kureshi, A., Bhatti, Y. and Harris, M., (2021). Double standards in healthcare innovations: the case of mosquito net mesh for hernia repair. *BMJ Innovations*, 7(2).

Soni, P., Haripriya, V.B., Haripriya, A. and Dutt, V., (2015). Burst abdomen: a post-operative morbidity. *International Journal of Scientific Study*, 3(6), pp.75-78.

Stephens, M., & Hennefer, D. (2013). Internationalising the nursing curriculum using a Community of Inquiry Framework and blended learning. *Nurse Education in Practice*. 13(3): 170-175.

Stewart, B.T., Gyedu, A., Agbenorku, P., Amankwa, R., Kushner, A.L. and Gibran, N., (2015). Routine systemic antibiotic prophylaxis for burn injuries in developing countries: A best evidence topic (BET). *International Journal of Surgery*, 21, pp.168-172.

Tongaonkar, R.R., Reddy, B.V., Mehta, V.K., Singh, N.S. and Shivade, S., (2003). Preliminary multicentric trial of cheap indigenous mosquito-net cloth for tension-free hernia repair. *Indian Journal of Surgery*, 65(1), pp.89-95.

Tran, V.T. and Ravaud, P., (2016). Frugal innovation in medicine for low resource settings. *BMC medicine*, 14(1), pp.1-3.

van Ramshorst, G.H., Eker, H.H., Harlaar, J.J., Nijens, K.J., Jeekel, J. and Lange, J.F., (2010). Therapeutic alternatives for burst abdomen. *Surgical technology international*, 19, pp.111-119.

Vuagnat, H., & Comte, E. (2016). The WAWLC Wound Care Kit for less resourced countries: a key tool for modern adapted wound care. *EWMA Journal*, 16(2): 27-33.

Wang, C., Guo, M., Zhang, N., and Wang, G. (2019). Effectiveness of honey dressing in the treatment of diabetic foot ulcers: A systematic review and meta-analysis. *Complementary therapies in clinical practice*. 1(34), 123-31

Wilkins, R.G., and Unverdorben, M. (2013). Wound cleaning and wound healing: a concise review. *Advances in Skin & Wound Care*. 1;26(4), 160-3.

Wounds UK. (2021). Best Practice Statement: Addressing skin tone bias in wound care: assessing signs and symptoms in people with dark skin tones. Wounds UK, 2021. London. Available to download from: www.wounds-uk.com.

Yazdanpanah, L., Shahbazian, H., Nazari, I., Arti, H.R., Ahmadi, F., Mohammadianinejad, S.E., Cheraghian, B. and Hesam, S., (2018). Incidence and risk factors of diabetic foot ulcer: a population-based diabetic foot cohort (ADFC study)—two-year follow-up study. *International Journal of Endocrinology*.

Zaidi, S.R, and Sharma, S. (2020). Pressure Ulcer. InStatPearls [Internet] 2021 Oct 20. StatPearls Publishing. Retrieved from <https://www.ncbi.nlm.nih.gov/books/NBK553107/>

Zhu, G., Wang, Q., Lu, S., and Niu, Y. (2017). Hydrogen peroxide: a potential wound therapeutic target. *Medical Principles and Practice*. 26(4), 301-8.