



## Practical Management of Skin Lesions during COVID-19 Pandemic – IAWC International Academy of Wound Care

Ligresti C<sup>1</sup>, Facchin F<sup>2</sup>, Armstrong DG<sup>3</sup>, Carvalho Guedes MJ<sup>4</sup>, Oliveros C<sup>5</sup>, Marques Rodrigues A<sup>6</sup>, Sanches-Pinto DC<sup>7</sup>, Spagnolo L<sup>8</sup>, Verdù J<sup>9</sup>, Clerici G<sup>10</sup>, Maino C<sup>11</sup>, Montolese A<sup>12</sup>, Ottonello M<sup>13</sup>, Penna F<sup>14</sup>, Scarpa C<sup>2</sup>, Soldevilla Agreda J<sup>15</sup>, Caravaggi C<sup>16</sup>, Navarro W<sup>17</sup>, Guillermina AV<sup>18</sup>, Velasquez G<sup>19</sup>, Blasco Garcia C<sup>20</sup>, Bolgiani A<sup>21</sup>, Cordero MD<sup>22</sup>, Finotti E<sup>23</sup>, Del Rocio Gonzalez Garcia M<sup>24</sup>, Valle Freitas Serra MC<sup>25</sup>, Yaya Ortiz L<sup>26</sup>, Yaya Ortiz S<sup>27</sup> and Bassetto F<sup>2</sup>

<sup>1</sup>Plastic Surgery Team Maria Pia Hospital Turin, Director of IAWC - Italian Academy Wound Care, Italy

<sup>2</sup>Department of Plastic and Reconstructive Surgery, University of Padua, Padua University Hospital, Italy

<sup>3</sup>Keck School of Medicine of University of Southern California (USC), USA

<sup>4</sup>Intensive Care Unit Hospital Center of Vila Nova de Gaia/Espinho, Portugal

<sup>5</sup>Department of Plastic Surgery, Hospital Universitario de Maracaibo, Venezuela

<sup>6</sup>Associative Research Group in Feridas (GAIF), Portugal

<sup>7</sup>Faculty of Medicine of the University of São Paulo, Brazil

<sup>8</sup>Anesthesia Reanimation Maria Pia Hospital Turin, Italy

<sup>9</sup>Department of Community Nursing, Preventive Medicine and Health Public and History of Science, Spain

<sup>10</sup>Diabetic Foot Units San Carlo Hospital - Paderno Dugnano, Milan, Italy

<sup>11</sup>Pressure Injuries Observatory/Advanced Medication Clinic, DPS, ASST, USA

<sup>12</sup>S.C. Dermatology Local Health Authority of Reggio Emilia - IRCCS Head of Dermatology Unit, Arcispedale Santa Maria Nuova, Reggio Emilia, Italy

<sup>13</sup>Plastic Surgery as Suwaidi Hospital Dr. Sulaiman Al Habib Group Riyadh, Saudi Arabia

<sup>14</sup>Medical Director of the FKT Hospital of Asti, Italy

<sup>15</sup>Consultorio de Ausejo Servicio Riojano de Salud, Logrono, Spain

<sup>16</sup>Diabetic Foot Units Multimedita Group - IRCCS Sesto San Giovanni Milan, San Giuseppe Hospital Milan, Italy

<sup>17</sup>Department of Plastic Surgery, Reconstructiva y Quemados Hospital Arzobispo Loayza Lima, Peru

<sup>18</sup>Secretariat of Health of Mexico, Mexico

<sup>19</sup>Diabetic Foot Center Pierangeli Nursing Home, Pescara, Italy

<sup>20</sup>Germans Trias i Pujol University Hospital of Badalona, Barcelona, Spain

<sup>21</sup>Burns from the Benaim Hospital Aleman Mexico Foundation, Mexico

<sup>22</sup>Miami, USA

<sup>23</sup>Medical Toxicology, Cognitive Behavioral Psychotherapy Department Committee "Addiction Pathology" of Turin, Italy

<sup>24</sup>Department of Cardiac Surgery, Montevideo, Uruguay

<sup>25</sup>Federal Hospital of Andaraí, Brazil

<sup>26</sup>Critic Pontificia Universidad Javeriana, Colombia

<sup>27</sup>Universidad del Valle, Fundación Santa Fé de Bogotá, Colombia

### OPEN ACCESS

#### \*Correspondence:

Claudio Ligresti, Department of Plastic Surgery, Maria Pia Hospital Turin, Director of IAWC - Italian Academy Wound Care, Italy,  
E-mail: [ligresti.claudio@virgilio.it](mailto:ligresti.claudio@virgilio.it)

Received Date: 08 Sep 2020

Accepted Date: 30 Sep 2020

Published Date: 05 Oct 2020

#### Citation:

Ligresti C, Facchin F, Armstrong DG, Carvalho Guedes MJ, Oliveros C, Marques Rodrigues A, et al. Practical Management of Skin Lesions during COVID-19 Pandemic – IAWC International Academy of Wound Care. *World J Surg Surg Res.* 2020; 3: 1253.

**Copyright** © 2020 Ligresti C. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

### Abstract

Chronic wounds are an important burden for all the healthcare systems in the world. Their management requires constant follow up by specialized personnel and daily care by patients themselves. The spread of COVID-19 pandemic and the need for social distancing and limited hospital access caused significant limitation of patients' access to treatment, affecting in particular chronic wounds patients. In fact, due to the advanced age and the associated comorbidities, they are patients at higher risk of infection and lethality from COVID-19. In addition, an increase of Pressure Ulcers (PU) was observed worldwide, due to the dramatic number of patients immobilized in Intensive Care Unit (ICU), with systemic viral infection. Furthermore, prone position pressure

ulcer and PPE related ulcers have increased during pandemic. International recommendations are to be collected among healthcare providers and shared with patients in order to improve the management of ulcers in COVID-19 cases. Italian Academy of Wound Care organized and coordinated the International Wound Care Group – COVID-19, made up of around 30 experts to develop a document in support of chronic ulcers best practice during COVID-19. The scientific rationale of this Booklet is to summarize knowledge regarding the management of chronic wounds and analyze the impact of an higher rate pressure ulcers in hospitalized patients. The aim of the author is to collect a short and quote; Operating Manual and quote, concerning the management of chronic ulcers in the COVID-19 period. The chosen formula of booklet for quick consultation, easy to understand, will allow anyone who consults it to apply it immediately in daily practice at home and at the hospital.

## Introduction

On December 31<sup>st</sup>, 2019, the WHO office in China was informed of a group of pneumonia cases of unknown etiology subsequently defined Covid-19 (Coronavirus Disease 19) in Wuhan, Hubei Province. By January 30<sup>th</sup>, China already had 7,736 reported cases and the virus migration had reached 18 countries on 4 continents, 10 mainly by air. March 11<sup>th</sup>, WHO declares that the coronavirus epidemic is a pandemic [1-3].

Preventive measures including social distancing and limited hospital access helped in limiting the spread of infection among patients and healthcare providers [4]. However, they simultaneously severely impacted the management patients affected by chronic wounds. In fact, those are patients at high risk for infection and lethality from COVID-19, given the high number of diseases associated with age and chronic wounds (cardiovascular disease, diabetes) [5].

Moreover, they need constant support for the treatment of the ulcers in order to avoid systemic complications [6,7].

On the other hand, SARS-CoV-2 pandemic has been responsible for an increase of Pressure Ulcers (PU) worldwide, due to the dramatic number of patients in Intensive Care Unit (ICU) immobilized, with reduced systemic oxygen and nutritional deficits, together with microvascular impairment related with viral infection. 12% of all COVID-19 patients were admitted in ICU [8-10].

In addition to traditional pressure ulcers due to position of bedridden patients, PPE and antimicrobial agents induced skin lesions have increased during pandemic [11,12].

Italian Academy of Wound Care organized and coordinated the International Wound Care Group – COVID-19, made up of around 30 experts of various specialties, active worldwide and involved in the management of wounds and COVID-19 patients. A list of recommendations was developed to support patients affected by chronic wounds and personnel involved in their treatment during the lockdown period. In fact, regular follow up of chronic wounds was limited by the need of preventive isolation and high risk of COVID infection.

## Proposed Pathophysiology of COVID Skin Disease

According to the literature, in addition to reduced tissue oxygenation skin lesions could be related to:

- Peripheral thrombotic episodes responsible of local or disseminated intravascular coagulation with tissue perfusion deficits or ischemic necrosis (iliac-femoral-popliteal obstruction or

brachial and axillary vein obstruction) [13]. Those evidence appeared confirmed by increased level of D-dimer;

- Malnutrition and hypoalbuminemia due to ICU treatment, with reduced healing potential [14];
- High rate of curarization of patient treated in the ICU;
- Drug induced complication: [15]
  - o Heparin induced thrombocytopenia
  - o Peripheral ischemic lesion due to vasopressors norepinephrine and dopamine

## How to Manage a Patient Affected by SARS-CoV2 Admitted at the Hospital

Full unload of critical area should be always kept in mind, given the low level of tissue oxygenation due to respiratory impairment.

All patients should be assessed for the risk of developing pressure ulcers and other skin lesions.

The patient must be:

- Completely dressed and observed at all points of the body, evaluated with Braden scale to define the risk to develop PU, with score less than or equal to 16 as risk value; [16]
- Treated as high risk patient choosing support devices as air mattress and alternating pressure surfaces (donuts and air or water pillows are not recommended);
- Frequent position change (every 3/4 h in bed and every 15 min in a wheelchair) changing from supination, pronation to side position.

The treatment protocol presents different indications according to the clinical condition of the patients (i.e. ambulating patient vs. bedridden). However, all caregivers should maintain a high suspicious index of pressure ulcers development. Preventive use of polyurethane foam or gel pads, pillows, and heel and elbow devices is needed [17].

Nevertheless, precise nutritional deficits need to be addressed in COVID-19 patients, given the hyper-metabolic state due to systemic inflammatory response. Malnutrition further impairs wound healing, and it should be avoided possibly through enteral nutrition [18].

## Pressure Ulcers Management

The analysis of patient affected by COVID-19 and treated in ICU compared with a systematic review of the literature showed increased rate of pressure sores in patients affected by COVID-19. The systematic review reported a prevalence of pressure ulcers varying from 16.9% to 23.8% in ICU patients. On the contrary the prevalence of pressure

ulcers in an hospital in the peak of the pandemic in Italy between March 31<sup>st</sup> and April 07<sup>th</sup> appeared to approach the 38.7% in 62 patients analyzed despite usual preventive protocol applied (frequent repositioning, full unload of lesions, repeated skin monitoring and cleansing) [19,20].

Twenty four patients developed 35 ulcers (1.5 ulcers per patient). Male patients affected by diabetes, cardiovascular diseases and dyslipidemia undergoing prolonged mechanical ventilation, frequent pronation and longer hospital staying were at higher risk for pressure ulcers, mean age was 58.8years (range from 39 to 73 years).

In 40% of cases, unusual body area were affected by ulcers (thorax, nose, forehead and chin) even if sacral area was the most affected (15/35) followed by face and thorax.

The deeper lesions (stage III/IV) represent half of the observed PU (48.5%) and the cumulative prevalence excluding stage I lesions was substantially unchanged (34 lesions in 24 patients).

EPUAP Stage – Total	Sacral	Ischial	Heels	Chest	Nose	Front	Chin
I – 1							1
II – 17	2	3	1	1	1	7	2
III – 11	9						
IV – 6	4	1		1			

Follow TIME-H principles for wound management: [21]

- Washing of abscessed cavities: Hydrogen peroxide and rinsing with saline solution
- Cleansing: Saline/PHMB solution
- Disinfection: Iodopovidone - Chlorhexidine – Amuchina

#### **Soft debridement: Viscose gauze soaked with a solution based on: Aloe, Wet gauze**

##### **Dressing materials:**

- Extra-thin hydrocolloids as prevention and/or treatment of superficial lesions
- Collagen, hyaluronic acid, oxidized cellulose, extra-thin hydrocolloids as a cure for superficial lesions
- Polyurethane foams as prevention and treatment of injuries with moderate exudate
- Silver-based antibacterial dressings for open and septic lesions (hydro-fiber-alginates)
- Antibacterial dressings with bacterial uptake for open and septic lesions
- Dressings with bioactive materials in case of adequate bed vascularization

##### **Dressing change:**

- Thin hydrocolloids: 3 days to 4 days
- Bioactive materials: 2 days to 4 days
- Polyurethane 2 days to 3 days
- Silver antibacterial: 2 days to 7 days
- Collection antibacterial: 2 days to 3 days
- Septic cavities: 1 day

## **Wounds Management in SARS-CoV-2 Affected Patients**

The main issue of chronic wound patients affected by COVID-19 is O<sub>2</sub> blood levels. In fact, saturation level lower than 90% are critical for wound healing, and physicians should plan the treatment according to oxygen saturation and amount of exudates.

- Debridement of dry necrosis should be delayed until O<sub>2</sub> level reach compensation

- Wet necrosis, cavity and infections are to be surgically debrided with microbiologic tissue sample, starting empiric systemic therapy while waiting for response.

A. patients with peripheral vascular deficit: revascularization - necrosectomy – reconstruction

B. patients without peripheral vascular deficiency: Necrosectomy – reconstruction

C. chronic, bedridden, unrecoverable patients for walking: Desiccant dressings (Iodopovidone) monitoring humidity and degree of infection

The according to wound depth and tissue involvement:

**Stage 1:** Worsening prevention and dressing change

**Stage 2:** with little or moderate exudate it is recommended

- Swab for culture examination
- Detergents (polyvinylpyrrolidone iodine or chlorhexidine)
- Medication
  - o Alginates with Ag
  - o Hydro-fiber with Ag in case of major exudate

**Stage 3 and 4:**

- Careful surgical debridement (in patients with low perfusion and concomitant heparin therapies)
- Medication
  - o Alginates with or without cavitarigy Ag
  - o Hydro fiber with Ag

If the patient (especially the diabetic) is suffering from a wet necrosis with or without abscess, debridement must be considered an urgent/emergency procedure that cannot be postponed.

## **Advanced Therapy in Wound Management**

### **NPWT Use of negative pressure**

The use of negative pressure in III/IV degree lesions in the COVID-19 patient must be carried out with enormous attention, as in particular in the hypoxic patient it is contraindicated. However, the NPWT can be taken into consideration in the patient in positive evolution and compensation of the saturation in O<sub>2</sub>. It is possible to start from the negative pressure of 75 mmHg increasing only if there are no signs of tissue suffering. In other words the over-exuding lesions need negative pressure to avoid damage by maceration [22].

### **Biophotonic Therapy**

This physical therapy is designed to stimulate healing through disinfection and stimulation of tissue regeneration. Chromophore

gel applied on the injured or inflamed skin is subsequently irradiated by a blue-led light 5 cm from the skin site for 5 min once or twice a week. Hard to heal ulcers showed significant improvement in a multicenter study. (EUREKA study - the evaluation of real-life use of a biophotonic system in chronic wound management: An interim analysis Marco Romanelli, Alberto Piaggese, and Franco Bassetto Drug Design, Development and Therapy) Biophotonic therapy seems appealing also for COVID patients admitted in the hospital. On the contrary the frequent outpatient clinic consultation reduced its applicability during pandemic.

## COVID Related Skin Lesions

According to the literature, skin involvement has been described in 20% of patients affected by COVID-19 disease. Rash, urticarial lesions and vesicles similar to common manifestations of viral infections have been described, even if acro-ischemic lesions similar to vasculitis have been reported in children and young patient.

Similarly, 20.45% (18 of 88) of COVID patients of the Hospital of Lecco, in Lombardy (in the center of pandemic of Northern Italy) developed skin lesions. Fourteen patients developed skin erythema, 3 patients developed diffuse urticarial lesion and 1 patient developed skin vesicles. Of note, all the lesions lacked of pruritus and mainly involved the trunk. They all healed in few days with topical corticosteroid alone or associated to systemic corticosteroid treatment [23].

## Device Related Pressure Ulcers (DRPU)

Cutaneous Lesions associated with personal protective equipment (PPE - masks, protective eye goggles, gowns) are caused by additional pathogenic mechanisms of common pressure ulcers. In fact, skin tears, DRPU, friction injury (lesion), irritant contact dermatitis and Moist-Associated Skin Damage (MASD) are responsible of lesions among the 20% to 40% of healthcare providers [24].

As frequent repositioning is discouraged due to high risk of infection, preventive measures are mandatory to prevent not only skin lesions but also virus contamination [25].

Even if international consensus are still defining the best approach, friction-reducing skin protectants (i.e. petroleum jelly or spray) and impermeable/prophylactic dressing have shown promising results in improving healthcare workers wellness [11,12,26].

## Healthcare Organization to Address Chronic Wound Patients

Chronic wounds patients affected by pressure sores or vascular/diabetic ulcers are affected by many comorbidities (cardiovascular, pulmonary and renal disease), thus at high risk of COVID-19 infection. For this reason, their hospital admission should be avoided at any costs. At the same time, patients affected by chronic wounds need to be taken care of, due to the risk of potential dramatic complications such as infections, sepsis, amputations, or death [27,28].

Reduced patients' appointments have been reported by many healthcare provided and confirmed by the survey of Tinelli et al., who reported a worsening of ulcer stage in 15.4% of cases. In addition they report an increased use of antibiotic and pain medications [7].

Telemedicine could be an effective tool in the management of chronic wounds, even if regular follow up by dedicated caregiver are fundamental to heal ulcers.

Experienced nurse team of the Clinical Referral Centers should be dedicated to home-treatment with specific aim of instruct patients and care-giver to prevention of lesions and performing dressing changes with prompt medical availability in case of complications. Trained nurses should recognize sign of infection.

Telemedicine need to be improved in wound healing centers: photo app and Smartphone thermometry will allow precise monitoring of wounds recognizing wound data (wound area, tissue aspect and vascularization).

## Conclusion

The pandemic and healthcare system modifications during lockdown have been responsible for closure of many outpatient clinics and suspension of non-urgent surgical procedures, which were very detrimental for patients affected by chronic wounds with clinical worsening of pressure, vascular, inflammatory and diabetic ulcers.

In addition, prolonged hospital admission, intensive care procedures (including pronation-supination protocols) widely increased the number of skin lesions, often in unusual sites. Only a strict application of preventive protocols in the management of skin ulcers will prevent further worsening of the economical burden for the healthcare system.

Sharing the recommendations for the best management of many skin lesions related to COVID pandemic will allow optimal treatment during pandemic in the near future.

Preventive measures, nutritional support together with telemedicine support will aid healthcare workers to treat chronic wound patients.

## References

1. Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, et al. Early transmission dynamics in Wuhan, China, of novel coronavirus infected pneumonia. *N Engl J Med.* 2020;382(13):1199-207.
2. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A Novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med.* 2020;382(8):727-33.
3. WHO Director-General's opening remarks at the media briefing on COVID-19, 11<sup>th</sup> March, 2020.
4. Facchin F, Scarpa C, Vindigni V, Bassetto F. Effectiveness of preventive measures against coronavirus disease of 2019 in a Plastic Surgery Unit at the epicenter of the pandemic in Italy. *Plast Reconstr Surg.* 2020;146(1):112e-3e.
5. Paschou SA, Stamou M, Vuagnat H, Tentolouris N, Jude E. Pain management of chronic wounds: Diabetic ulcers and beyond. *Maturitas.* 2018;117:17-21.
6. Rogers LC, Armstrong DG, Capotorto J, Fife CE, Garcia JR, Gelly H, et al. Wound center without walls: The new model of providing care during the COVID-19 pandemic. *Wounds.* 2020;WNDS20200420-1.
7. Tinelli G, Sica S, Guarnera G, Pitocco D, Tshomba Y. Wound care during COVID-19 pandemic. *Ann Vasc Surg.* 2020;S0890-5096(20)30545-8.
8. Phua J, Weng L, Ling L, Egi M, Lim CM, Divatia JV, et al. Intensive care management of Coronavirus Disease 2019 (COVID-19): Challenges and recommendations. *Lancet Respir Med.* 2020;8(5):506-17.
9. Moore Z, Patton D, Avsar P, McEvoy NL, Curley G, Budri A, et al. Prevention of pressure ulcers among individuals cared for in the prone position: Lessons for the COVID-19 emergency. *J Wound Care.* 2020;29(6):312-20.



10. Gefen A, Alves P, Ciprandi G, Coyer F, Milne CT, Ousey K, et al. Device related pressure ulcers: Secure prevention. *J Wound Care*. 2020;29(Sup2a):S1-52.
11. Lan J, Song Z, Miao X, Li H, Li Y, Dong L, et al. Skin damage among healthcare workers managing coronavirus disease-2019. *J Am Acad Dermatol*. 2020;82(5):1215-6.
12. Lin P, Zhu S, Huang Y, Li L, Tao J, Lei T, et al. Adverse skin reactions among healthcare workers during the coronavirus disease 2019 outbreak: A survey in Wuhan and its surrounding regions. *Br J Dermatol*. 2020;183(1):190-2.
13. Tang N, Bai H, Chen X, Gong J, Li D, Sun Z. Anticoagulant treatment is associated with decreased mortality in severe coronavirus disease 2019 patients with coagulopathy. *J Thromb Haemost*. 2020;18(5):1094-99.
14. Barazzoni R, Bischoff SC, Breda J, Wickramasinghe K, Krznaric Z, Nitzan D, et al. ESPEN expert statements and practical guidance for nutritional management of individuals with SARS-CoV-2 infection. *Clin Nutr*. 2020;39(6):1631-38.
15. Zhou B, She J, Wang Y, Ma X. Venous thrombosis and arteriosclerosis obliterans of lower extremities in a very severe patient with 2019 novel coronavirus disease: A case report. *J Thromb Thrombolysis*. 2020;50(1):229-32.
16. Chen HL, Cao YJ, Zhang W, Wang J, Huai BS. Braden scale (ALB) for assessing pressure ulcer risk in hospital patients: A validity and reliability study. *Appl Nurs Res*. 2017;33:169-74.
17. Gaspar S, Peralta M, Marques A, Budri A, Gaspar de Matos M. Effectiveness on hospital-acquired pressure ulcers prevention: A systematic review. *Int Wound J*. 2019;16(5):1087-102.
18. Caccialanza R, Laviano A, Lobascio F, Montagna E, Bruno R, Ludovisi S, et al. Early nutritional supplementation in non-critically ill patients hospitalized for the 2019 novel Coronavirus Disease (COVID-19): Rationale and feasibility of a shared pragmatic protocol. *Nutrition*. 2020;74:110835.
19. Boyko TV, Longaker MT, Yang GP. Review of the current management of pressure ulcers. *Adv Wound Care (New Rochelle)*. 2018;7(2):57-67.
20. Edsberg LE, Black JM, Goldberg M, McNichol L, Moore L, Sieggreen M. Revised National Pressure Ulcer Advisory Panel pressure injury staging system: Revised pressure injury staging system. *J Wound Ostomy Continence Nursing*. 2016;43(6):585.
21. Ligresti C, Bo F. Wound bed preparation of difficult wounds: An evolution of the principles of TIME. *Int Wound J*. 2007;4(1):21-9.
22. Piaggese A, Läubli S, Bassetto F, Biedermann T, Marques A, Najafi B, et al. Advanced therapies in wound management: cell and tissue based therapies, physical and bio-physical therapies smart and IT based technologies. *J Wound Care*. 2018;27(Sup6a):S1-S137.
23. Recalcati S. Cutaneous manifestations in COVID-19: A first perspective. *J Eur Acad Dermatol Venereol*. 2020;34(5):e212-3.
24. Gheisari M, Araghi F, Moravvej H, Tabary M, Dadkhahfar S. Skin reactions to non-glove personal protective equipment: An emerging issue in the COVID-19 pandemic. *J Eur Acad Dermatol Venereol*. 2020;34(7):e297-8.
25. Avellana Moreno R, Estela Villa LM, Avellana Moreno V, Estela Villa C, Moreno Aparicio MA, Avellana Fontanella JA. Cutaneous manifestation of COVID-19 in images: A case report. *J Eur Acad Dermatol Venereol*. 2020;34(7):e307-9.
26. Gefen A, Ousey K. Update to device-related pressure ulcers: SECURE prevention. COVID-19, face masks and skin damage. *J Wound Care*. 2020;29(5):245-59.
27. Rogers LC, Lavery LA, Joseph WS, Armstrong DG. All feet on deck-the role of podiatry during the COVID-19 pandemic: Preventing hospitalizations in an overburdened healthcare system, reducing amputation and death in people with diabetes. *J Am Podiatr Med Assoc*. 2020.
28. Frykberg RG, Gordon IL, Reyzelman AM, Cazzell SM, Fitzgerald RH, Rothenberg GM, et al. Feasibility and efficacy of a smart mat technology to predict development of diabetic plantar ulcers. *Diabetes Care*. 2017;40(7):973-80.