

# **Stress Related Wound Care Management during the COVID-19 Pandemic: Improving Outcomes through Kaki Diabet Indonesia Telemedicine**

Ronald Winardi Kartika<sup>1</sup>, Niko Azhari Hidayat<sup>2</sup>,

Pamela Hendra Heng<sup>3,\*</sup>, David Victorious Lukas<sup>4</sup>

<sup>1</sup>*Faculty of Medicine, KridaWacana Christian University, Jakarta*

<sup>2</sup>*Faculty of Advanced Technology and Multidisciplinary, Universitas Airlangga, Surabaya*

<sup>3</sup>*Faculty of Psychology, Universitas Tarumanagara, Jakarta*

<sup>4</sup>*Director of Marketing, P.T. Ananta Karya Sejahtera, Tangerang*

\*Corresponding author. Email: [pamelah@fpsi.untar.ac.id](mailto:pamelah@fpsi.untar.ac.id)

## **ABSTRACT**

Many Diabetes Mellitus (DM) patients do not receive treatment from hospital policies that reduce visits and consultations to avoid transmission of COVID-19. There have been many implementations of Telehealth. This review aims to determine the implementation model of Telehealth in Diabetes Mellitus patients during the COVID-19 pandemic, especially for diabetic foot consultation. Telehealth is an implementation that can be applied during the COVID-19 Pandemic, especially for people with Diabetes Mellitus. We created the Indonesian Diabetic Foot Telehealth called KakiDiabet Indonesia (KDI) which is able to offer face-to-face consultations by reducing patient absenteeism (from 21% to 4%), compared to before the pandemic, and being able to meet physical and psychological needs. During the COVID-19 pandemic, the estimated time for health services provided was 75 minutes different from before the pandemic (patients needed 175 minutes). Conclusion: Telehealth systems are the best solution for treating DM patients in preventing the spread of COVID-19. The KDI service system is integrated from prevention, education, Psychotherapy and Diabetic Foot Ulcer Therapy Home Care if needed.

**Keywords:** *Diabetic Foot Ulcer, Stress in COVID-19, Diabetes Foot Indonesia Telehealth.*

## **1. DIABETES MELLITUS IN COVID-19 ERA**

The coronavirus disease of 2019 (COVID-19) which is perpetrated by an infection by the Severe Acute Respiratory Syndrome- Coronavirus 2 (SARS-CoV-2) has plunged the world into a pandemic. The COVID-19 virus not only affects the lungs, but it also aggravates the probability for hyperglycemia. Hyperglycemia can modulate immune and inflammatory responses which in turn makes patients more susceptible to severe COVID-19 disease which increases mortality [1]. The main receptor for SARS-

CoV-2 is Angiotensin converting enzyme 2 (ACE-2) the main receptor site of entry for the SARS-CoV-2 virus. The important effect of will reduce the SARS-CoV-2 susceptibility [2].

Considering the information above, it is imperative that glucose levels be well controlled in diabetic patients so as to prevent complications of diabetes [3].

In type-2 DM patients, an increase in glucose levels directly increases the effect of SARS-CoV-2 replication [4]. In addition, the glycolysis process also promotes the replication of SARS-CoV-2

through the production of mitochondrial reactive oxygen species and the activation of hypoxia-induced factor 1 $\alpha$  [5] which is an independent predictor of morbidity and mortality in patients with COVID-19 [6]. In vivo studies in MERS-CoV-infected diabetic mice resulted in an irregular immune response, leading to severe and widespread pulmonary pathology [7,8]. Thus in patients with SARS-CoV-2 infection with type 2 diabetes mellitus with poor glycemic control predicts an increased need for medication and hospitalization, as well as increased mortality [9].

### *1.1. Diabetic Foot Disease during the COVID-19 Pandemic*

A paper from Wuhan about COVID-19 with a comorbidity of diabetes mellitus lists risk factors for mortality include advanced age, being a man with poor glycemic control, having high blood pressure, and a history of cardiovascular disease. These are the same risk factors for a poor prognosis for people with diabetes who later develop diabetic foot as a sequelae [10].

The COVID-19 pandemic has brought to light particular challenges in the management of people with DM and its complications such as foot ulceration. Approaches towards patients have had to be modified to be accommodating towards a new normal of social distancing and have had to use telemedicine or teleconferencing such that classical in person practices have had to be cancelled and replaced by telephone consults, including outpatient consults regarding diabetes and its sequelae [11].

Moreover, diabetes patients have had to deal with the “fear” factor as well. The pandemic has made patients have to deal with the possibility that if they get COVID and have to be admitted to the hospital, the statistics say that people with a comorbidity of diabetes have a poorer prognosis. Therefore, a lot of diabetic and diabetic foot patients are afraid to go to clinics or hospitals because they perceive these places to be hotbeds for the COVID-19 virus. This perception has led to a decrease in hospital and clinical attendance thus patient follow-up and care has been reduced. In summation, the current pandemic increases the risk of poorly controlled diabetes and the consequent complications that come

with it which are Diabetic Foot Ulcers and Stress related Diabetic Foot.

### *1.2. Effects of Stress on Health and Diabetic Foot Ulcer*

The fight or flight response, also known as the rapid stress response, can be triggered by physical or psychological dangers or by emotional distress [12]. This will lead to an increase in hormones, amino acids, and glucose produced during stress and may be valuable in overcoming these stressors because the hormone glucagon will make the patient calmer [13]. However, as a result of the increase in glucagon, there will be an increase in the process of glycolysis which will cause an increase in blood glucose levels. This will slow down the wound healing process on a biological level. Kiecolt-Glaser et al. [14], the effect of stress on cytokine production and healing rate in diabetic foot ulcers associated with interleukin (IL)-1 $\beta$  was significantly released [14].

The next section of this article will review specific reports on diabetic foot care from a third world country during the COVID-19 pandemic, that is Kaki Diabet Indonesia Telehealth.

## **2. TELEHEALTH AND TELEMEDICINE APPLICATIONS FOR THE DIABETIC FOOT**

The use of telehealth and telemedicine applications will help in the self-monitoring of foot health status by diabetic patients, as well as control of routine drug therapy. Besides that, telehealth is a diagnostic, therapeutic, and educational tool so that it will increase the efficiency and effectiveness of treatment. It also has a socio-economic impact in health care such as reducing transportation costs to the hospital and saving time more efficiently [15]. Many applications have been developed in the field of diabetic foot wound diagnosis such as dermal thermography, foot imaging tools, whether mobile or video or online technology. However, currently very few applications have been implemented in diabetic foot care, which may be related to its psychometric properties, which provide holistic care to both diabetic patients and diabetic foot wounds [16]. The purpose of this paper is to inform the public about recent advances by guiding development and

implementation in the fields of medicine and psychology. It is intended that the telehealth and telemedicine applications used can provide assessment, monitoring, prevention, and treatment of diabetic foot disease. In addition, telehealth or telemedicine services can provide education and mental psychological services for diabetic patients who tend to experience depression. Many diabetic foot wound patients experience depression due to wounds that take a long time to heal [17,18].

The telehealth and telemedicine modes reviewed in this paper need investment in equipment, setup, training, and personnel and so these must be weight against the benefit of the patient involved. Being cost-effective is an important aspect to consider for the success of this mode to be accepted and implemented for the use in diabetic foot

### **3. KAKI DIABET INDONESIA TELEHEALTH**

Kaki Diabet Indonesia (KDI), is a Digital Health Telehealth Platform that explains for Foot disease. Diabetes which is one of the complications of "Mother's Disease" namely Diabetes Mellitus. In Indonesia, diabetes sufferers are estimated to reach around 8.5 million people with ages ranging from 20-79 years (quoted from the International Diabetes Federation), ironically no more than half (<50%) are aware of it, are alert so they won't face it [19].

Kaki Diabet Indonesia is a medical service system consisting of an online (telemedicine) and offline (vascular clinic) platform that focuses on treating Diabetic Foot disease. Telemedicine services include: (1) online education to increase public knowledge about Diabetic Foot disease; (2) online consultation between patients and doctors. Services at the vascular clinic include all medical services that must be in direct contact with doctors, starting from diagnostics, drug administration and action [19].

Kaki Diabet Indonesia, which is a holistic medical service system with telemedicine technology that is devoted to certain diseases, in this case is Diabetic Foot. Holistic medical services which consist of health promotion, patient education, consultation, to complete treatment, using online and offline platforms. Health promotion services, education, initial consultations, and online referrals can be carried out by utilizing digital information and

communication technology in the form of telemedicine so that goals are achieved with minimal costs. This online medical service is also equipped with an offline medical service system, namely the Vascular Clinic, Airlangga University Hospital and other partner clinics, which include follow-up consultations, diagnostics, therapy and rehabilitation. The combination of these 2 systems can achieve comprehensive medical services with broad coverage and cost effectiveness [19].

Kaki Diabet Indonesia application, available on Playstore - Google Play, is designed as a Digital Platform Health (Telehealth) that can be done in the management of Diabetic Foot disease encapsulating aspects of Information, Education, Communication & Consulting [19].

The achievements of this developed Indonesian Diabetic Foot digital platform have been successfully realized by Technology Digital Health - IndoHCF Award at ICE - BSD 2019, Jakarta Indonesia. Over time, Diabetic Foot Indonesia, increasingly working through regular webinars, and then in this pandemic era, anticipating the difficulty of patients & families attending control at the hospital, which was developed an additional prospective platform namely KDI Home care [19].

Through telehealth services, specifically Kaki Diabet Indonesia, patients are able to, in practice, substitute a hospital visit and it becomes a one-stop-shop for routine checkup which takes away a lot of the "fear and stresses" of a hospital visit especially in this pandemic as patients do not have to leave the comfort of their own homes for most of the services, which include health promotion, patient education, medical and psychological consultation that are provided by Kaki Diabet Indonesia. This in turn, will have a higher probability for patient compliance towards management for their stress-related diabetic foot wounds and also a reduced risk of transmission for COVID because of the reduced duration in high-risk areas for transmission such as hospitals. In conjunction with better patient compliance, the hospital system will have a lighter workload regarding diabetic foot management. Additionally, because of ease of access to the application, this essentially means that patients who need psychological support are able to reach out towards licensed psychiatrists and psychologists a lot more easily.

Digital Blended services for Diabetic Foot Indonesia further strengthen the strengthening of Digital Health -Telemedicine in Indonesia, specifically for Diabetic Foot problems in Indonesia.

#### **4. STRESS**

Stress was identified as a non-specific symptom and sign of disease by Selye, the first scientist to study this. While at McGill, Selye was assigned by Prof Collip to identify various female sex hormones that had yet to be discovered. To carry out this project, Selye collected cow ovaries for examination and processing. To measure the response, he also injected various extracts into the female rats. There were three findings at autopsy: peptic ulcers of the stomach and duodenum, enlargement of the adrenal glands, and atrophy of the lymphatic system including the thymus. This happened not because of a hypothetical new hormone, because the injected noxious agent had the same findings. The next experiment was to place rats in various stressful conditions. The rats were placed on the cold roof of the medical building and the rats were also placed on a rotating treadmill so that the rats had to run continuously. Each trial yielded the same findings, namely the presence of peptic ulcers, lymphatic atrophy, and adrenal hyperactivity. From there Selye realized that his findings were an expression of the internal environment proposed by Claude Bernard and homeostasis at work, and linked the hypothalamic-pituitary-adrenal axis to the body's way of dealing with stress [20].

Selye differentiated acute stress from chronic stressors, naming the latter 'general adaptation syndrome'. The general adaptation syndrome divides the total response to stress into three phases: the alarm reaction, the stage of resistance and the stage of exhaustion. When individuals are faced with something stressful, they are initially taken off guard, then try to maintain a stable condition by resisting change, if the stressor continues, they will eventually experience exhaustion in dealing with the stressor. Stress is a complex sequence of events, not just a term used by psychologists. All individuals experience stress during periods of illness. Walter Cannon, a physiologist in 1915 explained that this is different from the fight-or-

flight response or acute stress experienced by a person when he feels threatened [20].

##### *4.1 Factors of Stress*

Generally, stress is divided into internal stress and external stress. The most common cause of stress that comes from within us, is called internal stress. Another type of stress that comes from the environment, is called external stress. Internal stress relates to thoughts and feelings which cause anxiety. Most of the time, humans put themselves in the situations that will make themselves stressed out by worrying about uncertainty, having unrealistic expectations, and having low self-esteem that caused by a lack of assertiveness and negative self-talk [21].

External stress relates to the environment, such as daily hassles, noise, pollution, population density, financial problems, work stress, and stress that comes from the relationships in the family or with others. It is necessary to identify internal and external stresses, and then learn how to manage them, this will help to deal with stress (First Psychology Scotland) [21].

Tse, Flin, and Mearns in Shahsavarani, Abadi, and Kalkhoran<sup>[22]</sup> state that either or both individual perceptions and environmental factors are causes of stress. Individual perceptions can cause several negative emotions such as anxiety, pain, sadness depression, etc. as well as post-traumatic stress disorder (PTSD) which is serious psychological disorders.

There are various factors in the variation in the quantity and quality of the stress process. This has been analyzed by studies in the areas of executive function and cognitive performance. One of the main factors was the role of stress on higher cognitive and cortical functions. Basically, external factors do not always create a threatening or stressful situation, but individual perceptions mean that. When people do not believe that they have adequate resources to solve problems, they can experience stress or perceive a problem as a threatening or dangerous situation [22].

#### 4.2. Stress with Diabetes Melitus

An enhancement in proinflammatory cytokines that has been linked to various diseases, such as cardiovascular disease, rheumatoid arthritis, diabetes type 1, diabetes type 2 and certain cancers is being triggered by stress with negative emotions that accompany by anxiety and depression. Stress is a potential cause of chronic hyperglycemia in diabetics. This happens because stress has been proven to contribute a great stimulus to the body's metabolism. The body provides a fight response or sometimes flight response as a result of energy mobilization. When a person experiences stress, the body releases various hormones. This can cause an enhancement in blood glucose. Though this is a normal and important adaptation for healthy organism, but in diabetes, this condition is a result of relative or absolute insulin deficiency, additional in glucose caused by stress cannot be metabolized properly. Abnormalities in the regulation of stress hormones in diabetes may occur [23].

Research in humans has shown that stress can cause hyperglycemia, hypoglycemia, or no establishment effect of glycemic status in diabetes [24].

Stress can also be a result of diabetes because people with diabetes cannot be cured completely, so discipline, obedience and strong motivation are needed to adhere to a balanced diet so that it can cause balance and stress [25].

#### 4.3 Stress with Diabetic Foot Ulcer

Pain and widening of the sores on the feet due to diabetes make it difficult to move and perform daily activities. They become dependent on others because they cannot perform activities independently. This is of course a cause of stress due to limited mobility.

To cope with the expansion of the wound, it is necessary to remove dead tissue and cut the part that is felt to aggravate the infection. Amputation is an alternative for diabetic feet. But amputation not only eliminates aesthetics, but self-confidence can also be lost as a consequence of amputation. Stress is caused by fear of amputation on diabetic foot ulcers [26].

Diabetic foot ulcers have stress due to fear of amputation. To prevent the amputation, the patient must perform sound care properly. Diabetic foot ulcer treatment requires no small amount of money, this has an impact on the economic status for sufferers who are also a stressor in the patient. Besides that, diabetic foot ulcers also have an impact on social change due to sufferers have a condition that causes pain, impaired activity and unpleasant odors [27].

There are four important components to inhibit the growth of diabetes mellitus wounds:

1. Foot Temperature Monitoring

Foot temperature monitoring is a routine activity carried out to identify the occurrence of diabetic wounds. The utilize of technology for remote review of screening to help optimize daily care that can reduce the risk of complications of diabetic foot ulcers.

2. Foot Image Monitoring

Diabetic wound healing is influenced by routine in controlling wounds. the use of a camera and sending images is one method of monitoring wounds that is effective remotely in its application, this image will show different colors on the feet with diabetic wounds. There are eight studies that discuss the role of images in the detection and monitoring of wound healing in diabetes mellitus.

3. Guided Treatment

Targeted exercise is an intervention programmed to improve overall care independently as well as in carrying out physical activities guided by technology. Diabetic foot ulcers have been following four sessions of practice and behavioral counseling for half a month or so, accompanied by technology capable of reviewing activities and text messages. Pre- and post-intervention measures of activity measured were accelerometer results, daily mobility, and glycemic control. The result is an increase in the number of steps with the average of 881.89 steps per day. As the steps of the participations increase, the glucose level also drops by 0.33%. The results showed that participants felt

the benefits of the intervention. Because it is able to provide more information related to physical activity and dealing with pain.

#### 4. Consultation

The role of online consulting in terms of communicating both virtual audio and video is able to be the most important component of the influence of telemedicine on diabetic wound healing. According to the research finding by Elpriska [28], it shows that the most influential factor that occurs in the complications of diabetic foot ulcers in type 2 DM patients is caused by stress.

#### 4.4. Stress Management

Stress management is the process of taking predetermined actions with the aim of controlling one's stress level. It involves thoughts, lifestyle, and emotions including the way a person handles personal problems. Stress management uses various techniques and psychotherapy for a person to effectively deal with stress. Lazarus and Folkman in Christian and Obiageli [29] stated that coping is a behavioral and cognitive constantly changing effort to manage certain internal and external demands that tend to overload or exceed one's resource capacity. Coping is a process that can help a person to master, minimize or tolerate stress, while stress management enhances coping [29].

Stress management techniques if practiced regularly can help the body produce a relaxation response. The relaxation response is when the body is in a state of deep rest as explained by Benson in Christian and Obiageli [29] that the relaxation response changes the emotional and physical response to stress, which is the opposite of the response when our bodies choose to fight or flight when there is a danger. This stress management technique is not only beneficial for people experiencing symptoms of stress but also for people who are not experiencing stress. There are several techniques that are used as proactive measures to combat stress, i.e:

##### 1. Sports

Exercise is one of the main stress management techniques that has been shown to contribute to effective coping. When we are under stress, our

bodies often increase levels of stress hormones such as cortisol and adrenaline. During physical activity, stress hormones are metabolized, making the body and mind become more calm and relaxed. Relaxing tense tissues and muscles contributes to easing feelings of stress. Exercise can maintain a healthy body thereby reducing stress and vulnerability. In addition, it can increase blood flow to the brain, improve sleep quality, stimulate the nervous system, release hormones and beta-endorphins that have a positive effect on our feelings. Exercise serves as a distraction from stressors especially when we are doing competitive activities because it makes a person feel compelled to go further than usual. Examples of exercises such as jogging, brisk walking, swimming, rowing, cycling, etc [29].

##### 2. Progressive Muscle Relaxation (PMR)

PMR is a stress management technique that can reduce tension in the body. It involves alternate tension and relaxation of specific muscle groups in a systematic and sequential pattern to combat stress. These muscle groups can include the neck, chest, abdomen, back, arms, legs etc. When tightening the muscles should be very careful not to harm yourself. In addition, you need advice from a professional such as a doctor if there are certain medical conditions like bone or muscle problems that can create an obstacle for physical activity. If practice regularly, PMR can help a person to know what total tension and relaxation looks like in several parts of the body. As a result, a person can recognize and resist the pressure, which is the first sign of muscle tension accompanying stress [29].

##### 3. Diaphragmatic Breathing

Deep breathing, abdominal breathing, belly breathing, or paced respiration is called Diaphragmatic breathing. The University of Texas Center for Counseling and Mental Health, states by doing diaphragmatic breathing, a person may be able to take normal breaths and also maximize the amount of oxygen that enters the bloodstream. This method is used to trigger the body's normal relaxation response and also stop the 'Fight or Flight' response. Diaphragmatic breathing can release tension in the

body and improve physical and mental health, because diaphragmatic breathing stimulates the parasympathetic nervous system. Stress is usually accompanied by changes in breathing patterns, or anxiety characterized by shortness of breath. Using the shoulders to inhale and exhale instead of the diaphragm can create an imbalance of oxygen and carbon dioxide in the body. Shortness of breath that occurs can prolong anxiety and exacerbate the physical symptoms of stress. It should be noted that apart from stress relief, diaphragmatic breathing also helps with cardiorespiratory fitness, improving respiratory muscle strength, and respiratory muscle length, lung function, and posture [29].

#### 4. Visualization or Guided Imagery

Visualization is considered as a mental vocation consisting of perceptual experiences across sensory modalities i.e. using one's imagination such as hearing, smell, taste, touch, and movement imagination to induce a state of relaxation in the body. A person's thoughts may cause anxiety and anger that leads to tension and stress on the body. This visualization can involve imagining yourself in an atmosphere or place that is calm, serene and relaxed to details that are very interesting and calm a person. For example, you can imagine being in a park, beach, tourist center, etc [29].

#### 5. Meditation

One of the other stress management techniques is meditation. It can make the state become deeply relaxed and the mind becomes calm. Meditation can help a person to calm the mind or eliminate negative thought patterns that are often the underlying cause of stress. It can also increase a person's level of resilience and make a person less reactive to stress. Meditation can improve physical, emotional well-being and improve overall health well-being [29].

#### 6. Social support

Having social support is also a way to ward off stress. In this case the role of the closest person to

help overcome difficulties. Those other people include family, friends, church, and even coworkers [29].

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