Degree of Burn: A Digital Tool for Burn Area Assessment And Fluid Requirement Calculation Using Wound Image Analysis

Wahyu Rima Agustin[1], Muhamad Nur Rahmad[2], Hermiana Ernastin Tobi[3]
[1,2] Universitas Kusuma Husada Surakarta
[3] Institutu Ciencia Saude (ICS) Dili
Email: wra.wahyurimaagustin@gmail.com[1], rahmatmuh77@gmail.com[2], hermianatobi@gmail.com[3]
Orchid ID: https://orcid.org/0000-0003-0588-4805[1], https://orcid.org/0000-0002-3308-8622[2], https://orcid.org/0009-0004-2704-0405[3]

Article Info	ABSTRACT
  Corresponding Author: Wahyu Rima Agustin, Universitas Kusuma Husada Surakarta Email, wra.wahyurimaagustin@gmail.com	Burns are tissue damage due to contact with a heat source, such as fire, hot water, chemicals, electricity, or radiation. Burns are a type of trauma with high morbidity and mortality rates and require high treatment costs. In Indonesia, burns are still a serious problem that requires special care, high costs, and skilled personnel. Currently, burn assessments are carried out manually, which is time-consuming and the results are subjective. Treatment efforts include preventing infection and encouraging epithelial cell regeneration to close the wound. Therefore, innovation is needed in the form of a system that helps assess burns more effectively, including classifying wound tissue, measuring wound area, and monitoring wound development. The use of an Android-based system can provide more accurate measurements through a digital planimetry approach or image segmentation, which can identify wound boundaries and tissue types. Technology-based health applications, such as the "Degree of Burn" application, allow for more efficient calculation of burn area and fluid requirements. This study uses a literature review method from international journals, national journals, books, and conference results related to burn assessment to support the development of this system. ***Keywords:*** *degree of burn, extent of burn, calculation of fluid requirements*

1. INTRODUCTION

Burns are trauma caused by heat from electric current, chemicals and lightning that hit the skin, mucosa and deeper tissues. Extensive burns affect the metabolism and function of every cell in the body, all systems can be disrupted, especially the cardiovascular system (Rahayuningsih, 2012). Burns are a condition of damage or typical tissue misfortune caused by direct contact with a heat source such as flames, introduction of hot water, contact with hot objects, electric shock, exposure to chemicals, and exposure to radiation. Burns caused by hot objects are associated with a high likelihood of death in patients (Kara, 2018). Burns are a common cause of traumatic damage and a major crisis condition in the crisis room that has various types of problems, levels of mortality and morbidity that require extraordinary management from the shock stage to the advanced phase (Young et al, 2019).

Burns often occur in life and are a challenge for medical personnel. Burns are most common in lower middle-class countries (WHO, 2018). The etiology of burns is fire, hot water, electricity, chemicals, radiation contact, and cold injuries. Burns can affect all ages, genders, and can affect the psychological and physical conditions of patients, and can even lose their jobs due to burns. Burns and their complications affect mortality and morbidity (KEMENKES RI, 2019)

Burn care has improved in the last decade, resulting in a decline in burn mortality. Burn care centers are well established, with multidisciplinary burn teams working together to care for patients and their families.

Burns are the third leading cause of death due to accidents in all age groups. Men tend to experience burns more often than women, especially in the elderly (over 70 years old). According to data from the World Health

Organization (WHO), globally there are 180,000 cases of death per year caused by burns. The most cases of burns occur in people with lower to middle socioeconomic levels. Based on age, the risk of burns is most vulnerable to elderly women and young children. The problem of burns in society can occur due to permanent disruption of appearance and function, which can lead to job loss. Along with the rapid development of digital technology, one of which is through the presence of the internet, it makes it easier and faster for someone to get information. The internet is also able to make it easier for someone to interact with others quickly, without having to meet face to face and access the internet via mobile.

The extent of burns can be calculated using the percentage of Total Body Surface Area (%TBSA). TBSA calculations are needed for fluid resuscitation and markers for patients at high risk of complications (Broadis, 2017). The greater the percentage of TBSA in burn patients, the higher the mortality rate (Jugmohan, 2016). Lund and Browder chart is the most accurate method of measuring the extent of burns for children, especially toddlers. This method can adjust to various variations in body shape based on age so that it is considered accurate in measuring the extent of burns in toddlers (Broadis, E., T. Chokotho, 2017).

Burns are also classified by the depth or degree of the injury. First-degree burns involve only the top layer of skin and are the mildest. Second-degree burns involve the deeper layers of skin and underlying tissue, while third-degree burns are the deepest, involving the entire layer of skin and underlying tissue, often requiring hospitalization and surgery. Burns can cause serious complications, especially when they occur on the face and neck, which are much more dangerous than burns on the lower limbs.

Another method of measuring the extent of burns is the Palmar Surface. Palmar Surface can be performed on cases of adult and child burns with a small area. This method is performed using the surface area of the patient's palm, calculated from the wrist to the fingers which are considered equivalent to 1% of the burn area. Another strategy for measuring the distance of burns is the Wallace Rule of Nines. This method of measurement is carried out by dividing the body into several parts equivalent to 9% and multiples thereof. This method is considered accurate in adult burns of 10 and less accurate in burns in children under 10 years of age (Kara, 2018).

The development of digital technology is also one of the main trends of sustainable and innovative development that has an impact on health services. The development of the world of technology does not only have an impact on the world of business, industry or education, but also has an impact on the health aspect.

This shows that the world of health also utilizes technological developments to the maximum. As a result of the use of technology, this has an impact on the creation of various innovations in web-based health technology and applications that we encounter today, one of which is the calculation of burn fluid using the degree of burn application. With the application of technological developments in the health sector through applications, it is hoped that it will facilitate the work of health workers in achieving patient recovery. Through this degree of burns application, health workers can more easily calculate the extent of burns and fluid requirements in patients with burns.

The Degree of Burn application is an Android-based application designed to assist the process of assessing burns and calculating fluid requirements for patients with burns. Currently, burn assessments are still done manually, which takes a long time and tends to produce subjective results. This application was created to speed up and simplify the assessment of burn severity and calculate fluid requirements more objectively.

This study aims to design an application system that can help nurses and other health workers in the process of assessing the extent of burns and calculating fluid requirements in burn patients. This application is expected to facilitate the nursing care process and accelerate decision-making related to the treatment of burns in patients.

The specific objectives of this study include two main aspects: first, to make it easier for nurses and health workers to assess the extent of burns through an application called "Degree of Burn." Second, this application also helps health workers to calculate the amount of fluid needed for burn patients accurately and quickly.

Fluid therapy for burn patients must be done with precise calculations, one of which is by using the Baxter or Parkland method. This method requires data on the percentage of burn area, which is calculated using Wallace's "Rule of Nine". According to this method, the human body is divided into several areas with certain percentages to calculate the burn area accurately. The head has a total value of 9%, which is divided into 4.5% for the front and 4.5% for the back. The body has a total of 36%, with 18% for the chest and abdomen and 18% for the back. The arms have a total value of 18%, consisting of the front and back arms each 9%. The legs have a total of 36%, with 18% for the upper legs and 18% for the lower legs. Finally, the genital area has a value of 1%.

2. RESEARCH METHODS

The method of creating works on the Degree of Burn application involves several main stages, namely application design, development, and testing. At the design stage, an analysis of user needs (nurses and health workers) is carried out to understand the functions needed, such as assessing the extent of burns and calculating fluid requirements. Furthermore, the application concept and features, such as measuring the extent of wounds using the rule of nine and the algorithm for calculating fluid requirements using the Baxter/Parkland method, are developed in an intuitive interface design.

The development phase involves programming an Android-based application, where technologies such as digital image processing and wound segmentation are used to identify and measure the wound area. Once the application is built, testing is carried out to ensure that all functions work correctly, are easy to use, and produce accurate results as per clinical needs.

How to Use the Application

1. Open the degree of burn application on your Android phone
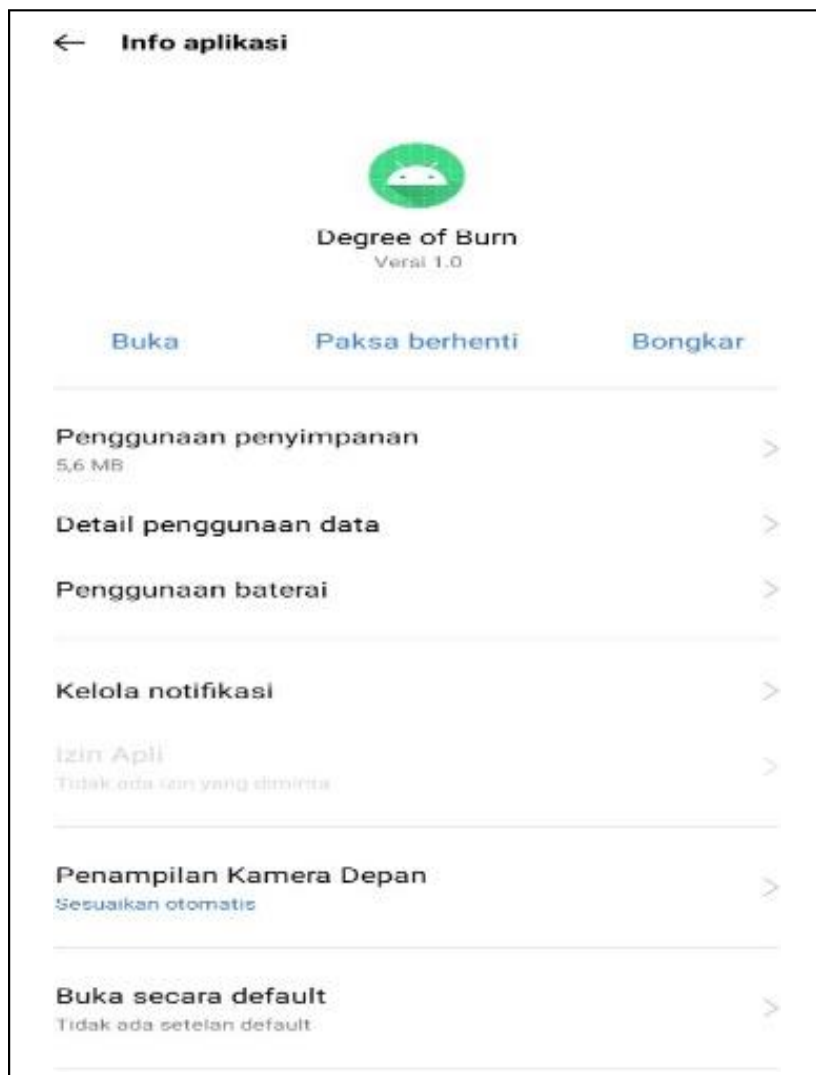
Figure 1. Degree of burn application view

2. Enter the patient's weight in kg, and enter the area of the burn.

Figure 2. Slide show 1

3. Click Calculate to display the following results.


Figure 3. Slide Show 2

The results of fluid requirements will appear according to the data entered. This degree of burn application will be developed by adding more complete information and explanations regarding the percentage of the area of burns in the rule of nine image, which will make it easier for nurses or health workers to identify the extent of the degree of burns in patients.
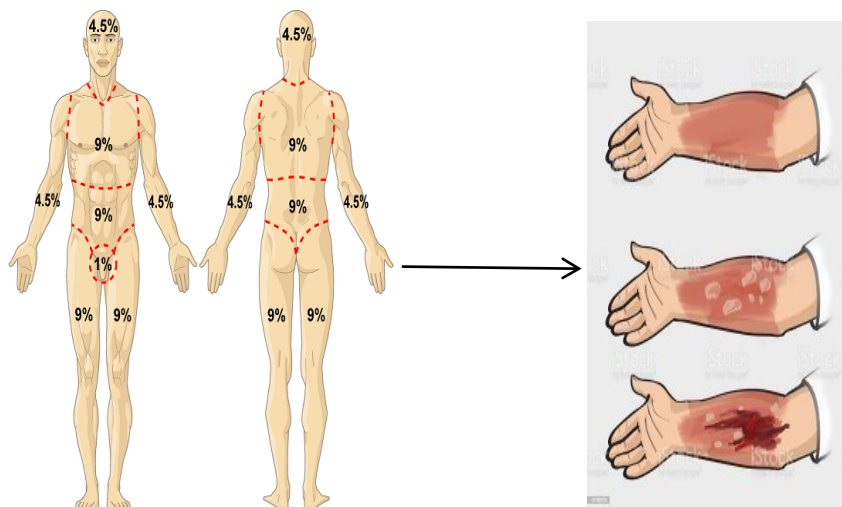
In the results section, information will be added regarding the amount of fluid needed in the first 8 hours and the fluid needed in the second 16 hours.
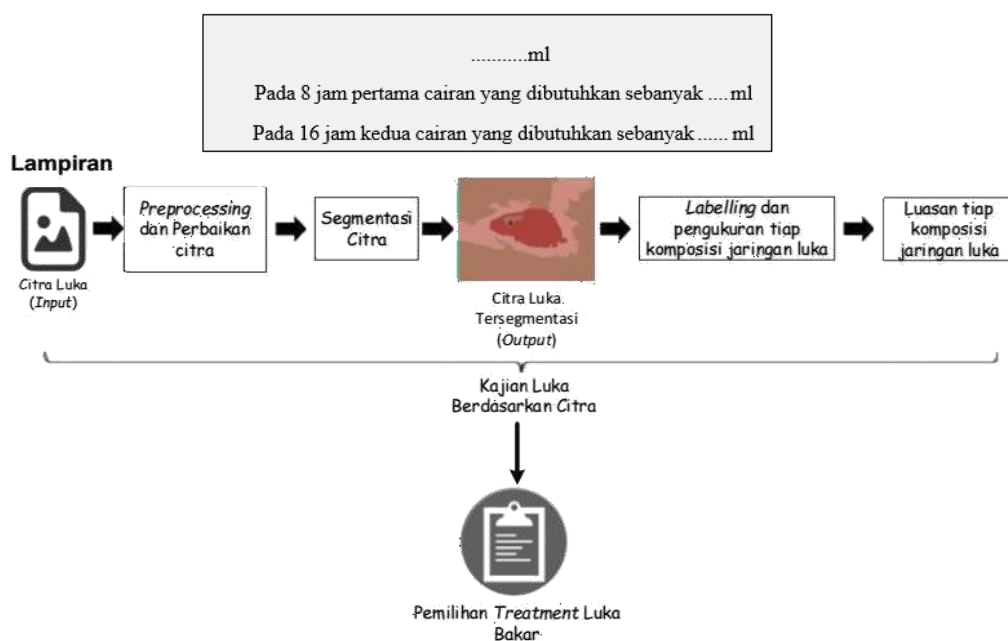
Gambar 1. Desain Sistem

Gambar 3. Ilustrasi Pengukuran Luka

Application design in previous research (Sholeha, RA et al., 2016)

The planned research activity stages will take place from March to August: The initial stage of the research is the preparation of a proposal that will take place in March. This proposal includes the background, objectives, methods, and schedule of the research implementation. After the proposal is completed, the licensing process is carried out to obtain approval from the relevant agencies or institutions, so that the research can run smoothly. This process is estimated to take place from March to April. In April, the materials and tools needed for the research begin to be prepared. This preparation includes procurement of tools, selection of materials, and checking the readiness of all needs for data collection. Data collection will be carried out for two months, namely May and June. This stage involves the observation or experiment process according to the planned methodology. The data that has been collected is then analyzed and interpreted from June to July. This stage aims to obtain valid research results and in accordance with the objectives to be achieved. Based on the results of the analysis, a research report is prepared in July. This report covers the entire process and findings obtained during the research. The final activity is a results seminar that will be held in August. At this stage, the research results are submitted to stakeholders to get input and suggestions. Through this schedule, it is hoped that research can take place in a structured and efficient manner, with the results delivered by the end of August.

3. RESULTS AND DISCUSSIONS

RESULTS

The result of this research is the development of software for direct measurement of burn area on the human body using computer vision technology. The expected output is that users can get information on how much fluid is needed after obtaining body weight and burn area data. Users also get information related to the degree of burn area based on image analysis of burns in burn patients.

The development plan for this application goes through the following progressive steps:

1. Creating Wound Size Detection (Object Measurement). At this stage, a program is created to detect the size of the burn area in units of cm^2 using OpenCV technology with Python programming language. In this program, the simple way of working is to detect objects in one image file (.jpeg, .jpg, .png). The image has many color pixels which are then processed by the program to be made into a grayscale image and the program can identify which part of the image should be measured. In this case, there is a sample photo of a burn wound that will be measured, as in the image below.
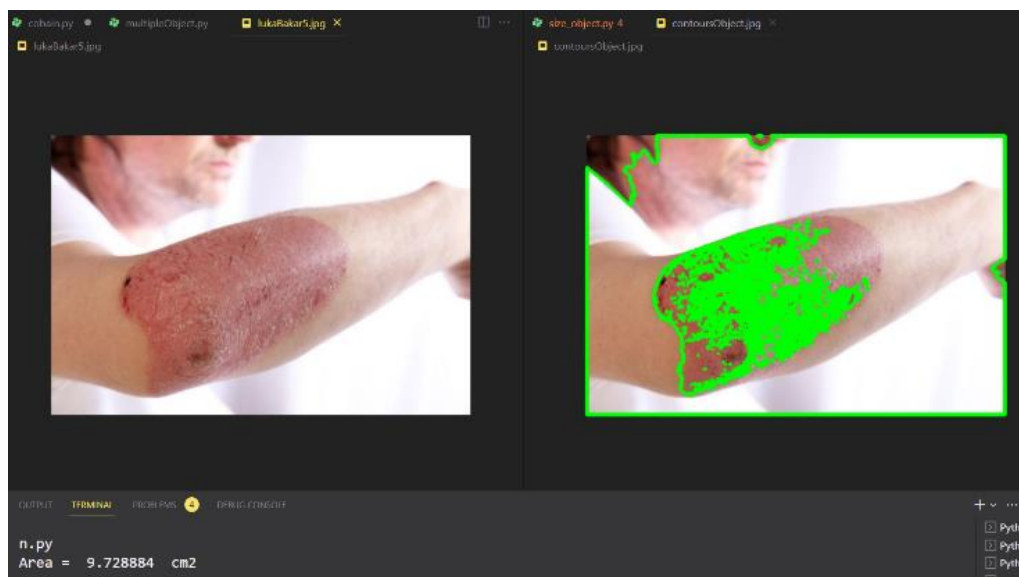

Figure 4. Detection of burn area

2.   Improved Wound Extent Detection

In this second step is closely related to the first stage, where the first stage that only uses the color changing method for wound area detection will be refined so that wound area detection is more accurate. By using several other methods provided in OpenCV, this refinement step can be done.

3.   Creating Object Type Detection

After making accurate size detection, then continue making a program that can detect what type of object is being scanned. A simple example is the program can know that the body part being scanned is a hand/foot/chest and so on. This object detection greatly affects the calculation of fluid requirements based on the rule of nine.

Application Feature Development

1. Philosophy of the "Degree of Burn" Application Logo

    a. **Flame**

        Meaning: The flame represents the burn, the essence of this application. The reddish orange color of the flame indicates the intensity and severity of the burn.
        The flames also illustrate the urgency required in treating burns.

    b. **Caduceus Wand**

        Meaning: The Caduceus Wand is a classic medical symbol consisting of two snakes wrapped around a staff and wings. It symbolizes health care and medicine.

    c. **Right and Left Wings**

        The wings are red and orange on the left side, and green and blue on the right side, flanking the Caduceus staff. It symbolizes speed and efficiency in medical care.

    d. Color

        Red and Orange: Used to indicate burns and the urgency of treatment.
        Green and Blue: Used to balance the logo with a sense of calm and medical professionalism.

    e. **Circle Composition**

        The circle shape symbolizes unity, protection, and total coverage.

2. Web Admin

    1. Login

        This page displays the login page to enter as an admin by entering your Phone/Mobile Number and Password. Then click enter.


    2. Dashboard

The dashboard page displays important information such as today's number of examinations, total patients, total doctors, and total examinations. The "Today's Treatments" section shows no scheduled treatments, while the "Patients" section displays the number of patients with daily, monthly, and yearly view options. "Top Diagnoses" has no data currently displayed. In the upper right corner, there is the current user information as Admin. The left side navigation provides access to various parts of the dashboard or other clinic systems.
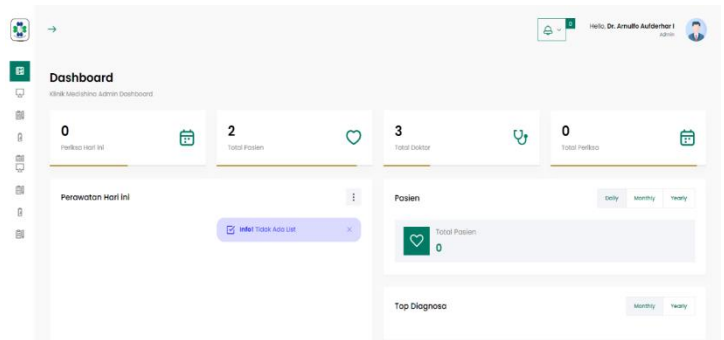
3. Patient data

The Patient Data page managed by the admin has a button to add a new patient, and displays the patient's data identity such as ID, RM No., Patient Name, Place and Date of Birth, Address, Gender, Mobile No., Treatment, and status.
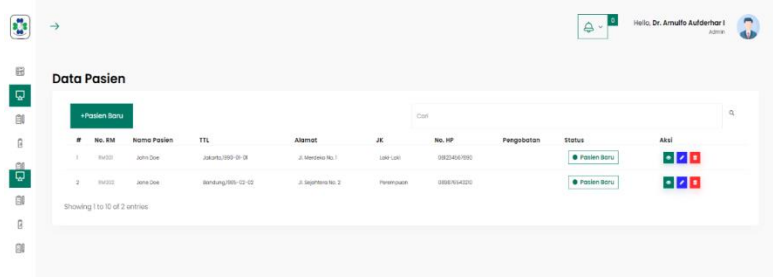
4. Add patient

The Add Patient page managed by the admin can add patient data by inputting the patient's name, RM number, place and date of birth, gender, marital status, religion, education, occupation, complete address, village, district, sub-district, postal code, cellphone number, citizenship, payment method, BPJS/KTP number, allergies, general uncent file. then to save the data, click the save button.
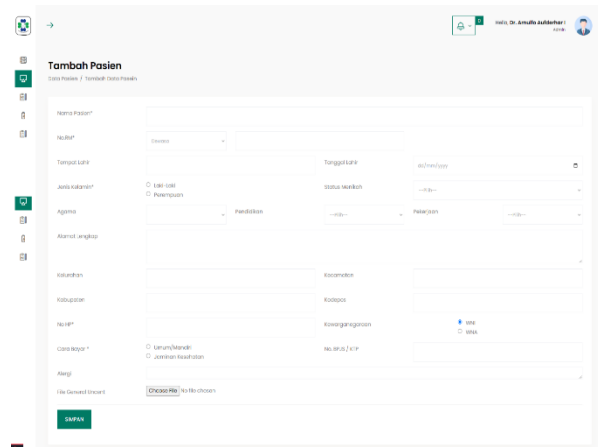
5. Burn Data

The Medical Record page managed by the admin has a button to add burns and display data containing ID, date, patient name, weight, % burns, fluid, status and action. In the action feature, you can check the data details.
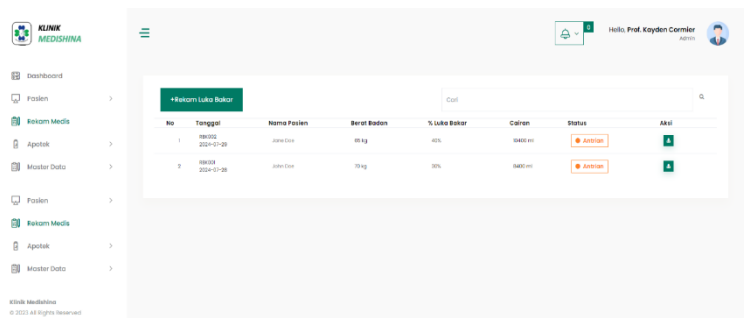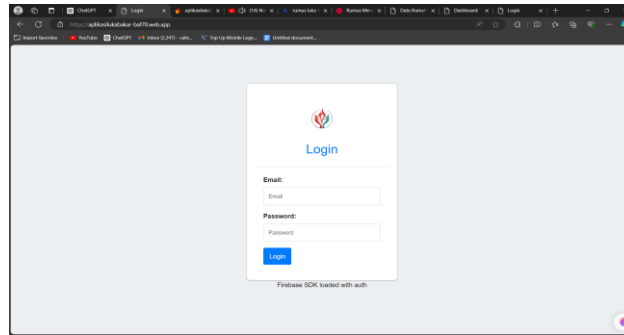
6. Add burn data

Adding a new burn medical record page, managed by the admin can input data on the date of examination, patient name, weight, and burn percentage. then it can be saved.
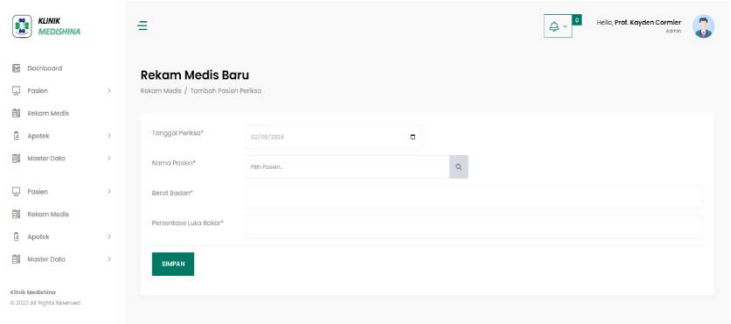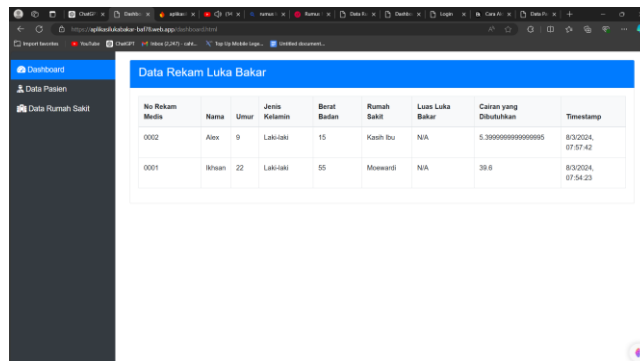

3. Website

1. Login

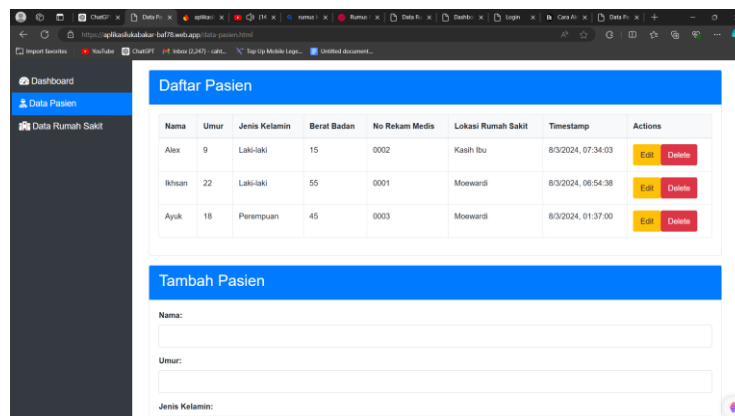Visit the page https://aplikasilukabakar-baf78.web.app/ then login with email aplikasilukabakar@gmail.com and password Applicationburn123

2. Dashboard

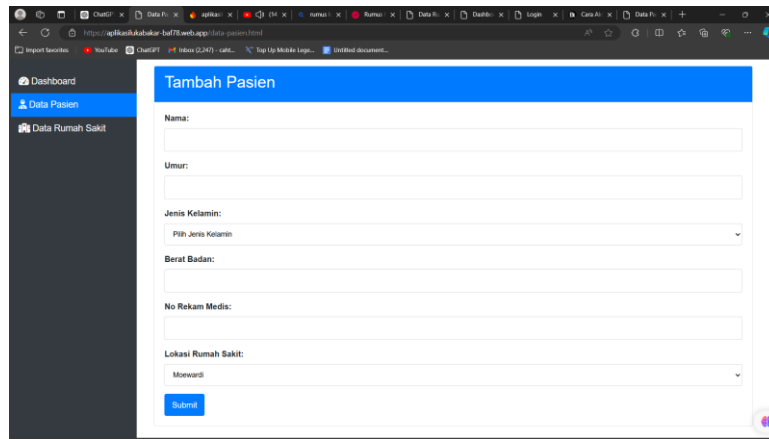

On the dashboard page there is burn record data which is the calculated data from the mobile application.
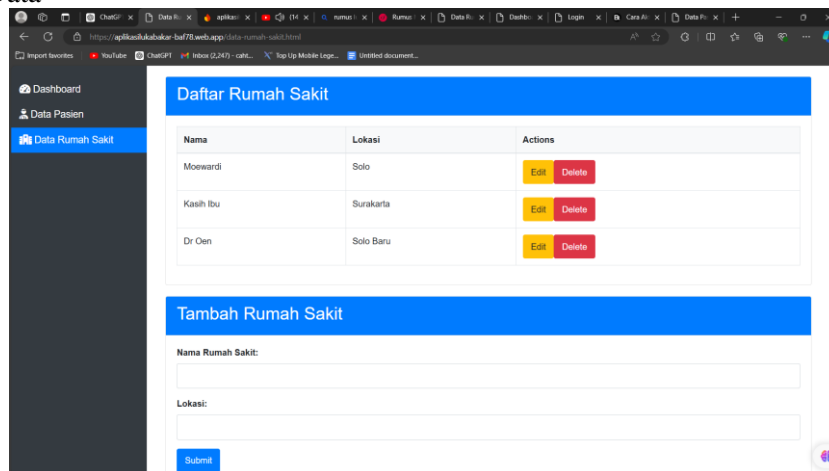
3. Patient Data

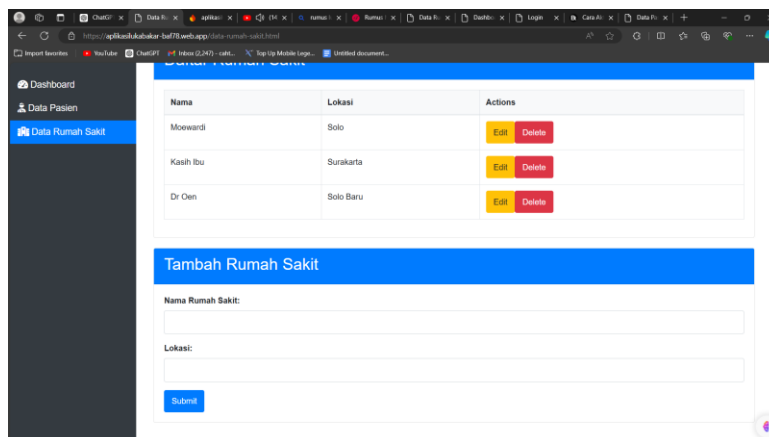The patient list contains patients who have been registered.

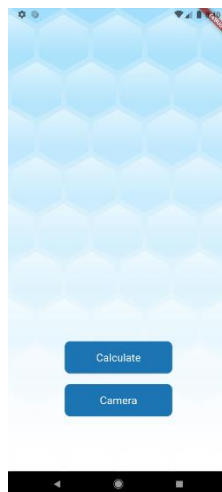Add patient contains a form for adding new patients.

4. Hospital Data

The hospital list contains a list of hospitals that have been added.
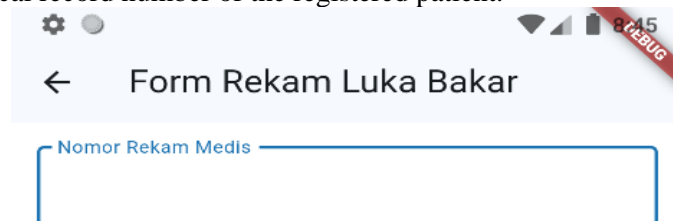

Add hospital contains a form to add a new hospital.

4. Application
   1. Homepage

   2. Burn injury record form page
      a. Enter the medical record number of the registered patient.

      b. Medical record number data
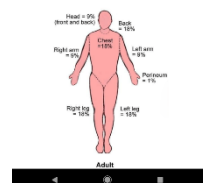   After entering the medical record number, the patient's data will automatically appear. The burn percentage image will also appear according to the patient's age. If the patient's age is <12 years, the child percentage image will appear. If the patient's age is >12 years, the adult percentage image will appear.
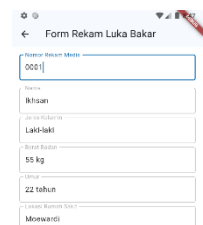
The following is an example of an image for children
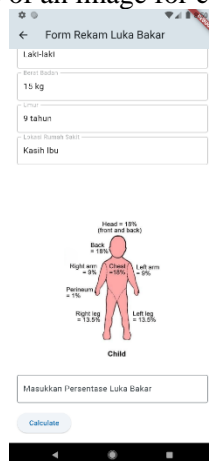
Here are the pictures for adults
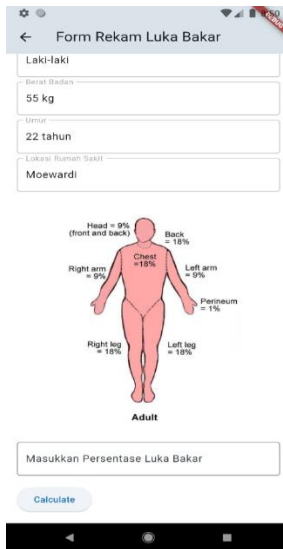
When the image is tapped, the image size will be enlarged.

c. Enter the burn percentage

d. Displaying calculation results

Next Stage Plan

The next plan and stage is to compile a wound image scanning feature using an Android camera.

DISCUSSION

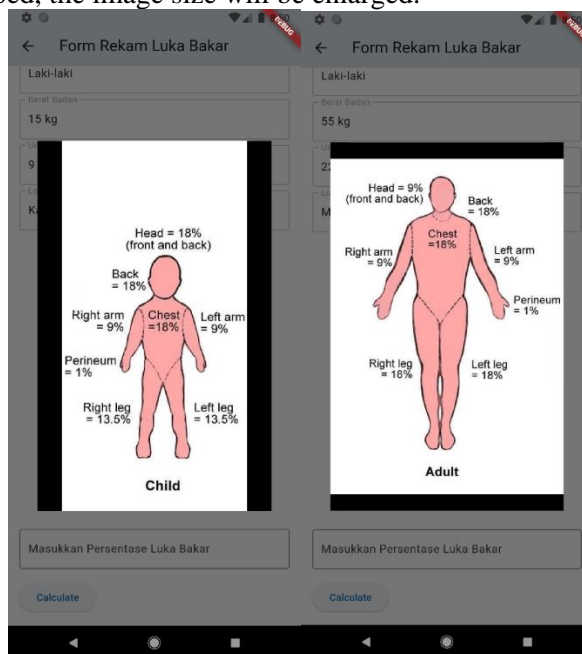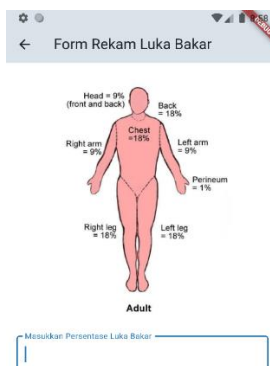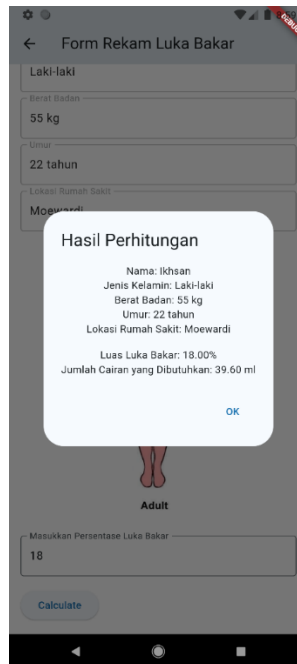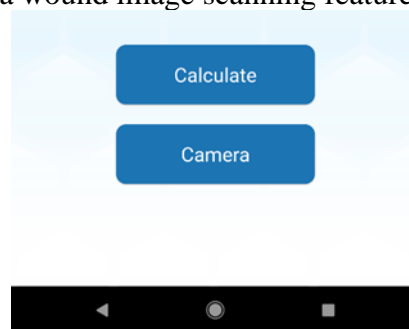Understanding the calculation of the degree and extent of burns is essential to provide appropriate and targeted care. Each degree of burn, from first to fourth degree, has a different depth and risk, thus requiring a different treatment approach. For example, minor burns (first degree), generally only involve the outermost layer of skin (epidermis) and can be treated with immediate cooling and application of ointment or cream. However, for second degree burns and above, which affect deeper layers of skin and underlying tissue, more intensive care is needed.

The Rule of Nines method is a common method used to estimate the extent of burns in adult patients. This method divides the body into sections that represent approximately 9% of the total body surface area, thus helping health workers to calculate the extent of burns quickly and accurately. The surface area of the body burned, expressed as a percentage (% TBSA - Total Body Surface Area), is the basis for calculating fluid requirements which are very important to avoid complications due to fluid and electrolyte loss.

In second, third, or fourth degree burns, calculating fluid requirements is a crucial component of care. The Parkland formula is often used to determine the volume of fluids needed during the first 24 hours after a burn. This   formula   is   as   follows:

Total Fluid = 4 mL × body weight (kg) × % TBSA

Of the total fluid calculated, half is given in the first 8 hours since the burn occurred, and the remaining half is given in the next 16 hours. This arrangement is very important to prevent hypovolemic shock (lack of fluid in the blood) and maintain blood pressure and circulation in the patient.

Once fluid requirements have been determined, it is important to monitor the patient's vital signs, such as blood pressure, pulse, and urine output, to ensure that fluid requirements are being met and that the patient is not becoming dehydrated or overhydrated. This process requires ongoing monitoring by the medical team to adjust fluid levels based on the patient's body's response. In cases of more extensive or deep burns, hospitalization and consultation with a burn specialist may be necessary, including possible additional interventions such as debridement, surgery, and infection control.

This approach allows for safer, more controlled and targeted burn care, increasing the patient's chances of recovery and reducing the risk of long-term complications.

4 CONCLUSION

Burns are significant trauma conditions, caused by various factors such as heat, electricity, chemicals, or radiation, which damage skin tissue and even underlying tissues. Burns not only affect the physical but also the psychological impact of patients and often cause morbidity and mortality, especially in extensive or severe burns. Appropriate and rapid treatment is essential to prevent serious complications and ensure optimal recovery. Burn measurement technologies and methods such as the Rule of Nines, Palmar Surface, and Lund and Browder Chart allow for rapid assessment of the burn area, which supports accurate fluid requirements calculation through the Parkland formula, especially in second and third degree burns.

The use of the Android-based "Degree of Burn" application is an important innovation in burn care. This application makes it easier for health workers to assess the extent of wounds and calculate the required fluids quickly and objectively, compared to manual methods that are slower and more subjective. This application is able to accelerate essential clinical decision-making in burn care and provide significant support to the patient's healing process.

Suggestions/Recommendations

1. Advanced Technology Development: The "Degree of Burn" application should continue to be developed with additional features, such as infection rate analysis and treatment recommendations according to the degree of burn. This will further support health workers in providing more comprehensive care.
2. Training for Healthcare Professionals: It is important to provide specific training for healthcare professionals on the use of this application and techniques for evaluating and treating burns. A thorough understanding of appropriate fluid assessment and management methods is essential to improving the quality of care.
3. Further Research: Further research is recommended on the effectiveness of this app in different clinical settings. Data from different healthcare facilities can help refine the app and ensure that it meets the needs of healthcare professionals in a variety of emergency and non-emergency situations.
4. Increased Socialization: The use of this application should be widely socialized, especially in regional health facilities with limited resources. This application can provide great benefits in the care of burn patients in remote areas and contribute to reducing morbidity and mortality related to burns.

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