IJMA

International Journal of Medical Arts

Volume 3, Issue 2 [Spring (April-June) 2021]

http://ijma.journals.ekb.eg/

Print ISSN: 2636-4174

Online ISSN: 2682-3780

About IJMA [last updated March, 1st, 2021]

- ✓ International Journal of Medical Arts is the Official Journal of the Damietta Faculty of Medicine, Al-Azhar University, Egypt
- ✓ It is an International, Open Access, Double-blind, Peer-reviewed Journal
- ✓ Published four times a year
- ✓ The First Issue was published in July 2019
- ✓ Published under the following license: Creative Commons Attribution-ShareAlike 4.0 International Public License (CC BY-SA 4.0). It had updated from the Creative Commons license [CC BY] in volume 2, Issue 4, October 2020 About IJMA
- ✓ The Egyptian Knowledge Bank hosts the web site of IJMA
- ✓ The Egyptian Knowledge Bank supports IJMA
- ✓ IJMA follows the regulations of the International Committee of Medical Journal Editors
- ✓ IJMA is indexed in the "Directory of Open Access Journals" [Indexed on 15 January 2021].
- ✓ IJMA is a member of the International Society of Managing and Technical Editors
- ✓ Listed in "Index Copernicus", "Publons", "Academic resource index [ResearchBib]", "Electronics journal library", "Eurasian Scientific Journal Index", and "Citefactor"
- ✓ IJMA introduced to the search engine [BASE] through DOAJ

Click image to reach the page

International Journal of Medical Arts 2021; 3 [2]: 1329-1341

Available online at Journal Website
https://ijma.journals.ekb.eg/
Main subject [Basic Science; Plastic Surgery] *

Original Article

A Computer System for Classification of Burns and Determination of Fluid and Nutritional Needs for Burn Patients

Safwat Ibrahim [1,4], Reda H. Abo-Alez [2]; Fawzy A. Hamza [1]; Lotfy A. Nassar [1]; Esam A. Taman [3]; Abdel Moneim H. Huta [1]

Department of Plastic Surgery and Burn, Faculty of Medicine, Al-Azhar University, Egypt [1]
Department of Computers and Engineering, Faculty of Engineering, Al-Azhar University, Egypt [2]
Department of Plastic Surgery and Burn, Damietta Faculty of Medicine, Al-Azhar University, Egypt [3]

Corresponding author: Safwat Ibrahim
Email: safwat177@yahoo.com

Submission date: March 27, 2021; Revision date: April 25, 2021; Acceptance date: April 26, 2021

DOI: 10.21608/ijma.2021.69708.1287

ABSTRACT

Background: The assessment and classification of burin severity and extent is very important for proper treatment. A computer system to assess burns seems to be crucial for the determination of fluid and nutritional requirements.

The aim of the work: The objectives of this work are to design a computer system to assess and classify burns according to burn depth and extent and to implement the designed system for the assessment of fluid and nutritional needs using a database system for the automation of the entire process. Then test the computer system in reality through clinical application of the system on fifty patients with acute burn injury.

Patients and Methods: This study was divided into two parts: Development of a burn management computer system [BMS] to facilitate the process of documentation, classification, and management of acute burn patients. The BMS contains three subsystems: Database, Classification, and Management subsystems. The second part was the clinical application of the system on fifty patients to test the efficacy, accuracy, and applicability of this system in comparison to the traditional method used at our unit.

Results: Clinical application of the BMS has showed a reduction in the burn percentage calculation with 7.36%. It also decreased the amount of fluid calculated automatically by the system by about 7.28%, while the reduction in nutrition calculated automatically by the BMS was about 2.7%. Burn Management System has showed an overall shorter time in dealing with the cases.

Conclusion: Clinical application of the BMS showed an accurate estimation of the burn percent, accurate and rapid calculation of resuscitation fluids and nutritional needs, and easy electronic documentation of patients' data that required a minimal effort.

Keywords: Burn; Depth; Severity; Resuscitation fluids; mHealth

Citation: Ibrahim S, Abo-Alez RH, Hamza FA, Nassar LA, Taman EA, Huta AH. A Computer System for Classification of Burns and Determination of Fluid and Nutritional Needs for Burn Patients. IJMA 2021; 3[2]: 1329-1341. DOI: 10.21608/ijma.2021.69708.1287

* Main subject and any subcategories have been classified according to the research topic.

INTRODUCTION

For a good outcome after treatment of a burn injury, it is mandatory to start the accurate initial treatment as soon as possible. It is necessary to precisely assess the burn wound regarding its extent and depth in order to guide the fluid requirement and nutrition [1]. The majority of assessments of percentages of total burn surface area [%TBSA] to-date have revealed inaccuracies, typically due to human error, with overestimations of about 100% recognized in emergency departments [2].

The average of physicians may overestimate or underestimate the burn Percent. This overestimation or underestimation will be associated with errors in resuscitation fluids and nutrition calculations. In addition, some errors may occur during manual calculations of resuscitation fluids and nutritional needs for burn patients especially in busy situations such as emergency departments or during burn mass causalities. The unaccepted result of these errors will be the use of an incorrect initial treatment or unnecessary patient transportation, with a subsequent increase in cost and psychological stress for the patient and his family. Moreover, and irrespective of the complex care provided to burn patients, the extensive documentation was practically a deterrent to achieve compliance with evaluation and management needs. The amount of documentation needed to sufficiently reflect the amount of care provided to burn patients is quite extensive, but most surgeons are less familiar with the documentation requirements for evaluation and management services [3]. The revolution in the computer's development has already affected our everyday lives and we are now at the stage where we must take active steps to identify this and integrate the information storage and processing ability of computers in different burn units around the world and to provide training for all staff about it [4]. Furthermore, In the management of burns, variable smartphone applications have been used to offer a range of functions, ranging from first-aid leaflets, literature, or games to calculation applications [5].

AIM OF THE WORK

The objectives of this work were to design a computer system to assess and classify burns according to burn depth and extent and to implement the designed system for determination of fluid and nutritional needs for burn patients as well as a database system for the automation of the entire process.

MATERIALS AND METHODS

Materials:

We have developed a Burn Management System [BMS] to automate the process of documentation, assessment, and treatment of adult burn patients. The BMS can be used with desktops or laptop computers. The BMS is subdivided into three subsystems; each subsystem contains multiple electronic forms [Figure 1].

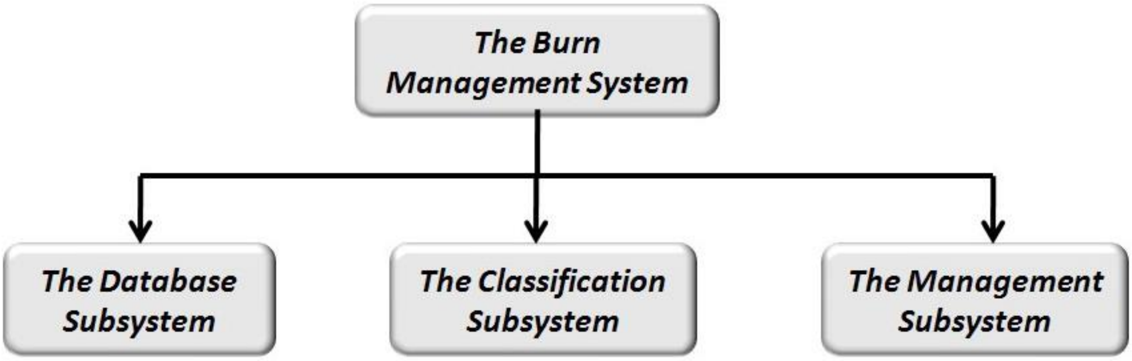

Figure [1]: Different Subsystem of the BMS

1. The Database Subsystem:

The Database Subsystem contains multiple electronic database forms for documentation of the history, examinations, investigations, medical and operative treatments, search tools, summary and reports [Figure 2].

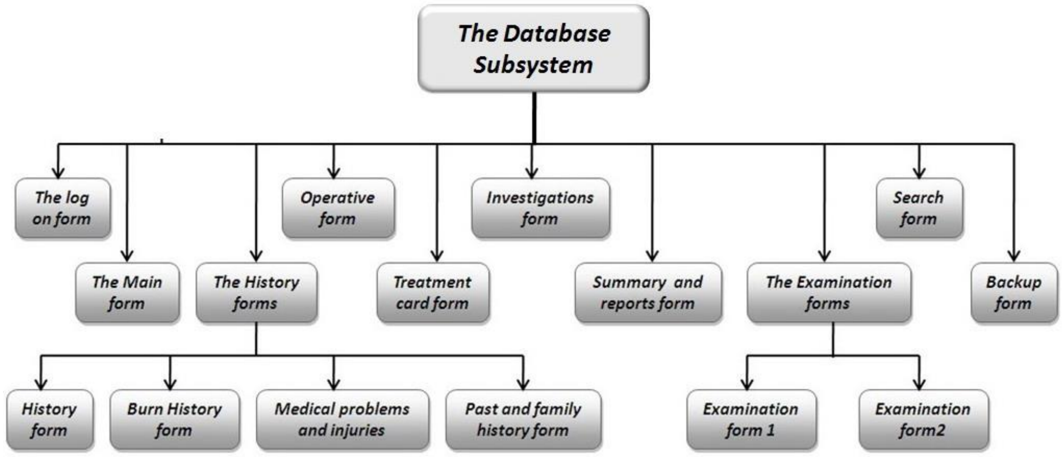

Figure [2]: Different Forms of the Database Subsystem

2. Burn Classification subsystem:

A computer model has been designed to automate the process of assessment of burn patients depending on standardized digital images taken immediately after burn. These images are fed to the system after the primary survey of burn patients' assessment. The system displays the real patient's digital images alongside electronic models to guide the user to plot the burned areas on electronic models using three colors for different burn depth in a subjective manner. The system calculated the percent of different depths of burn according to Lund and Browder charts then summate all to give the total body surface area burn **[Figure 3]**

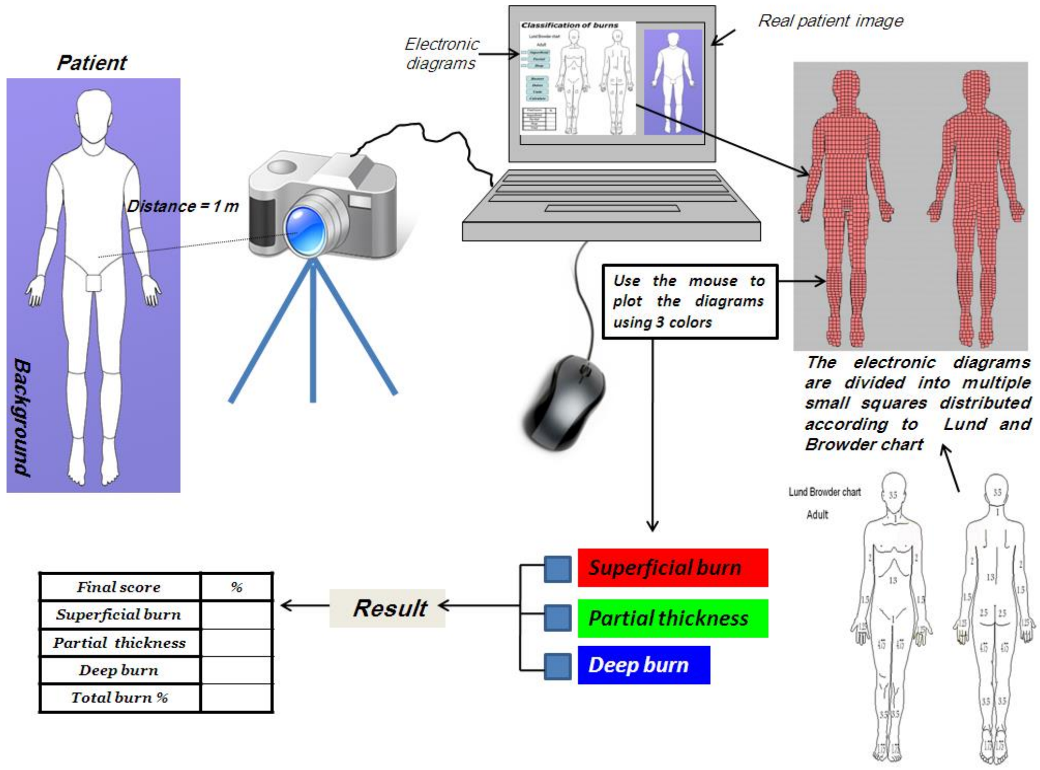

Figure [3]: A flowchart for the mechanism of action of the burn classification subsystem

3. Burn Management Subsystem:

Management of the burned patient by the BMS divided into two parts**: [Figure 4]**

A. Fluid Resuscitation:

Calculation of fluid needs for the burn patients using the previous electronic calculation of burn percent. The

BMS automates Parkland formula for calculation of resuscitation fluids: [Figure 5]

i. The total fluid requirement in 24 hours = 4 ml × [total burn surface area [%]] × [body weight [kg]]. 50% given in the first 8 hours. 50% given in the next 16 hours[6]. BMS considers any delay between the time of injury and admission and any fluid given during transportation.

ii. The total fluid requirement in the next 24 hours = 2 ml × % total burn surface area × body weight in kg [6].

iii. After the first 48 hours the BMS calculates fluid maintenance if needed as follows = {fluid loss from the burn [Burn % x Body weight x 0.5] + daily requirement + any loses from the body [e.g., vomiting]} [7]. The user can use hourly urine output to calibrate the fluid maintenance therapy using the same interface [Figure 5].

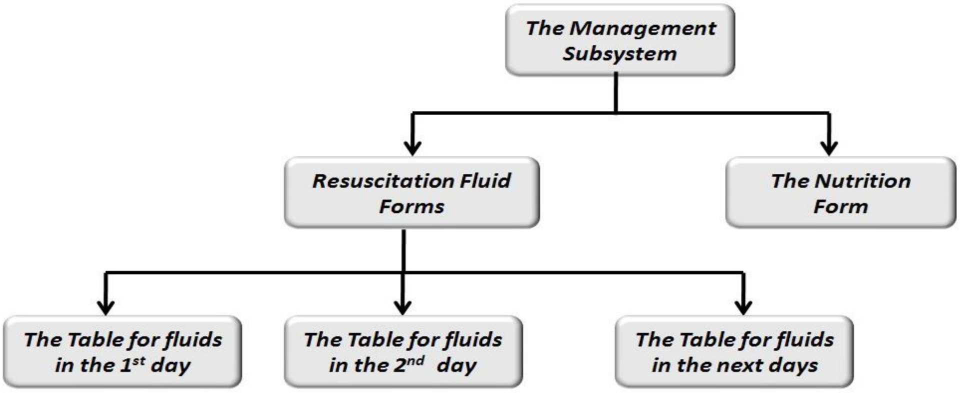

Figure [4]: Different Forms of the Management Subsystem

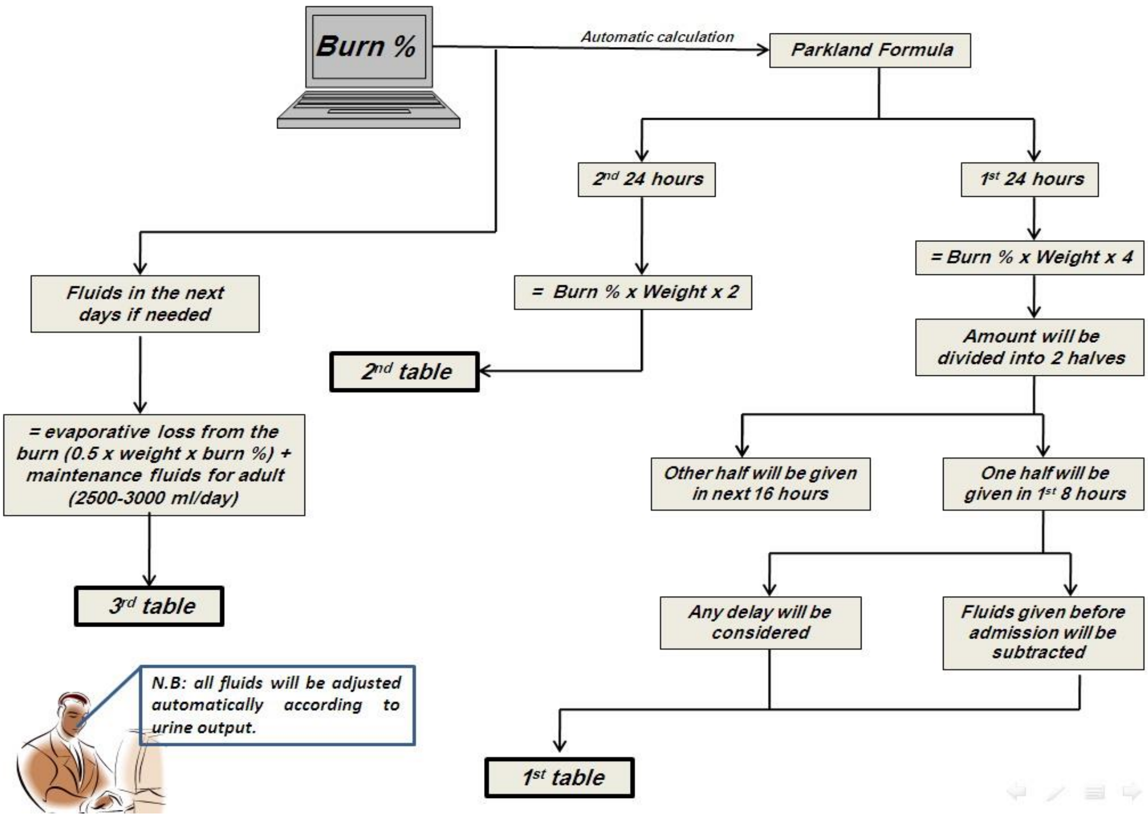

Figure [5]: A flowchart shows how the system is calculating fluid needs for burn patients

B. Nutritional needs for burn patient:

The BMS automates Curreri formula to calculate the nutritional needs for the burn patients according to his age, body weight and body surface area burn as follows: [Figure 6]

i. The Curreri formula for calculation of the total caloric requirement per day = 25 x body weight in Kg + 40 x % TBSA = T cal. [Total calories] [9]

ii. Protein requirement / day:

Protein is provided to achieve a calorie to nitrogen ratio of 100:1. The amount of nitrogen in grams equals the number of total calories divided by 100. The daily protein requirements in grams are calculated by multiplying the amount of nitrogen in grams by 6.25 [6.25 grams of protein contain 1 gram nitrogen] [7]

iii. Calculation of carbohydrates and fat needs as follow:

First calculate the calories from proteins per day, which equals the amount of protein in grams multiplied by 4.1 [one gram of protein contains 4.1 calories]. Then calculate the calories from non-protein sources that equals the number of calculated total calories minus calories from protein source. Calories from carbohydrates equal the number of calories from non-protein sources multiplied by 82%. The resulting number is divided by 4.1 [one gram of carbohydrate contains 4.1 calories] to give the daily requirement of carbohydrate in grams.

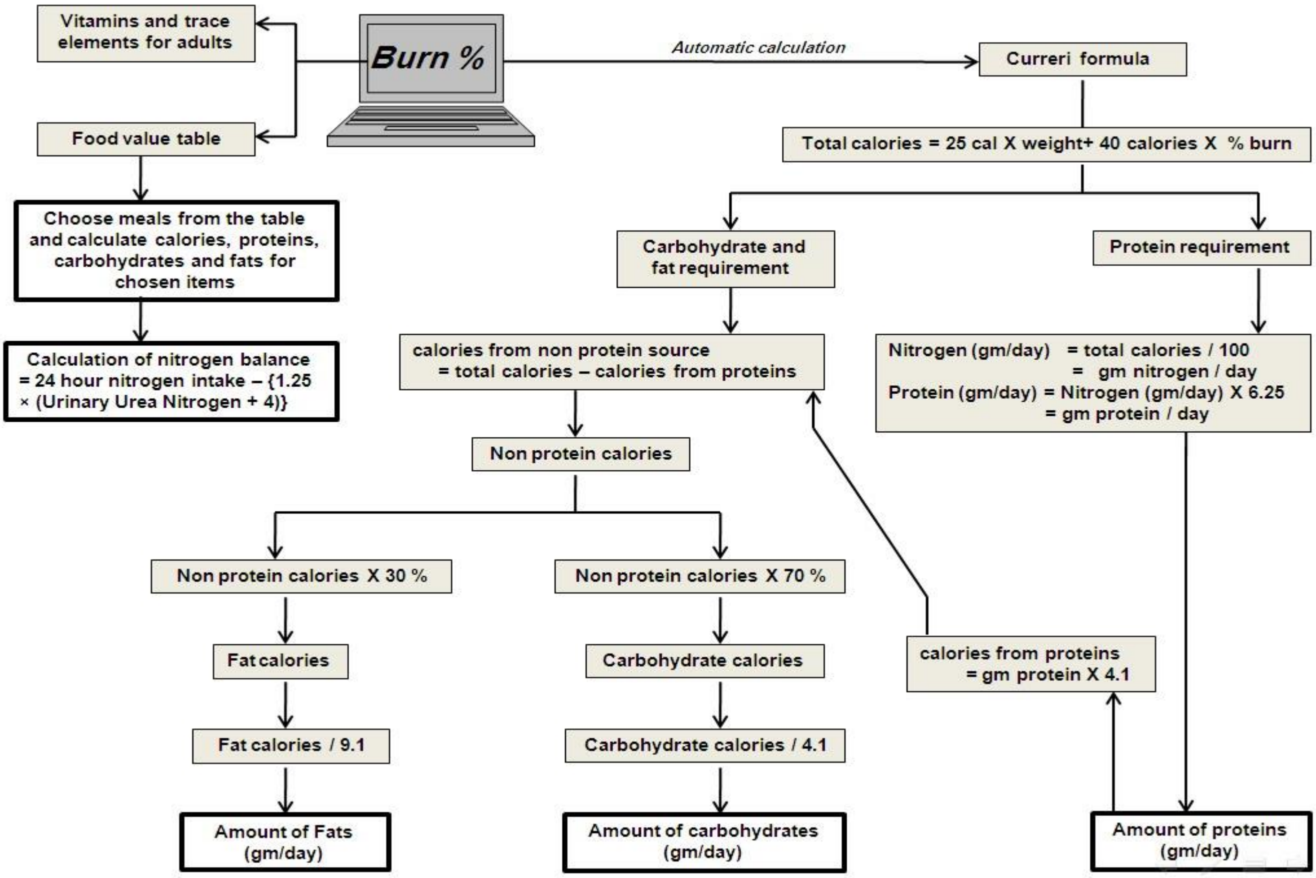

Figure (6): A flowchart shows how the system calculates the nutritional need as well as meals for the burn patient

To calculate the calories from Fats, the system multiplies the number of calories from non-protein source again by 3%. The daily requirement of fat in grams equals the number of calories from fat divided by 9.1 [one gram fat contains 9.1 calories]

iv. Nitrogen balance [N2bal] is then calculated using the following formula: N2bal = N2I – {1.25 × [UUN + 4]}

Where N2bal = Nitrogen balance, N2I = 24-hour nitrogen intake, UUN = Urinary Urea Nitrogen [12]

v. The user can use the automated food value table in the nutrition interface to choose different meals for the burn patients guided by the calculated nutritional requirements.

Once the system was designed, programmed and set up, it allowed us to study the effects of the new system clinically on the burn patients.

Methods:

The study was conducted on 50 adult patients [age range between 15 and 50 years] with no specific sex predilection; these patients were victims of recent thermal burns of different degree in depth with total body surface burned area between 15 and 50 %. Patients with other associated injuries, inhalation injuries or medical problems were excluded from the study. These patients were selected from victims admitted immediately after the injury to burn units at Al-Azhar University Hospitals. These burn Patients were selected for comparison between the automatic method using the BMS and the manual method. In the study the BMS was used directly for the documentation, assessment and management. Manual assessment and management were done also at the same time but without interference to see the applicability, efficacy and the accuracy of BMS in comparison to the manual method. This assessment was done after treatment of life-threatening conditions and includes the following steps:

1. **History taking:** The patient's clinical history was taken in detail and saved in the BMS database which contains electronic forms for Personal history, burn history, other medical problems and associated injuries, past history, and family history.

2. **Physical examination:** Complete physical examinations were performed and saved in the BMS database.

3. **Routine investigations were done and entered to the database.**

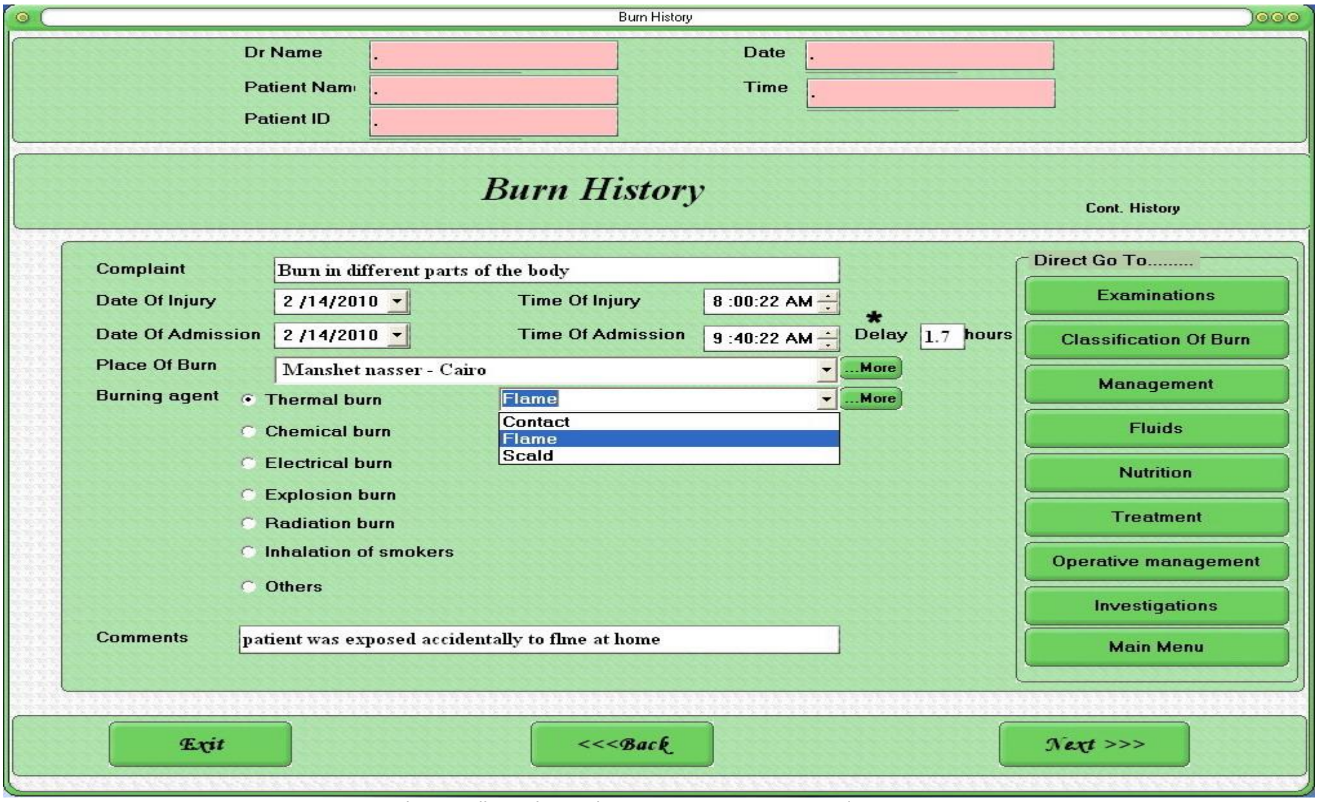

Figure [7]: The Burn History Form as an example for the different forms of the database. Note that delay* means the time between injury and admission and it was automatically calculated and considered during calculation of resuscitation fluids.

4. **Classification of Burns:**

Taking digital images for the burn patients [for the front and back] following a standardized image acquisition protocol which includes:

- Consent.
- The patient is placed parallel to the camera in anatomical position.
- Images are taken for the front and back of the patient with flash using homogenous background to preserve burn characteristics.
- Images used in the JEPG form.

Digital images uploaded immediately to the BMS to help in the automatic assessment of burn using the classification subsystem.

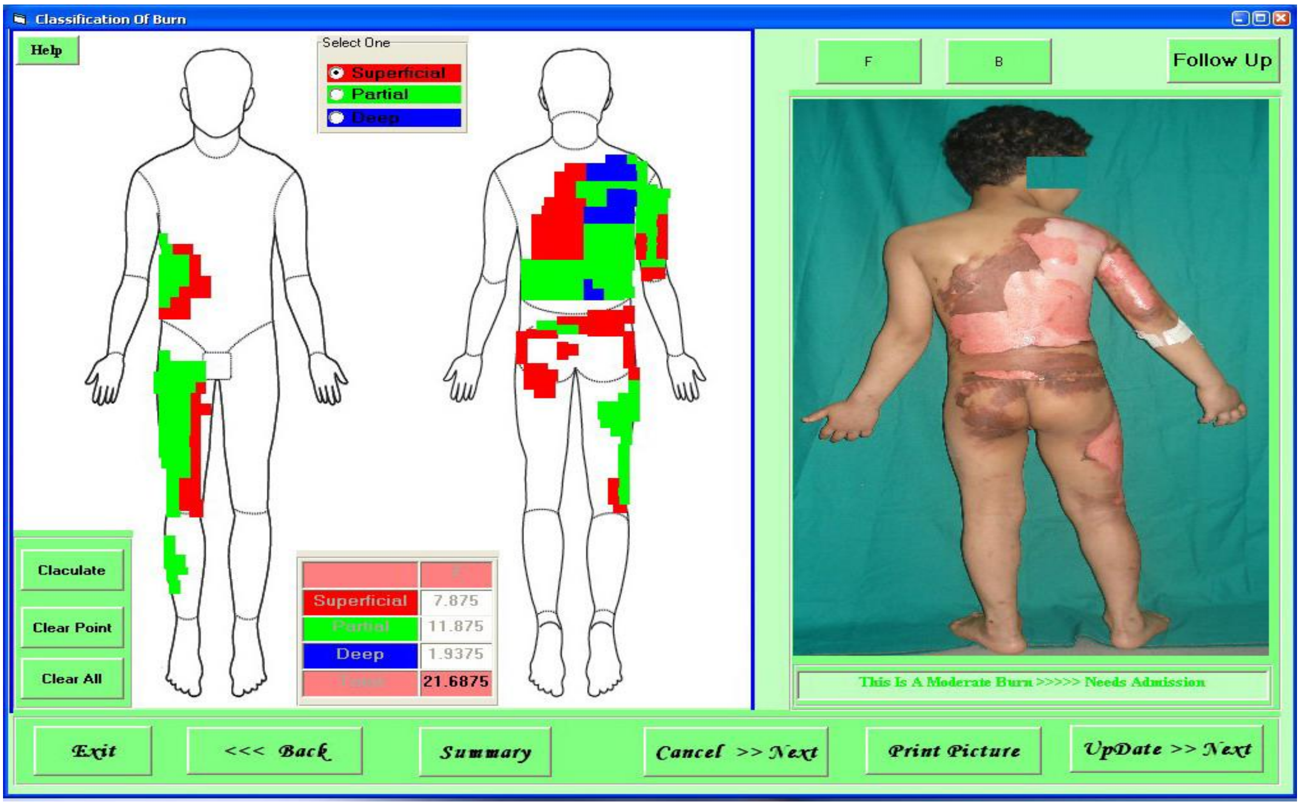

Figure [8]: The classification subsystem is assessing and classifying burns according to the extent and depth of burn. F and B buttons display the front and back real patient images respectively on the right side of this form. The electronic models for the front and back will be displayed on the left side of the form. Follow up button to display other forms for follow up the burn wound. This table in the lower part of the form will show the final result of automatic burn percent calculation.

5. **Management of the burn patients using the BMS:**

   a) Automatic calculation of fluid resuscitation:

The management subsystem of the BMS will automatically calculate the resuscitation fluids depending on body weight and automatically calculated burn percent. The system uses:

- Parkland formula and Ringer's lactate solution for fluid resuscitation.
- Resuscitation fluids were given through a peripheral line or central venous line if indicated.
- Colloids and blood were given when indicated.
- Fluid resuscitation was guided by clinical parameters [Patient's conscious level, Hourly urine volume 0.5-1ml/kg/hour, Heart rate, respiratory rate, and blood pressure] and laboratory tests [Hematocrit, and Serum electrolytes].

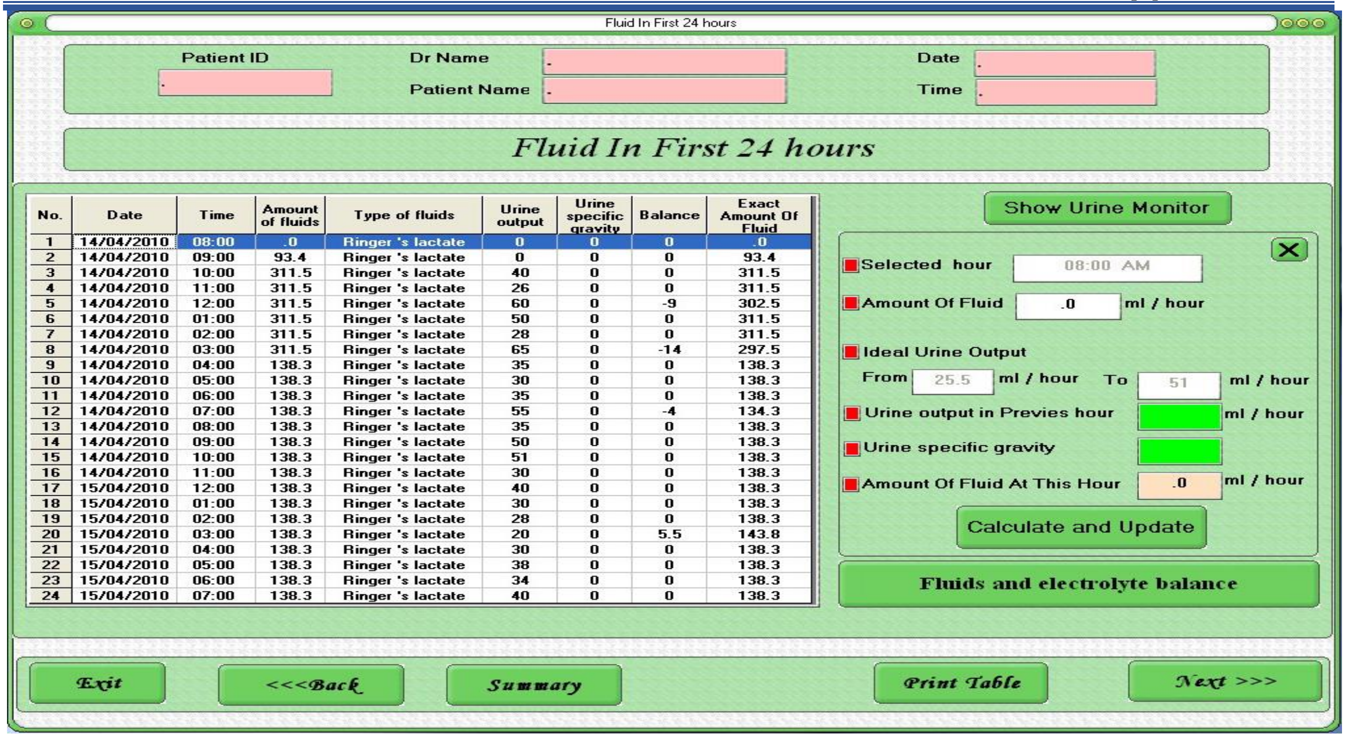

Figure [9]: Fluid Resuscitation Form for the first 24 hours as an example for the different forms of Management Subsystem. Note the urine output monitor in the right side of the form. If you want to adjust fluids intake just Select the hour you want to adjust from the table then enter the patient urine output in the previous hour, the system will automatically calculate the balance and update the table on the left side.

b) Automatic calculation of nutritional needs:

The management subsystem of the BMS will automatically calculate the nutritional needs for the burn patients according to Curreri formula depending on body weight and automatically calculated burn percent.

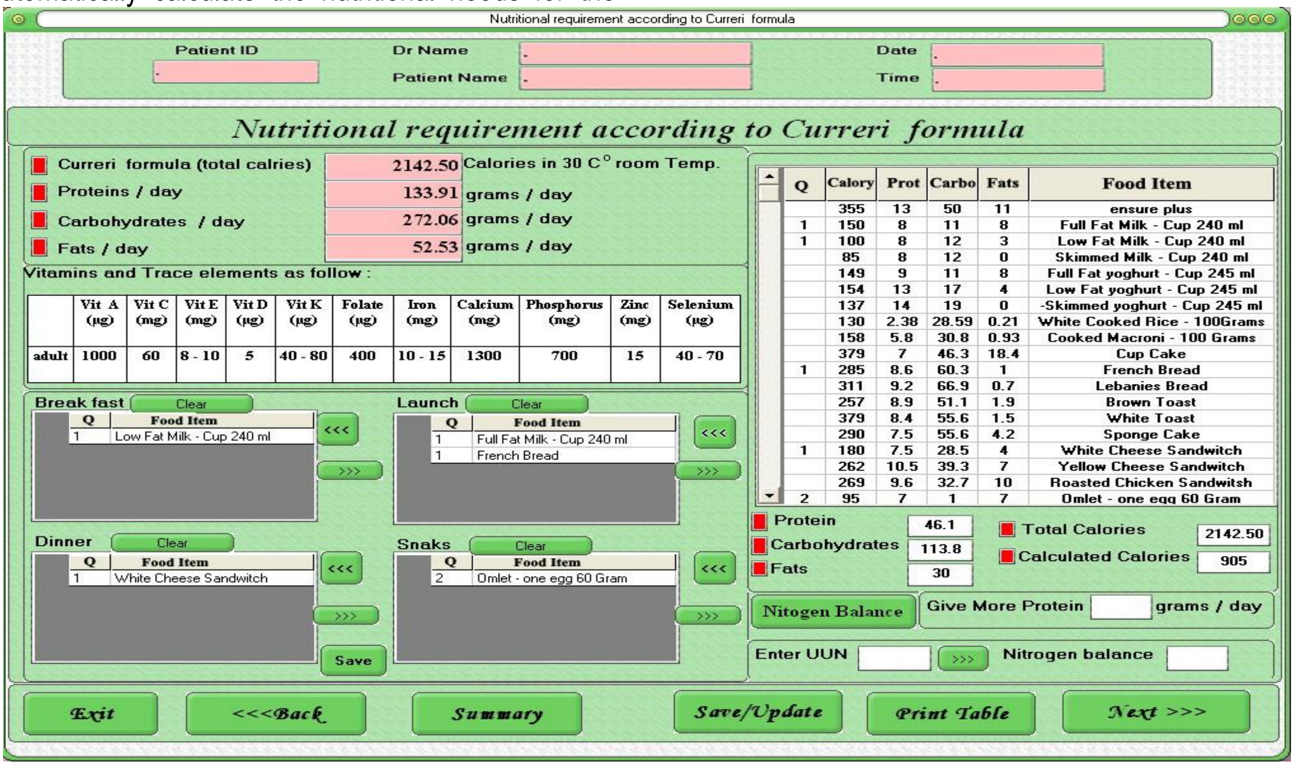

Figure [10]: The Nutrition calculation form. The result of automatic calculation for calories, protein, fat and carbohydrates is shown at the top of the form. The user can use the interactive food value table on the right side to construct the different meals on the left side below, while the system will calculate the food value for the chosen items on the right side below until it reaches the ideal calculated one. The system can also calculate the nitrogen balance and suggest the needed amount of proteins in grams to correct the negative balance.

The system will also do the following:

- Calculation of daily requirement of protein, carbohydrate, and fat.
- Choose patient meals using the interactive food value table and guided by the calculated calories.
- The nutritional support was guided by body weight, nitrogen balance, serum protein, and albumin.

c) Local wound management:

Local wound management was done for all patients according to hospital protocol for burn management.

Ethical considerations: for the second part of the study, the protocol was submitted to the Institutional Review Board [IRB] of Al-Azhar Faculty of Medicine [Damietta]. It was thoroughly revised and finally accepted [the acceptance number: #IRB 00012367-20-05-015]. Other ethics codes of research conduct according to Helsinki declaration were respected and followed through the research implementation.

RESULTS

The Database Subsystem was created. It contains multiple electronic forms on database accessible on computers in the burn unit to facilitate the documentation of burn patient's data. The Burn Management System was tested on fifty adult patients with recent thermal burns in comparison with the traditional manual method for calculation of burn percent, fluid resuscitation, and nutrition as well as manual documentation for the patient's data. The age of patients ranged from 15 to 49 years with a peak incidence at 16 to 25 years and Male to female ratio of 64% to 36%. Personal characteristics of cases, delay and amount of fluid taken before hospital admission are shown in Table [1].

We found a statistically significant difference between manual and BMS calculations for burn percentage, resuscitation fluids and nutrients needed for the studied cases. The manual methods showed a higher estimation for the burn percentage, fluids needed for the 1st and 2nd days post burn. The mean decreases in the burn percentage after using the BMS was 7.36%. Moreover, the mean decreases in the amount of fluid calculated automatically by the BMS was 7.28%. Table 2

There was also a statistically significant difference between the time consumed to calculate the resuscitation fluids and nutrition requirements manually compared to the automatic calculation using the BMS management subsystem. The automatic method decreased the time significantly with an overall shorter time in dealing with the cases.

Furthermore, BMS facilitates fast and accurate automatic calculation of each burned patient's individualized nutritional needs. This includes the calculation of their total required calories and the macronutrient breakdown of these in grams. BMS uses the Egyptian food value table to allow for ease of conversion of both calories and macronutrients to meals.

Table [1]: Personal characteristics of cases, delay and amount of fluid taken before hospital admission

	N	Min	Max	Mean	SD
Age	50	15	49	28.48	10.32
Weight (Kg)	50	46	95	71.92	12.28
Delay before hospital admission	50	0.25	4	1.58	0.82
The amount of Fluids taken before hospital admission	16	200	750	418.75	154.78

N: Number, Min: minimum, Max: maximum, SD: Standard deviation

Table [2]: The mean reduction in the burn percentage and fluids calculated automatically after using the BMS

	N	Minimum	Maximum	Mean	SD
Burn %	50	-14%	2.78%	-7.36%	3.87
Fluid	50	-14%	2.78%	-7.28%	3.95

DISCUSSION

In current practice, the accurate determination of burn percentage has been estimated based upon a diagram often drawn on a paper either from memory or direct observation of the burn area [13].

For experienced physicians, these methods may be reliable. However, standardization is serious for less experienced physicians and for pooling data from different burn centers.

Neuwalder et al. [13] studied two new techniques to calculate the percentage of body surface area [%BSA]: “Surface Area Graphic Evaluation II [SAGE II], a two-dimensional computer-assisted %BSA program, and 3D Burn Vision, a three-dimensional program”. The members in the burn team ranked the ease of use, as the most significant feature of a %BSA estimation programs, followed by accuracy, speed, multiple body types, and database capability.

In this study, electronic computer models in the Classification Subsystem were created to help in the calculation of burn percent in order to standardize the process of burn percent calculation and decrease errors. These models present familiar anterior/ posterior full body electronic diagrams which were designed according to the Lund and Browder charts for adults. Digital images were incorporated into the Burn Classification Subsystem to minimize burn percent estimation errors. The system will enable the burn physician to enter %BSA burn in direct observance of the clear standard digital images [not from the memory] for the front and back of the burn patients and plot the electronic models with three colors represent the different burn depths using the mouse in an easy way. Then the system will analyze the plotted electronic models to give the exact burn percent [superficial, partial thickness, full thickness, and total burn percent]. It was found that BMS will help to decrease the burn percent estimation errors for the adult burn patients especially by the less experienced physicians.

Body surface area calculation is the standard to compare between burns. The %BSA calculation correlates positively with the required volume of fluid and nutritional needs to be administered at the first treatment hours after a major burn. The accurate determination of %BSA correlates also with fewer complications due to over or under administration of fluids.

Konanas and Kofinas [7] designed a computer program to automate the calculation process for the required amount of fluids, calories, and nutrients for the burned patient depending on different data entry [e.g., body weight and burn percentages for adults]. They have clinically used this program since 1996 and have found it to be a reliable, flexible, and faster than similar methods of calculations carried out with the aid of electronic spreadsheet or with hand written technique. It calculates the total amount of fluids and nutrition with minimal details. It does not consider any delay before starting the fluid resuscitation or any fluids that has been given to the patient before admission.

In this study, complete and detailed automation of the process of calculation of fluid needs to the burn patients throughout the whole period of management was done in the Burn Management System. The system used the automatically calculated burn percentage. Other necessary entries to run the system are data relevant to the estimation of fluid requirements such as patient's weight, the time of injury, the time of admission [to calculate and consider any delay], and fluids given before admission [quantity and quality].

Yowler and Fratiann [14] reported that all formula serves only as guideline for fluid replacement therapy. Monitoring of urine output and clinical assessment of the patient are important guides to adequate resuscitation. The fluid administration should be tailored to preserve the urine output of 0.5 to 1 ml/Kg/hr. In order to achieve this aim, the BMS permitted the burn physician to control and monitor fluid resuscitation with urine output. The system calculated the ideal urine output. If the burn physician enters the amount of patient urine at any hour, the system did balance and update for the amount of fluid in the next hour in the corresponding fluid table.

In this study, the Management Subsystem for automatic calculation of fluid resuscitation will markedly decrease the time for calculation of fluid resuscitation. It will also decrease the calculation errors. So that the BMS is very useful and helpful in burn mass causalities and emergency department.

Nutrition is a significant, but often ignored piece of burn treatment. An accurate determination of caloric needs is crucial to obtain the complete benefits of nutritional therapy and helps to prevent underfeeding [infection, poor healing] or overfeeding- associated problems [15].

In this study, the BMS calculated the total caloric requirements for burned patient in detail according to this formula for adults. It will also calculate the nitrogen, proteins, fats, and carbohydrates daily need for the adult burn patient. An interactive food value table which contains the commonly eaten foods with its caloric, fat, protein, and carbohydrate content were incorporated in the system.

The BMS enables the burn physician to choose different types of food from the interactive food value table to construct different meals for the burn patients with calculation of the caloric, protein, fat, and carbohydrate content of the chosen food until it reaches the calculated ideal amount. It also enables the user to calculate of the nitrogen balance automatically if urinary urea nitrogen in the previous day entered to the system. The system also suggested the needed amount of protein to correct the nitrogen balance if it is negative.

The BMS represented an accurate, easy, and rapid way for calculation of nutritional needs for the burn patients as it decreased the time as well as the errors of nutrition calculation for the burn patients. BMS will be a good tool in the hands of the burn specialists in the burn units as well as non-burn specialists.

In this study, a modified Burn Calculator was created for calculation of fluid and nutritional needs for the burn patients using different fluid resuscitation and nutrition formulas without the need for formula memorization. It is a good tool in emergencies [Figure 11].

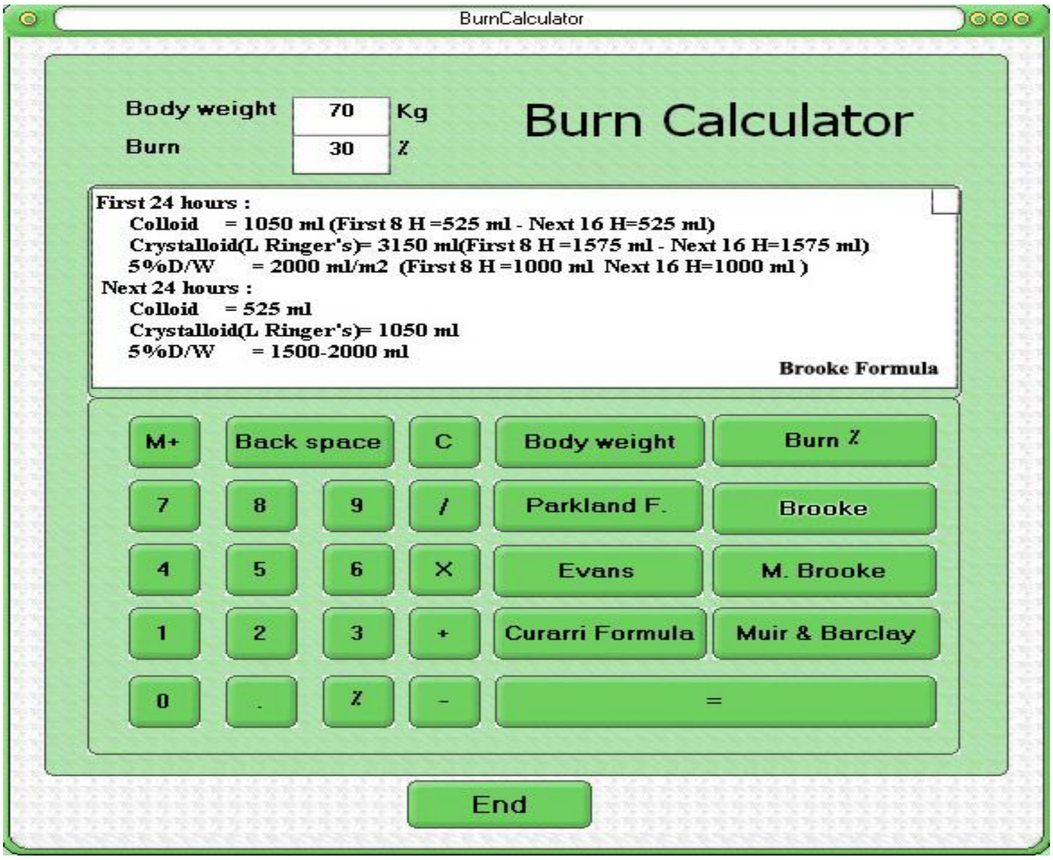

Figure [11]: The Modified Burn Calculator. Note that the body weight and burn percent should be entered to activate the calculator

The burn patient's charts are always lack of data and cannot reflect the amount of care provided to the burn patients. It is always very difficult to recover the burn patient charts. It is also difficult to do statistics from these charts. For this reason, Heistein et al. [16] developed a computerized documentation system for history, examination and note of progress for hospitalized non-operative burn cases. They found that this software maximized the burn-related documentation efficiency and improved patient care, while reducing necessary efforts to comply with the assessment and management guidelines.

In this study, an interactive database system was created. It included multiple forms that would address the patient's clinical history, including the history of the present illness, past medical and surgical histories, family history, patient allergies and medications. Multiple forms dealing with the review of body systems and physical examination were also included. It also included other forms for laboratory investigations, treatment card, and operative management. It contains search tools, reports, and printing options.

This database is different from the documentation system used by Heistein et al. [16] as the important data from this Database system will be taken directly without interference to be used in the management of the burn patient. It is also more comprehensive as it contains more forms to cover all the patient related data together with search tools. It can be used for surgical and non-surgical burn patients.

The effectiveness of the constructed system is in line with a previous study Boissin et al. [17], who reported that, the use of computer screen to view burn images is a useful tool for experts to assess severity. They share the same idea with the current work; the use of technology in burn assessment. However, current study has a major impact as it is a complete set of tools to assess different aspects of burn and guide its treatment. Cheah et al. [18] carried out a study to assess the validity of three-dimensional application in burn assessment, and reported that the application is slow. However, it provided an accurate assessment of total body surface area of burn when compared to traditional methods.

In a more recent study, Wang et al. [19] suggested that, the use of deep learning networks in classification and early diagnosis of burns can achieve good results when compared to professional physicians. Their model achieved quick diagnosis with good application value.

In addition, Abubakar et al. [20] reported successful implementation of two systems of image processing systems to fully automate the prediction of wound healing process. Their results revealed a decreased length of hospital stay and increased accuracy of wound classification and prediction of treatment outcome. In addition, they reported that, the use of machine learning facilities to aid evaluation of the burn, could facilitate early decision making with subsequent reduction of long hospital treatment delay. However, they reported a misclassification in some patients due to complete dependence in image processing [with heterogenous datasets and poor illumination of some images]. Thus, the system described in the current work seems to be superior as it depends on multiple inputs. Another strength point of the current work is the direct application of the system in clinical practice with satisfactory results.

Conclusions: The Burn Management System [BMS] has been built to automate the process of documentation, classification, and management of burn patients. BMS will decrease the burn percent estimation errors especially by the non-burn specialists, decease errors during manual calculation of resuscitation fluids and nutrition, decrease the time needed for calculation of fluid and nutritional needs for the burn patient, and make the memorization of complex formulas unnecessary. BMS may help in remote diagnosis of burns through the internet as a computerized patient's data, burn digital photographs, and treatments given to the patient can be easily transferred to the burn center for further advice. BMS is useful in primary health centers, burn mass causality, and emergency department where expert burn advice may not be immediately available.

One limiting step of the current system could be the inability to take digital images in parallel to the camera for the burn patients (e.g., extensive burn cases). However, this could be overcome by assigning one of the team for camera when the system adopted for application. Then, calculation could be completed.

Financial and Non-financial Relationships and Activities of Interest

None

REFERENCES

1. Serrano C, Acha B, Gómez-Cía T, Acha JI, Roa LM. A computer assisted diagnosis tool for the classification of burns by depth of injury. Burns. 2005 May;31[3]:275-81. doi: 10.1016/j.burns.2004.11.019. PMID: 15774281.
2. Kamolz LP, Lumenta DB, Parvizi D, Dirnberger J, Owen R, Höller J, Giretzlehner M. Smartphones and burn size estimation: "Rapid Burn Assessor". Ann Burns Fire Disasters. 2014 Jun 30;27[2]:101-4. PMID: 26170784.
3. Hampe HM, Keeling T, Fontana M, Balcik D. Impacting Care and Treatment of the Burn Patient Conversion to Electronic Documentation. Crit Care Nurs Q. 2017; 40 [1]: 8-15. doi: 10.1097/CNQ. 0000000000000135.
4. Shakespeare PG. The information technology revolution and burns. Burns. 1998 Feb;24[1]:1-2. doi: 10.1016/ s0305-4179 [97]00119-8. PMID: 9601582.
5. Wurzer P, Parvizi D, Lumenta DB, Giretzlehner M, Branski LK, Finnerty CC, et al. Smartphone applications in burns. Burns. 2015 Aug; 41 [5]:977-89. doi: 10.1016/ j.burns. 2014.11.010.
6. Salisbury RE. Thermal burns. In McCarthy JG editor. Plastic Surgery, Philadelphia, WB Saunders; 1990, p. 787-813.
7. Kononas TC, Kofinas G, Katergiannakis V. Computer-assisted determination of fluid and nutritional needs for burn patients. Plast Reconstr Surg. 2002 Dec; 110 (7): 1801-2. doi: 10.1097/01.PRS.0000037268. 30369.F6.
8. Saffle JR, Hildreth M. Metabolic support of the burned patient. In: Herndon D, editor. Total Burn Care, 2nd edition, London: WB Saunders; 2003, P. 271-287.
9. Shakespeare PG. The information technology revolution and burns. Burns. 1998 Feb; 24 (1):1-2. doi: 10. 1016/s0305-4179 (97)00119-8.
10. Matsuda T, Kagan RJ, Hanumadass M, Jonasson O. The importance of burn wound size in determining the optimal calorie: nitrogen ratio. Surgery. 1983 Oct;94(4): 562-8. PMID: 6414099.
11. Demling RH, Seigne P. Metabolic management of patients with severe burns. World J Surg. 2000 Jun;24 (6): 673-80. doi: 10.1007/s002689910109.
12. Rodriguez DJ. Nutrition in patients with severe burns: state of the art. J Burn Care Rehabil. 1996 Jan-Feb; 17 (1):62-70. doi: 10.1097/00004630-199601000-00013.
13. Neuwalder JM, Sampson C, Breuing KH, Orgill DP. A review of computer-aided body surface area determination: SAGE II and EPRI's 3D Burn Vision. J Burn Care Rehabil. 2002; 23(1):55-9; discussion 54. doi: 10.1097/00004630-200201000-00011.
14. Yowler CJ, Fratianne RB. Current status of burn resuscitation. Clin Plast Surg. 2000; 27(1):1-10. PMID: 10665352.
15. Masch JL, Bhutiani N, Bozeman MC. Feeding During Resuscitation After Burn Injury. Nutr Clin Pract. 2019 Oct; 34 (5): 666-671. doi: 10.1002/ncp.10400.
16. Heistein JB, Coffey RA, Buchele BA, Gordillo GM. Development and initiation of computer-generated documentation for burn patient care. J Burn Care Rehabil. 2002; 23 (4): 273-9. doi: 10.1097/ 00004630-200207000- 00009.
17. Boissin C, Blom L, Wallis L, Laflamme L. Image-based tele-consultation using smartphones or tablets: qualitative assessment of medical experts. Emerg Med J. 2017; 34:95–9. doi:10.1136/emermed-2015-205258.
18. Cheah AKW, Kangkorn T, Tan EH, Loo ML, Chong SJ. The validation study on a three-dimensional burn estimation smart-phone application: accurate, free and fast? Burns Trauma. 2018 Feb 27; 6:7. doi: 10.1186/ s41038-018-0109-0.
19. Wang Y, Ke Z, He Z, Chen X, Zhang Y, Xie P, et al. Real-time burn depth assessment using artificial networks: a large-scale, multicentre study. Burns. 2020;46(8):1829-1838. doi: 10.1016/j.burns.2020.07.010.
20. Abubakar A, Ugail H, Smith KM, Bukar AM, Elmahmudi A. Burns depth assessment using deep learning features. J Med Biol Eng 2020**;** 40: 923–933. doi: 10.1007/s40846-020-00574-z

International Journal of Medical Arts

https://ijma.journals.ekb.eg/
Print ISSN: 2636-4174
Online ISSN: 2682-3780