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Evaluation of hematological parameters and alterations in burned patients

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Abstract: *Background:* Burn injuries, categorized into four degrees, are common in-home accidents caused by heat, cold, electricity, chemicals, radiation, and friction. This study aims to determine the ideal parameters for burn patients and regulate their hematological parameters to ensure appropriate care and overall well-being. *Materials and Methods:* From 148 victims' examinations only 40 patient case histories have been examined. Investigations are conducted into determination of various hematological parameters. Statistic investigation of those parameters represented by bar diagrams to compute t-values and p values. *Results:* The study involved 40 adult burn patients, with a mean age of 31.05±12.05. Women were more affected than men, with thermal burn being the most common. The mean TBSA was 22.0±13%, with a higher rate of 2nd degree burn. On Statistical analysis of hematological parameters showed negative "t" statistic values, with hemoglobin showing the highest value t-value (2.20). Age-based comparisons showed a decrease in Hb and RBC, with platelets, WBC, neutrophils, and ESR significantly reduced. Positive correlations were found for PCV (0.183, p=0.217), Hb (0.299, p<0.05), RBC (0.297, p<0.05), lymphocytes (0.213, p=0.145), monocytes (0.063, p=0.687), and eosinophils (0.190, p=0.198). *Conclusion:* Hematological characteristics, bleeding profiles, and renal and hepatic dysfunction are all brought on by burn injuries. For medical teams to forecast prognosis and treatment response, biochemical marker estimation is essential. Burn patients frequently have decreased platelet counts, higher TLC, and lower hemoglobin levels. For better results, liver, kidney, serum electrolyte, and CBC monitoring are crucial.

Keywords: Burn Injury, Hematology, Complete Blood Picture, Platelets, Mortality.

Abbreviations: PCV, Packed Cell Volume; TBSA, Total Body Surface Area; BSA, Body Surface Area; Hb, Hemoglobin; WBC, White Blood Cell; ESR, Erythrocyte Sediment Rate; FFP, Fresh Frozen Plasma; TLC, Total Leucocyte Count.

Introduction

Globally burn injuries rank as the fourth most prevalent form. In 2018 March, WHO described burns as "a global public health problem". WHO reports ~1,80,000 deaths occur annually worldwide due to burns, with a predominant occurrence in low- and middle-income countries. Among the most common injuries sustained in severe events and accidents are burns. Participation of the primary sources of fire include a variety of physical elements, including thermal, cold, chemicals, electricity, irradiation, and friction [1-5]. Thermal burns from hot liquid or solid flames are among the most serious causes. Burn injuries have been linked to a number of complications, including tissue destruction, excruciating pain, disbelief, getting sick, imbalances in electrolytes or breathing problems, mental distress, and prolonged hospitalization that can cause psychological changes in individuals, such as scarring and deformity [6]. The primary cause of chemical burns, which also result in fatal coagulation and liquification necrosis, is acidic and alkaline substances [7].

Electro injuries due to burns may result from exposure to an electric source, a voltage flash, or lightning strikes that cause high-energy current to flow through the body [8]. Another

kind of burn those results from prolonged exposure to extreme cold is Frostbite, which constricts blood vessels, reduces blood flow, and forms ice crystals [9]. The severity, depth, and size of the wound are used to classify the injury once the etiology has been assessed [10-12]. The evaluation of burn injuries is crucial for providing first aid and determining the depth of the burn, which is essential for patient recovery [13]. A diagrammatic representation of the four burn degrees.

Burn injury is generally classified into two types: skin injury and other causes. The outermost layer of the skin, known as the epidermis, the dermis layer, which is further subdivided into superficial and deep papillary and reticular layers, and the inner hypodermis layer, which is made up of connective tissues and fat, make up the biggest organ in the human body. Burns can range from four degrees, depending on the depth and size of the layers.

First-degree burns typically heal in three to six days and cause erythema and discomfort on the epidermis [14]. Blisters, erythema, and oedema are symptoms of second-degree burns, sometimes referred to as 2A burns, which are superficial lesions that spread to papillary regions [15]. They can need surgery and recover in 7–21 days. Blisters occur, and most skin appendages are destroyed in second-degree burns, sometimes referred to as 2B burns, which are profound wounds that extend to the reticular dermis [16]. Third-degree burns cause deep pressure discomfort and necessitate infection prevention since they penetrate both the epidermis and the dermis [17]. A fourth-degree burn is described as a severe, likely fatal burn that affects all layers of the skin, tendons, muscles, and bones [18]. Deeper regions are injured with fourth-degree burns, which frequently result in blackening and necessitate surgery [19].

Due to loss of fluid, burn patients first have increases in hemoglobin, hematocrit, and red blood cells; this is followed by anemia [20]. Increased monocytes, neutrophils, as well as white blood cells as a result of burn patients' acute inflammatory responses; however, the amounts vary according to the extent of the burn and the length of the damage [21-22]. The early indication of a severe allergic reaction resulting from burn injuries are an elevated erythrocyte sedimentation rate among burn patients [23-24]. Due to the loss of plasma fluid from the burn area, which results at a concentration of red blood cells in the remaining blood volume, the PCV value had been higher than usual [25]. The differential hematological variations in burn patients.

When treating burn injuries, doctors may suggest the following preventative measures, such as using silver sulfadiazine antibiotics cream, which elevates the wounded area and reduces pain and swelling [26-27]. Despite the fact that additional precautions include Accidents may be avoided by keeping children out of the kitchen, covering the outlets, putting chemicals out of reach, checking smoke detectors once a month, and relocating the handles of pots away from burners.

An estimated 6-7 million burns occur each year in India, the second most populous country with over 125 crore inhabitants, making it the second most common cause of injury behind traffic accidents [28]. Of these burns, 25% die from their wounds, while almost 10% are life-threatening and need hospitalization [29]. Almost 2.8 lakh people have debilitating injuries that need several operations and rehabilitation, while between 1 and 1.5 lakh people die from burns [30]. In contrast to affluent nations where the frequency and number of burns are declining, India is one of the few countries with a high incidence of burns, which may be on the rise [31].

Material and Methods

Study design, time frame, and location: Hospitals strategically position themselves based on their area of expertise, the level of healthcare services they provide, the facilities they provide, and their role within the community's healthcare system. Two renowned tertiary care facilities included in this study; Bishnupur District Hospital & Bankura Sammilani Medical College and Hospital (BSMC&H) were situated in a prominent area with a high population density. Of the approximately 148 burn victims who received treatment in those medical facilities,

40 patients had been selected for additional research, and 108 were excluded because they didn't fulfill the inclusion criteria.

Inclusion criteria: Age between 18 to 60 years, admitted within 48 hours of thermal burn injury of 20 to 60%, and total burn surface area (TBSA) without inhalational injury.

Exclusion criteria: Pregnancy, patients with associated injuries or comorbidities.

Ethical aspects: It was followed the guidelines of the center's Institutional Review Board. Written informed consent was not required for this retrospective study.

First-aid procedure and TBSA measurement: First aid is the initial response for every burn injury. It involves halting the burn process, cooling the area, reducing discomfort, covering the area, and transferring the patient to the closest facility for diagnosis and care [32]. Extinguishing the fire, using a simple wooden scale for electrical burns, applying irrigation chemical lesions with running water, performing active cooling within 20 minutes, dressing the burn, and refraining from topical lotions are all examples of on-site treatments. To save wasting time on rescue, victims should be transferred as soon as possible. To minimize heat loss and hypothermia in infants and children, maintain airway at the site of injury, use the proper splinting for fractures and spinal injuries, and remain wounded limbs covered.

After a burn injury, the total body surface area burned (%TBSA) is important for figuring out the necessary rescue fluid volumes and whether to send the patient to a burn center [33]. However, human error is the main cause of the mistakes seen in existing approaches. A smartphone application that combines the burned BSA and total BSA computations has been created in order to solve this problem [34]. This program fixes typical problems in %TBSA calculations and is straightforward and easy to use [35]. The application can be used for testing in upcoming clinical studies and is accessible on widely used mobile device platforms [36-38].

Population or sample, inclusion and exclusion criteria: Patients aged 18 to 70 years, for both sexes, with a percentage of less than 20% to more than 50% of their total body surface area (TBSA) affected by burns, who were admitted to this hospital and underwent anthropometric measurements assessment within 72 hours of admission were included in the study. Patients with physical constraints that prevented them from performing anthropometry, people with disabilities, pregnant women, children, infants, elderly people, those with any implanted devices, and those with conditions that affect electromagnetic bioimpedance performances or evaluation were not included.

Study protocol: The sample was provided for ease of use. The service's medical records were examined in order to gather sociodemographic, medical, and statistical information about burns. Sociodemographic information was gathered, including age, sex (male and female), burn size, and burn etiology. Anthropometry, laboratory tests, and body composition assessments, were conducted during the first 72 hours of the injury. Data on hemoglobin (Hb), red blood cell (RBC), white blood cell (WBC) total count, WBC differential count, erythrocyte sediment rate (ESR), packed cell volume (PCV), along with platelets have been obtained from medical records while taking into account the reference ranges utilized by the hospital laboratory.

Neubauer's or hemocytometers were used to measure hematological parameters such as total RBC count, WBC count and platelet count [39]. Using a Neubauer's or hemocytometer diluted with RBC dilution fluid (Hayem's Fluid), the total red blood cell count (RBC) is determined [40]. Cells in five small squares of the central square are counted to calculate the total WBC count. The platelet count test measures the number of red blood cells, white blood cells, and platelets in blood. One method for figuring out the percentage of each type of WBC in the blood is the differential white blood cell count [41].

Red blood cells that sink to the tube's bottom, indicating inflammation, are measured by ESR testing [42-45]. Higher inflammatory levels have been detected by faster ESR rates, but they are unable to pinpoint the underlying

issue [46]. The number of packed red blood cells after centrifugation is known as the packed cell volume (PCV), which is expressed as a percentage of the total blood volume [47]. The value of PCV is measured by using a centrifuge, a microhematocrit tube, and a Pasteur pipette [48].

Statistical analysis: Microsoft software was implemented to do statistical analyses implementing methods based on statistics. The presentation of epidemiological and clinical factors took both absolute and relative frequencies into account. Standard deviations and means have been employed to characterize normally distributed variables. In order to examine the comparability of variations, parametric samples were subjected to the paired student's 't' test. To reject the null hypothesis, a significance level was determined using the correlation coefficient (r) and p-value.

Results

The sample consisted of 40 adult burn patients, with a mean age of 31.05±12.05. There was a higher frequency of women (N=25; 63%) had been affected in respect to men (N=15; 37%) [Table 1]. Then mean TBSA with burn was of 22.0±13%, among which TBSA <20% was higher (N=21, 52%), than ≥20% which is 2nd degree burn (N=16,40%), in respect to ≥50% TBSA (N=3,8%). The majority are suffered by thermal burn (N=30; 75%), compared to electrical (12%) and chemical (13%) burn [Figure 1].

Table-1: Clinical and epidemiological characteristics of patients admitted to the Burn Treatment Unit of a referral hospital, Patient characteristic (N=40)

Variable	Mean ± SD (N= 40)
Age (Years)	31.05 ± 12.05
Sex	
Male (%)	37%
Female (%)	63%
Burn size, Mean (%) area	22 ± 0.13
TBSA	
<20%	52%
≥20%	40%
≥50%	8%
Causes	
Thermal (%)	75%
Electrical (%)	12%
Chemical (%)	13%

Fig-1: Pie chart showing the TBSA % and causes of burn injury.

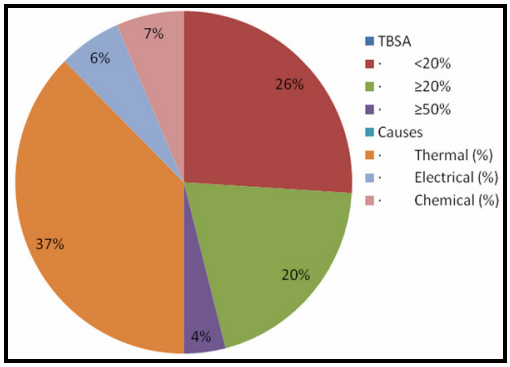


Table-2: Data Variables and statistical representation (N=40)

Variables	Initial phase	Normal value	't'-value
Hb*(g/dl)	11.08±1.44	13.4	2.20
RBC*(mil/µl)	4.225±0.52	4.5-5	2.18
Platelet*(lakh/mm^3)	1.75±4.90	1.5-4.0	-1.44
WBC* (thousands/µl)	14.1±3.82	4-11	-1.25
Neutrophil (%)	65.2±7.89	50-70	-1.80
Lympocyte (%)	25±5.90	20-40	1.25
Monocyte (%)	6.5±2.07	2-8	-1.18
Eosinophil (%)	3.3±1.45	1-4	1.48
ESR*, (mm/hr)	18.8±3.22	0-15	0.40
PCV*, (%)	41.76±4.99	35-45	1.30

*Hb-Hemoglobin; RBC-Red Blood Cells; WBC-White Blood Cells; ESR- Erythrocyte Sediment Rate; PCV- Packed Cell Volume. *Paired student t test for normally distributed variables. p<0.05.*

Table 2 shows the differential variables of the hematological parameters of burn patients along with the mean values of their first phases. "t" statistic values for platelets (-1.44), WBC total count (-1.25), neutrophils (-1.80), and monocytes (-1.18) were all negative. During the first phase of burn victims, Hb exhibits the highest "t" statistic value (2.20). The statistical illustration of the data variables was discussed diagrammatically [Figure 2].

Fig-2: Statistical representation of data variables by using bar diagram

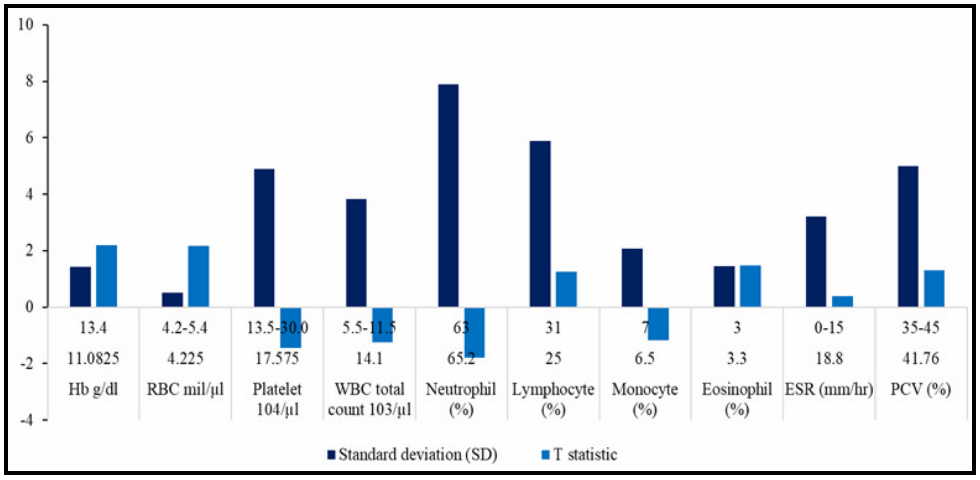


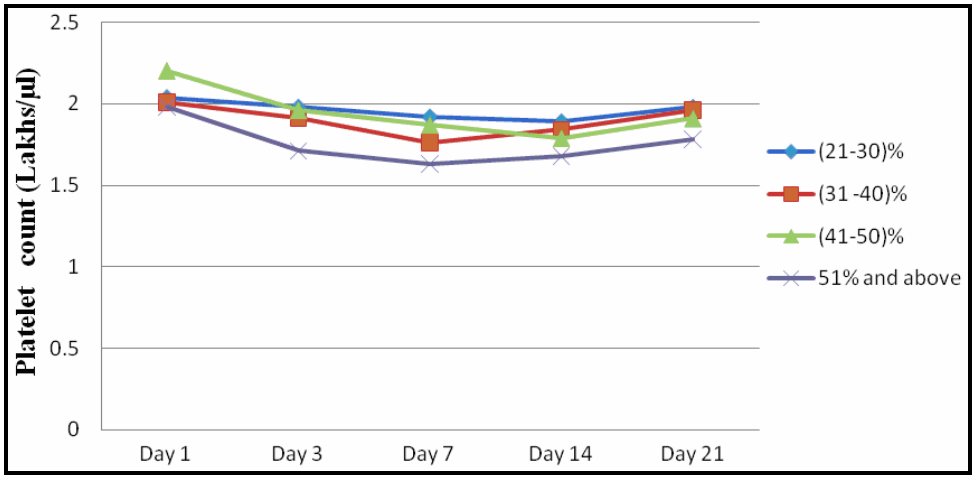
Table-3: Correlation of all variables and p value		
Variables	**Correlation (r)**	**P value**
Hb	0.299	0.033*
RBC	0.297	0.034*
Platelet	-0.263	<0.001*
WBC	-0.226	<0.001*
Neutrophil	-0.211	<0.001*
Lympocyte	0.213	0.145
Monocyte	0.063	0.687
Eosinophil	0.190	0.198
ESR	-0.338	<0.001*
PCV	0.183	0.217
*Hb-Hemoglobin (g/dl); RBC-Red Blood Cells (mil/µl); WBC-white blood Cells (103/µl); ESR- Erythrocyte Sediment Rate (mm/hr); PCV- Packed Cell Volume (%). Paired student 't' test for normally distributed variables. *p<0.05.*		

Age-based comparisons of anthropometric measurements and hematological variables were explained with Table 3. There was a decrease in hemoglobin ($p<0.05$) and red blood cells ($p<0.05$). Platelet ($p<0.001$), WBC total count ($p<0.001$), neutrophil ($p<0.001$), and ESR ($p<0.001$) were all significantly reduced. Monocytes ($p=0.687$), PCV ($p=0.217$), lymphocytes ($p=0.145$), and eosinophils ($p=0.198$) did not differ statistically. PCV, Hb, RBC, lymphocytes, monocytes, and eosinophils all showed positive correlations. On the other hand, platelets, WBC, neutrophils, and ESR showed negative connection.

Table 4 shows the trends in mean platelet counts, which were observed for 1st day, 3rd day, 7th day, 14th day and 21st day of the burn victims [Figure 3].

Table-4: Variations of Mean platelet count							
Sl . No.	**Burn groups**	**Number of patients**	**Mean platelet count (lakh/mm^3)**				
			1st day	**3rd day**	**7th day**	**14th day**	**21st day**
1	(21-30)%	24	2.04± 0.18	1.98± 0.11	1.92± 0.2	1.89± 0.19	1.98± 0.31
2	(31-40)%	8	2.01± 0.43	1.91± 0.23	1.76± 0.21	1.84± 0.14	1.96± 0.26
3	(41-50)%	5	2.2± 0.48	1.96± 0.19	1.87± 0.33	1.79± 0.23	1.91± 0.27
4	≥51% & above	3	1.98± 0.47	1.71± 0.43	1.63± 0.36	1.68± 0.31	1.78± 0.25

Fig-3: Trends in mean platelet count



Discussion

Every year, millions of people in India, the second most populous country, suffer burns from a variety of causes. They may result in damage to tissues, discomfort, and mental disorders. The high burn rate in India can rise day by day. This experimental study was conducted using reports of cases from 40 patients. Patients' samples are taken in order to investigate the determination of different hematological parameters. Through the calculations of "t" values, statistical analysis has been performed to compare those parameters that are depicted by Bar diagrams.

Two reputable tertiary care facilities in a densely populated area provide the patient reports. According to reports, women are more likely than men to suffer injuries from burns. The majority of survivors of burns are adults, though they come in a variety of ages. The bulk of them suffer from thermal burn, while the causes are similarly varied. A discernible decrease in hemoglobin was seen. Due to the intense heat, this might develop anemia and necessitate more blood transfusions for prompt treatment.

Because of sudden blood loss & cell deterioration, individuals with burns also have reduced RBC counts. That might be resolved temporarily with PRBC transfusions that take around one week to complete. Because platelets play a vital part in the wound healing mechanism, patients' platelet levels significantly drop as compared to normal individuals. The total WBC count report reveal that the values are higher than those of normal individuals. Due to the overproduction of WBCs and the increased production of neutrophils and lymphocytes as a result of wounds, hypovolemia, and inflammations, a total count of 14.2-14.4 thousand cells/µl was observed. In burn victims, PCV levels decline while ESR levels rises. In spite of this PCV and ESR revert to normal after 5–6 days.

Conclusions

The study discovered that because of losses of fluid along with low PCV levels, burned individuals initially have somewhat lower hemoglobin levels. However, Hb and PCV levels rise after receiving an FFP transfusion. Sometimes Hb doesn't rise, which causes problems and a gradual decline in life expectancy. For burn patients, hemoglobin is an important metric that is monitored every day while they are in the hospital. Due to inflammation and surface damage, burn victims have elevated TLC, which raises eosinophil counts.

Fluid loss lowers the platelet count, which impacts the clotting factor. To avoid problems and enhance results, careful monitoring of serum electrolytes, liver and kidney functions, and total blood count is essential. Finally, for the medical staff to understand the prognosis of burn patients' illnesses and how the victims' bodies are reacting to various treatment modalities, it is crucial to estimate various hematological and serum biochemical indicators in burn patients.

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