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# Management Of Fluid Resuscitation In Burn Wounds

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**ABSTRACT**
The World Heath Organization (WHO) states that women in the Southeast Asia region have a high incidence of burns, which is 27% of the total number globally. The Burn Incidence Fact Sheet of the American Burn Association (ABA) states that in 2016, 486,000 people sought burn care in the United States. Most burns are small with 67% occupying less than 10% of the total body surface area according to the National Burn Repository of the ABA . Resuscitation is needed to restore respiratory function and blood circulation in someone who has experienced cardiac or respiratory arrest. This research method uses a literature review with a narrative review design. Based on the review obtained, crystalloids are the type of fluid that is widely used for burn patient therapy and for colloid fluids that are widely used are 20% albumin. The importance of calculating the need for fluid intake with fluid output is seen from urine output in patients using one of the most common formulas, namely the Parkland formula because the amount of fluid entered is higher than the recommended amount indicating the potential risk of excess fluid which can increase complications



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## INTRODUCTION

Burns are a trauma that can affect anyone, anytime, and anywhere. Burns can be caused by friction, radiation, and chemicals or electrical sources but most burns are caused by heat from hot liquids and flames. Although all burns involve tissue damage due to *energy transfer* , different causes can be associated with different physiological and pathophysiological responses.[1]

Burns are injuries that can destroy the skin of a person who is exposed. The skin plays a key role in regulating body temperature and fluids and acts as a barrier against microorganisms. The anatomy of the skin can be divided into the epidermis (the outer layer of the skin), the dermis which consists of elastic fibers containing collagen, nerves, blood vessels, sweat glands, hair follicles and subcutaneous tissue which contains fat, blood vessels and nerves. The severity of a burn depends on the depth of destruction, location and surface area of the body involved. Inadequate burn care can lead to increased visible (physical) and invisible (psychological) scarring. [2]

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Burns are the fourth most common type of trauma worldwide, after road traffic injuries, falls, and interpersonal violence. The risk of burns tends to increase with lower socioeconomic status and up to 90% of burns occur in low- or middle-income countries. *The Burn Incidence Fact Sheet of the American Burn Association* (ABA) states that in 2016, 486,000 people sought treatment for burns in the United States. Most burns are small with 67% covering less than 10% of the total body surface area according to *the National Burn Repository of the ABA*.[3]

Data obtained from *the World Heath Organization* (WHO) states that women in the Southeast Asia region have a high incidence of burns, which is 27% of the total global figure and almost 70% of them are women. From an epidemiological study conducted at Cipto Mangunkusumo Hospital (RSCM) in 2011-2012, the data on patients treated were 303 burn patients and the ratio between men and women was 2.26: 1 while the average age was 25.7 years (15-54 years). [4] In South Sulawesi province, there was a 1.3% incidence of burns based on the national Basic Health Research (RISKESDAS) report in 2018. [5]

Burn care is one of the most expensive treatments since people of all ages are susceptible to burns. [6] In wound management, it is important to know the initial management or actions that will be given with the aim of obtaining rapid healing by minimizing disruption of function both locally and systemically and also to obtain the best aesthetic results that can be achieved. There are 3 principles of first aid for burns based on *Emergency Management of Severe Burns* (EMSB), namely stopping the burning process, cooling the wound, and preventing hypothermia. [7]

Fluid resuscitation is an essential part of burn management to prevent hypovolemic shock. Hypovolemic shock occurs when the body loses enough blood volume to maintain adequate tissue perfusion. [8] In burns, fluid loss can occur through several mechanisms, including evaporation from the wound surface, exudation into the surrounding tissues, and significant extracellular fluid loss due to the body's inflammatory response to injury[9]. Fluid resuscitation aims to replace lost fluid volume, maintain adequate blood pressure, and ensure adequate tissue perfusion. This can help prevent or treat hypovolemic shock which, if not treated quickly, can lead to organ damage and death. [10]

## METHOD

This research was conducted using the method *literature review* with *narrative review design* aims to identify & summarize previously published articles, avoid research duplication, and find new fields of study that have not been researched. The research flow carried out in writing a thesis for the *narrative review model* begins with determining the topic, searching for literature based on a database of related articles, selecting literature, processing data & conclusions.

## RESULTS AND DISCUSSION

| No. | Title | Writer | Year | Method | Results |
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| 1. | *Oral/Enteral Fluid Resuscitation In The Initial* | Hsiao, et all | 2024 | *Systematic Review* | Seven human and eight animal studies were included. Three human RCTs totaling 100 |

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| | *Management Of Major Burns : A Systematic Review And Meta-analysis Of Human And Animal Studies* | | | | participants contributed to the estimates. Compared with IV fluid resuscitation, oral/enteral fluid resuscitation was associated with a non-statistically significant increased risk of death (OR 1.33, 95% CI 0.33–5.36) but the evidence was very uncertain, and there was no difference in urine output (SMD −0.17, 95% CI −0.65–0.31) with moderate certainty evidence. |
| 2. | *Effect Of Fluid Resuscitation With Albumin On Mortality In Patients With Severe Burns : A Nationwide Inpatient Data Analysis* | Kazuha Nakamura, et al | 2024 | *Retrospectively Analyzed* | One-to-one propensity score matching yielded 530 pairs of patients with and without albumin administration. Mortality at 28 days was not significantly different between the two groups (albumin vs control, 21.7% vs 22.8%; risk difference, −1, 1%; 95% confidence interval, −6.1% to +3.9%). These results suggest that albumin administration within 2 days of hospital admission in patients with severe burns may not be associated with mortality during the acute phase. |
| 3. | *The Risks Of Sedation And Pain Control During Burn Resuscitation : In Creased Opioids Lead To Over Resuscitation And Hypotension* | John, M. McClellan, et all | 2023 | *Retrospective Study* | 208 patients were included with a median age of 43 years (IQR 29–55) and median %TBSA of 31 (IQR 25–44). The median 48-hour resuscitation milliliters per body weight per %TBSA was 3.3 (IQR 2.28–4.92). Pain/sedative medications included opioid combinations in 99%, benzodiazepines in 73%, propofol in 31%, and dexmedetomidine in 11% of patients. MME was associated with greater resuscitation volume (95% CI: 0.15–0.54, p = 0.01) as well as the number of hypotensive events (95% CI: 1.57–2.7, p < 0.001). No association was noted with other sedative medications when comparing the number of |

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| | | | | | hypotensive events and resuscitation volume. |
| 4. | *A Practical Formula For Fluid Resuscitation In Acute Pediatric Burns In A Low Resource Setting: A Pilot Study* | Allorto, et all | 2023 | *Retrospective Study* | Ten children were included. The median age was 3 (IQR 2–5) years, with a mean body weight of 14.9 (SD 5.07) kilograms, median TBSA 17.4 (IQR 16–26)%, at a median of 12 (6.5–18) hours post-burn. The mechanism of burn was scald in all cases, with 9 of these being hot water and one case being hot food. In the first 24 hours a mean of 2.05 (SD 0.58) ml/kg of fluid was received with a mean urine output of 1.66 (SD 0.57) ml/kg/hour. |
| 5. | *Weight-Based VS Body Surface Area-Based Fluid Resuscitation Predictions In Pediatric Burn Patients* | Jan Stvens, et al | 2024 | *Retrospective Study* | This study included 11 underweight, 60 normal weight, 18 overweight, and 21 obese children. Total fluid administered was higher as percentile increased; however, overweight children received more fluid than the obese ($p = 0.023$). The Galveston formula underpredicted fluid given over the first 24 h post-injury ($p = 0.042$); the Parkland and Cincinnati formula predictions did not significantly differ from fluids given. Further research is needed to determine the value of weight-based vs BSA-based or incorporated formulas in reducing risk of complications. |
| 6. | *Drug Untilization Study Of Fluid Therapy In Burn Injury* | Yulinda Risma RDW | 2022 | Descriptive prospective observational. | The fluid therapy used in this study was crystalloid, colloid, and TPN. NS, RL and RD5 are types of crystalloid fluids that are widely used for therapy in burn patients. The types of colloid fluids that are widely used are Albumin 20%, FFP and Gelofusin. While for the type of TPN fluid, most patients received Clinimix 20E, Ivelip 20% and Clinimix 15E. Fluid replacement is divided into two phases: the initial phase and the maintenance phase. RL and RA are the types of fluids used during the initial phase. The |

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| | | | | | selected fluid types used in the maintenance phase are NS, D51⁄2NS, and RD5. While RL, NS and Gelofusin are the types of fluids used during surgery. However, the type, dose, frequency and time of fluid therapy are determined clinically conditions and laboratory data of each patient. |
| 7. | *Is The Parkland Formula Still The Best Method For Determining The Fluid Resuscitation Volume In Adults For The First 24 Hours After Injury? A retrospective analysis of burn patients in Germany* | Marc Daniels, et al | 2021 | *Retrospectively Analyzed* | Patients in Group 0 showed significantly lower mortality at 1 week (4.5%) compared to group −2 (16.7%) and group +2 (19.5%) (p = 0.021). In addition , the mean number of operations in group +2 (5.81) was higher than that in group −2 (3.81). Surviving patients from group +2 showed longer hospitalization (68.1 days) compared to other groups. In addition, logistic regression analysis showed higher survival of patients in groups −2 and −1 (regression coefficient −0.11 and −0.086; Odds Ratio 0.896 and 0.918; 95% Confidence Interval (CI) 0.411–1.951 and 0.42–2.004). |
| 8. | *Vasoactive And/Or Inotropic Drugs In Initial Resuscitation Of Burn Injuries* | Kristine Knappskog, et al. | 2021 | *Retrospective Study* | 16 of 52 (31%) patients received vasopressors. Factors associated with vasopressor use were increasing age, burn depth, and % total body surface area (TBSA) burned. Another study observed that 20 of 111 (18%) patients received vasopressors. Vasopressor use was associated with increasing age, Baux score, and %TBSA burned as well as more frequent dialysis treatments and increased mortality. Study quality as assessed by the Newcastle-Ottawa Quality Assessment Scale was considered good in one study but uncertain due to limited description of methods in the other studies. |

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| 9. | *A Case Study Demonstrating Tolerance Of The Gut To Large Volumes Of Enteral Fluids As Complement To IV Fluid Resuscitation In Burn Shock* | Emily W Braid, et al. | 2021 | *Case Report* | An 82-year-old man with 14% total burns was prescribed Drip Drop oral rehydration solution starting 7 hours post-burn. Over the next 17 hours he consumed over 5 L of oral rehydration solution which was almost 1 L more than the total amount of IV fluids he received. There were no adverse gastrointestinal side effects, demonstrating tolerance to large amounts of oral fluids combined with IV resuscitation. |
| 10. | *Prehospital Management Of Burns Requiring Specialized Burn Center Evaluation: A Single Physician-Based Emergency Medical Service Experience* | Ludovic Maudet, et al. | 2020 | *Retrospective Study* | were included with a median age of 26 years (IQR 12–51). The median prehospital TBSA was 10% (IQR 6–25). The difference between prehospital and hospital TBSA estimates was outside the limits of agreement at 6.2%. The limits of agreement found in the small and large burn groups were −5.3, 4.4 and −10.1, 11, respectively. Crystalloid infusion was reported at a median volume of 0.8 ml/kg/TBSA (IQR 0.3–1.4) during the prehospital phase, which extrapolated over the first 8 hours would equate to a median volume of 10.5 ml/kg/TBSA. The median verbal numeric rating scale at the scene was 6 (IQR 3–8) and 3 (IQR 2–5) in the hospital ($p < 0.001$). Systemic analgesia was administered to 61 (71%) patients, primarily with fentanyl (n = 59; 69%), followed by ketamine (n = 7; 8.1%). The median doses of fentanyl and ketamine were 1.7 mcg/kg (IQR 1–2.6) and 2.1 mg/kg (IQR 0.3–3.2), respectively. |
| 11. | *Resuscitation With Albumin Using BET Formula Keeps At Bay Fluid Administration In Burned Patients.* | Pablo Blanco, et al | 2020 | *Observational Study* | The resuscitation volume during the first 24 hours was 2.58 ml/kg/%BBSA, significantly less than the Parkland estimate (4 ml/kg/%BBSA; $P < 0.05$). Successfully resuscitated patients |

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| | *An Observational Study.* | | | | showed increased base excess and lactate clearance. significant during the resuscitation period (base excess 120%; lactate 29%; P < 0.05). Burn-related complications were: ARDS 27%, renal dysfunction 53%, wound deepening 20%, abdominal compartment syndrome 4.5% . In conclusion, the BET formula is able to successfully resuscitate burn patients, and limit fluid administration. |
| 12. | Correlation Analysis of Fluid Resuscitation Time and Mortality of Severe Burn Patients in *the Emergency Phase* | Ida Ayu Agung Laksmi | 2019 | *Retrospective Study* | The mortality rate of burn patients in the emergency phase of Sanglah General Hospital was 12.82%. The Spearman test showed that the time of fluid resuscitation with the mortality of severe burn patients in the emergency phase had a p value of 0.013 and r (0.281). The duration of fluid resuscitation was related to mortality, the longer the resuscitation, the greater the possibility of patient death. Medical personnel need to improve the management of severe burns in the emergency phase by starting fluid resuscitation earlier and maintaining adequate circulation. |
| 13. | *Effectiveness Of Parkland Formula In The Estimation Of Resuscitation Fluid Volume In Adult Thermal Burns* | Geley Ete, et al. | 2019 | *Retrospective Study* | This study involved a total of 90 patients, about 86.7% (n 1⁄4 78) of patients received less fluid than the calculated Parkland formula. The rate of fluid administration for 24 hours in our study was 3.149 mL/kg/hour. The average hourly urine output was found to be 0.993 mL/kg/day. The average difference between the administered fluid and the calculated fluid by the Parkland formula was 3431.825 mL which was significant (p <0.001). The study showed a significant difference in infusion fluid based on urine output and fluid calculated by the Parkland formula. This may be |

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| | | | | | because the fluid given based on the endpoint of resuscitation is more physiological than the fluid calculated by the formula. |
| 14. | The Complexity Challenges of Bomb Blast Injury Management: Experience from a Private Type B Hospital in Surabaya | AK Wisnu Baroto Sutrisno Putro, et al. | 2019 | *Case report* | Bomb blast trauma has 4 stages of effects, namely primary (direct pressure effects), secondary (explosion projectile effects), tertiary (structure collapse and victim being thrown), and quarternary (burns, inhalation trauma, exacerbation of chronic diseases). Handling of burn patients due to high order explosive injuries is essentially the same as handling of burn patients in general, based on the primary and secondary survey stages. Based on history, initial assessment and clinical appearance, it is suspected that there is upper airway thermal trauma, airway protection with intubation is carried out immediately. Fluid management of burn cases is to maintain tissue perfusion in the early phase of burn shock. |
| 15. | Evaluation of Albumin Use in Burn Patients at Dr. Soetomo Hospital | Suharjono, et al. | 2019 | Retrospective observational | There were 26 burn patients who received albumin therapy, 69.2% male patients and 30.8% female patients, and the age of the most patients was 20 to 59 years (76.9%). The etiology of burns in most patients was caused by thermal sources (81%), electricity (15%), and chemicals (4%). The albumin used was 20% albumin 100 mL with a dose of 20 grams and was given by drip infusion. The average increase in albumin levels was 0.83 g / dL. In addition to the increase, there were also several patients who actually experienced a decrease in albumin levels after therapy. Of the 26 patients, there were 12 patients who experienced an average decrease of 0.68 g / dL. |

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| | | | | | In addition, there were no problems related to the use of drugs with low albumin levels. The results of the study showed that 20% albumin was the most widely used and no problems were found related to drugs with low albumin levels |
| 16. | Albumin Administration For Fluid Resuscitation In Burn Patients : A Systematic Review And Meta Analysis | Reoberto Eljalek, et al | 2019 | Systematic Review and Meta Analysis | The researchers identified 164 trials. Four trials involving 140 patients met our inclusion criteria. Overall, the methodological quality of the included trials was good. We found no significant benefit of albumin solution as a resuscitation fluid on mortality in burn patients (relative risk ( RR) 1.6; 95% confidence interval (CI), 0.63-4.08). Total fluid infusion volume during the resuscitation phase was lower in patients receiving albumin-containing solutions −1.00 ml/kg/%TBSA (total body surface area) (95% CI, −1.42 to −0.58). |
| 17. | *Effectiveness Of Parkland Formula In The Estimation Of Resuscitation Fluid Volume In Adult Thermal Burns* | Geley ete, et all | 2019 | *Observational Study* | This study involved a total of 90 patients. Approximately 86.7% (n = 78) of patients received less fluid than the calculated Parkland formula. The rate of fluid administered over 24 hours in our study was 3.149 mL/kg/hour. The mean urine output per hour was found to be 0.993 mL/kg/day. The mean difference between the fluid given and the fluid calculated using the Parkland formula was 3431.825 mL which was significant (p <0.001). |
| 18. | *Early Resuscitation and Management Of Severe Pediatric Burns* | Mary Arbuthnot, et all | 2019 | *Retrospective Study* | Severe burns >80% of total body surface area (TBSA) in children are considered fatal. Advances in fluid resuscitation, nutritional support, airway injury management, and burn wound care have improved overall survival of burn patients. Although the principles of resuscitation are similar between children and adults, there are major |

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| | | | | | differences in their physiologic response to burns, fluid resuscitation requirements, and airway management and burn wound care; a critical understanding of these differences is essential to improving short- and long-term outcomes in children with burns. |
| 19. | *New Fluid Therapy Protocol In Acute Burn From A Tertiary Burn Care Center* | Maninde Kaur Bedy, et al. | 2019 | *Prospective Randomized* | The mean sodium values at 24 hours were 137.79 ± 3.89 in group A and 133.2 ± 4.57 ($p < 0.0001$) in group B. Sodium levels remained in the range of 137–138 ($p < 0.0001$) in group A with only 22% of patients showing the lower range of sodium levels, whereas there was a decreasing trend ($p < 0.0001$) in sodium levels in group B on the following days with 54.00% ($p < 0.0001$) showing hyponatremia on the first day which increased to 76% on the 3rd day. The mean value of morning random blood sugar (RBS) in group A remained between 165.5 ± 65.51 mg/dL – 115.82 ± 32.52 mg/dL for 3 days but in group B there was a decreasing trend from 127.49 ± 46.11 mg/dL to 102.84 ± 22.92 mg/dL on day 3. Thus, there was a significant difference in sodium and RBS levels in patients receiving DNS as maintenance fluid in addition to RL in the acute phase. |
| 20. | *A Comparison Of Two Different Fluid Resuscitation Management Protocols For Pediatric Burn Patients : A Retrospective Study* | Miao Huang, et al | 2018 | *Retrospective Study* | All patients survived the first 24 hours after burn injury. There was no significant difference between Group A and Group B in lactic acid (LA) and base excess (BE) levels. The amount of water infused in Group A was greater than that in Group B at 24 first hour ($P = 0.024$). No significant differences were found in total hourly urine intake and output between the 2 groups in the first 24 hours. |

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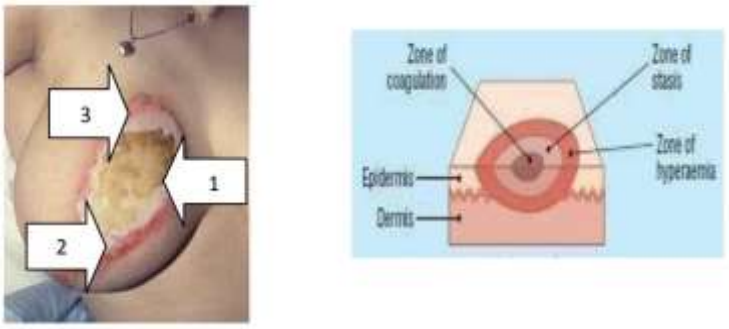
Burns are complex traumas that require multidisciplinary and ongoing therapy. Burns occur through intense heat contact with the body that destroys and/or damages human skin. In addition to thermal burns, there are also electrical, chemical, and radiation burns. [10] Burns contribute significantly to morbidity and mortality caused by injuries worldwide. [19]

As little as 44°C of heat can cause skin burns. In addition, the duration of the heat is also important. Transepidermal necrosis that occurs with 70°C heat in one second occurs in 45 minutes with 47°C heat. Burns can be classified according to thermal, chemical, electrical, and radiation. The cause of the burn must be known because different treatment protocols are applied in each case. Thermal burns that occur with the direct effect of a flame with a high level of heat, contact with hot objects, hot liquids, or hot steam are commonly seen. The duration of contact and the degree of temperature determine the level of cell damage. Chemical burns due to acids or bases, salts and solutions can cause burns due to the corrosive effect of these substances. In addition, burns can also develop due to electric current, radiation, ultraviolet, and laser light. Serious burns from the flames of weapons, explosives, and flammable materials can also occur during warfare. [20]

Burns can cause a local inflammatory response that includes three zones in the skin, namely the coagulation zone, the stasis zone, and the hyperemia zone. Coagulation zone: This zone limits the area of necrosis characterized by permanently damaged tissue at the time of injury. Stasis zone: This area experiences moderate damage associated with vascular leakage, increased concentrations of vasoconstrictors and local inflammatory reactions that result in impaired tissue perfusion. Depending on the wound environment, this zone can persist or progress to necrosis. Hyperemia zone: Inflammation due to vasodilation. This zone is characterized by increased blood supply to healthy tissue without a high risk of death. [21]




Clinical picture of injury zone in burns: 1. Coagulation zone; 2. Stasis zone; 3. Hyperemia zone [21]

Estimates of total body surface area and burn size can vary according to the method of estimation used (e.g. *rule of nines, rule of palms, Lund-Browder-Chart*) which can impact the initial management of burn patients. In practice, burn size is estimated as a percentage using the rule *of nines* which assumes that each body part represents 9% (or multiples thereof) of the total body surface area. Each arm is 9%, each leg is 18%, the trunk is 36% (back 18%, front 18%), the head is 9% and the genitals are 1% in adults. These figures are slightly different in children, where the head and neck occupy a larger proportion of the body. Another useful rule of thumb for assessing the extent of a burn is to compare the surface area to the surface area of the patient's hand which is 1% of the total body surface area (TBSA).

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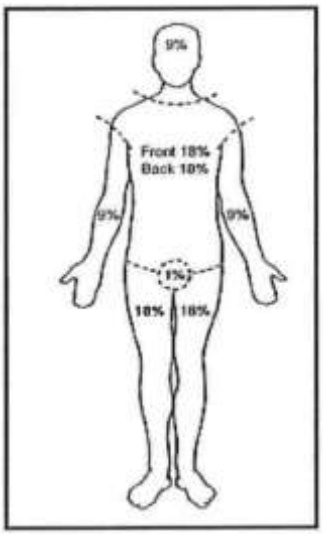


**Figure 4** : *Rule of Nines* [7]

Burns can cause shock, especially when more than 20% of the body is exposed. Shock occurs due to damage to capillaries due to high temperatures, which increases blood vessel permeability, causing anemia and edema. Fluid loss from second and third degree burns reduces the intravascular fluid volume, leading to hypovolemic shock. Symptoms such as restlessness, pallor, rapid pulse, and decreased blood pressure occur if the body cannot compensate for fluid loss. In addition, damage to the respiratory mucosa due to gas or smoke can cause shortness of breath, laryngeal edema, and even carbon monoxide poisoning.

Initial management of burns involves stabilizing the patient's condition through fluid resuscitation and controlling respiratory and circulatory functions. The Parkland formula is often used to calculate fluid requirements, but there is controversy regarding its accuracy because excessive fluid administration is common. Recent studies have shown that closely supervised fluid resuscitation results in lower mortality than under- or over-fluid administration. Several studies have suggested that the use of albumin as an additional fluid during the first 12 hours may be helpful in resuscitating patients with extensive burns . [17]

## CONCLUSION

Based on various reviews obtained, crystalloids are the type of fluid that is widely used for burn patient therapy and for colloid fluids that are widely used is 20% albumin. The importance of calculating the need for fluid intake with fluid output is seen from urine output in patients using one of the most common formulas, namely the Parkland formula because the amount of fluid entered is higher than the recommended amount indicating the potential risk of excess fluid which can increase complications. Providing additional fluid resuscitation using oral rehydration solutions and the use of additional drugs after the treatment phase can help recovery faster. The duration of fluid resuscitation is related to mortality, the longer the resuscitation, the greater the likelihood of death. The use of albumin as part of fluid therapy can be considered although crystalloid fluids are usually the main choice. Albumin as a colloid fluid can help prevent other complications.

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