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Mortality in the Burn Intensive Care Unit (2017-2023) at Mohammed VI University Hospital, Department of Reconstructive and Aesthetic Surgery, Marrakech

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Abstract **Original Research Article**

This internal audit aims to evaluate the management of burn patients in the intensive care unit (ICU) of Mohammed VI University Hospital in Marrakech, a specialized burn treatment center in Morocco. The retrospective study spans from 2017 to 2023, analyzing the deaths of 27 patients admitted to the ICU, with an average age of 62. The primary causes of death identified were septic shock (54%) and acute respiratory distress syndrome (18%). Key challenges emerged, including nursing staff shortages, inadequate stock management of dressing materials, and the absence of care assistants, all of which impacted the quality of care provided. The study also underscores the importance of improved care organization, drawing from international best practices. The report proposes several solutions, such as increasing nursing staff, optimizing workflows, and improving sanitary infrastructure to minimize infection risks. A crucial recommendation involves reassessing admission criteria to ensure that critically ill patients are redirected to appropriate units, particularly by strengthening the presence of full-time intensivists in the burn ICU. Furthermore, the report highlights the need for continuous training of medical personnel and interdisciplinary collaboration to enhance the quality of care. The introduction of assistive technologies and companion programs for isolated patients would also improve their nutritional and psychological support. These initiatives could alleviate the burden on medical staff and improve patient outcomes. By implementing these recommendations, the burn ICU could be transformed into a model of excellence, providing optimal, safe, and respectful care tailored to the individual needs of burn patients. This audit serves as a foundation for ongoing improvement, emphasizing patient safety and well-being as the core priorities in burn patient management.

Keywords: Burns, Intensive Care Units, Mortality, Sepsis, Healthcare Quality Assurance, Internal Auditing, Nursing Staff, Resuscitation, Clinical Protocols.

1. INTRODUCTION

Internal auditing plays a crucial role in the healthcare sector, particularly when it comes to evaluating and improving resuscitation protocols for burn patients. The management of severe burn cases in the intensive care unit presents a complex challenge, requiring precise coordination and advanced protocols. However, despite continuous advancements in medical techniques, deaths occurring in the ICU raise important questions about the effectiveness of existing procedures.

This internal audit report aims to thoroughly analyze the circumstances surrounding the deaths of burn patients in the ICU within our healthcare facility. The ultimate goal is to extract meaningful lessons to identify potential gaps, promote a culture of continuous learning, and strengthen our commitment to patient safety and quality care.

By closely examining these tragic cases, we seek to highlight contributing factors, assess the relevance of existing protocols, and formulate tangible recommendations. This introspective approach aims to provide valuable insights into the complexities of resuscitating burn patients and, consequently, to inspire significant improvements in care delivery.

We invite all stakeholders involved in the care chain, from medical staff to administrative leaders, to actively collaborate in this critical analysis. Together, we aspire to create an environment where each ICU death becomes an opportunity for learning, thereby reinforcing our commitment to the safety and well-being of the patients we have the privilege to serve."

2. PATIENTS AND METHODS

i. Report Framework

Our study was conducted in the burn intensive care unit of Mohammed VI University Hospital in Marrakech. This is a major burn care center in southern Morocco, with a threefold mission: multidisciplinary burn patient management, education, and research. The unit comprises six individual rooms, each equipped with state-of-the-art equipment, and a single specialized bathroom for burn patients. The department is led by Professor Benchemkha. The medical staff includes three associate professors, one assistant professor, and 15 residents.

ii. Study Type and Duration

This is a retrospective study focused on burn patients who passed away after being admitted toor transferred through the burn intensive care unit. The patients were observed over a 7-year period (2017-2023).

iii. Excluded from the study were: Burn patients who were admitted to the shock room or surgical intensive care unit."

3. RESULTS

A total of 27 patients died in the burn intensive care unit between 2017 and 2023.

1. **Age:** The average age of the deceased patients was 62 years, with a median age of 65 years, ranging from a minimum of 5 years to a maximum of 95 years.

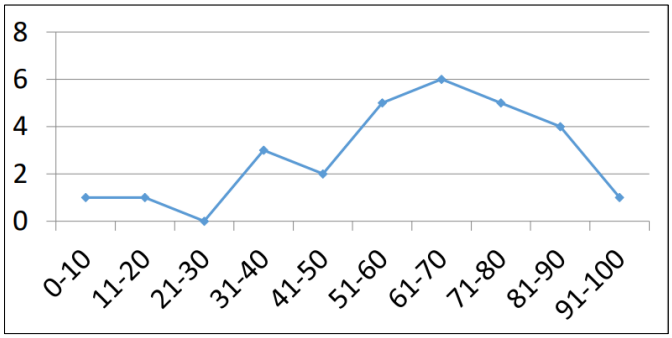

Figure 1: age of deceased patients

2. **Gender:** A slight female predominance was observed, with a sex ratio of 1.07.

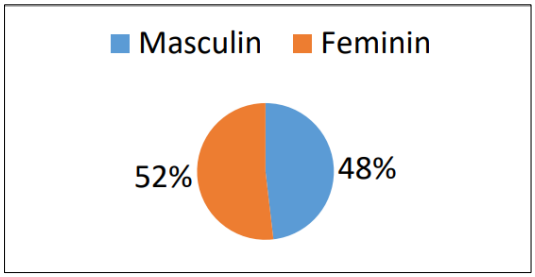

Figure 2: Gender

3. **Number of Deaths per Year:** This number has been increasing exponentially over the years."

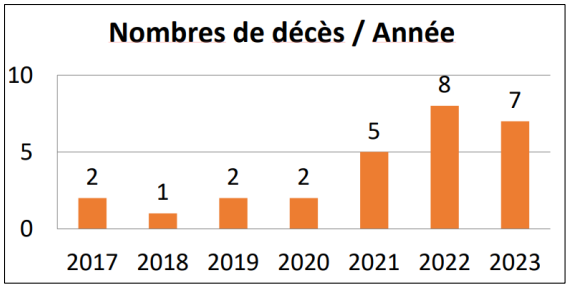

Figure 3: Number of Deaths per Year

4. **Burned Skin Surface Area:** The average burned skin surface area is 30%, with a minimum of 4% and a maximum of 68%.

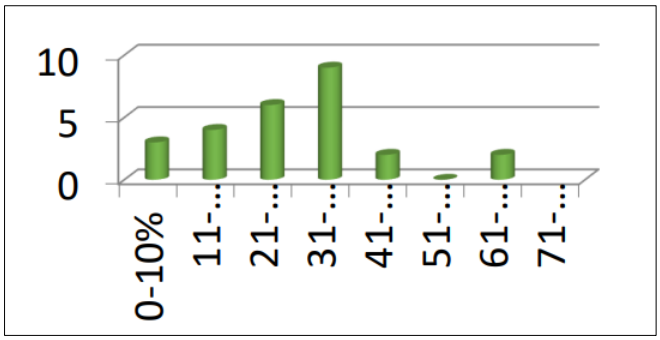

Figure 4: Burned Skin Surface Area

5. **Burn Index:** The minimum index is 50, the maximum is 115, and the median is 95. The median is close to the critical value of 100.

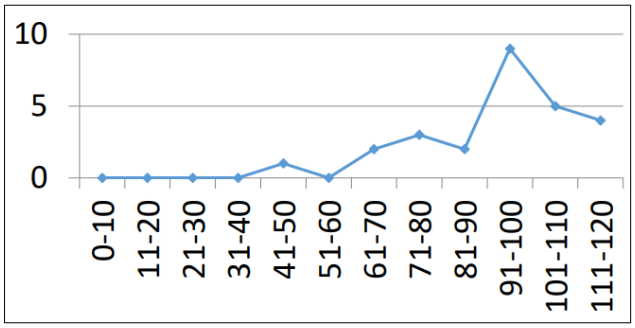

Figure 5: Burn Index

6. **Mechanism:** The predominant mechanism is butane flame (37%) followed by contact burns (19%) and gasoline flame (15%).

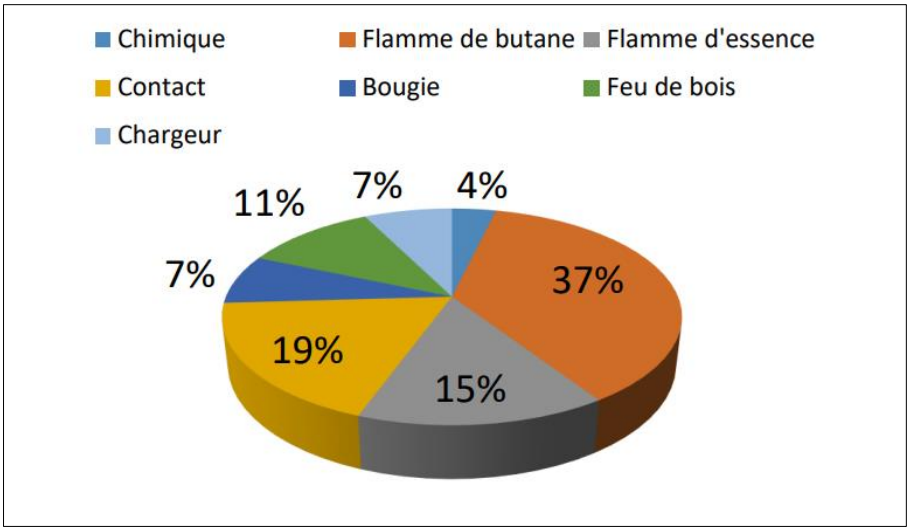

Figure 6: Mechanism

7. **Age of the Burn**:

Two phases are distinguished: the peak of the acute phase and the phase where chronicity begins, with the minimum at Day 1 post-burn and the maximum at Day 117 post-burn.

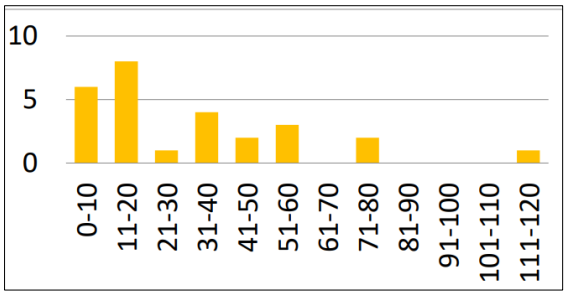

Figure 7: Age of the Burn

8. **Day of Death Occurrence:**

In the context of our report, we aimed to determine whether the weekend was a factor that increased the occurrence of deaths, but this was not found to be significant.

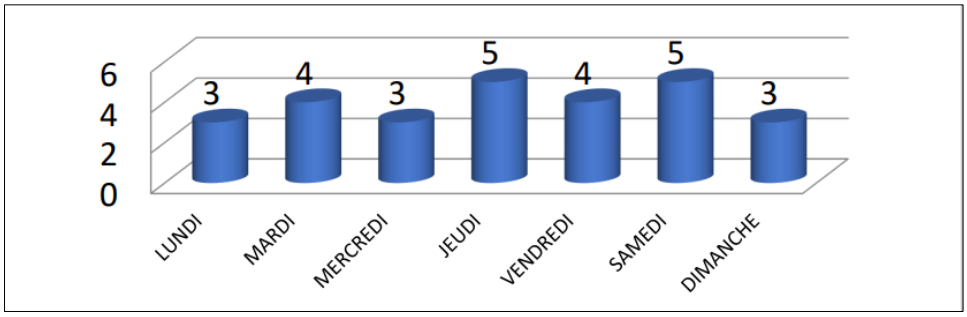

Figure 8: Day of Death Occurrence

9. **Cause of Death:** We also reviewed the exact causes of death, which are primarily septic shock at 54%, followed by acute respiratory distress syndrome at 18%.

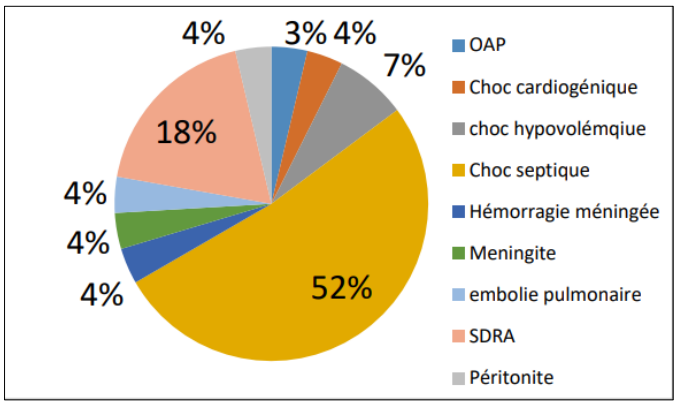

Figure 9: Cause of Death

10. **Occupancy Rate of the Intensive Care Unit:** As this rate increases, the number of deaths also rises, and this is statistically significant.

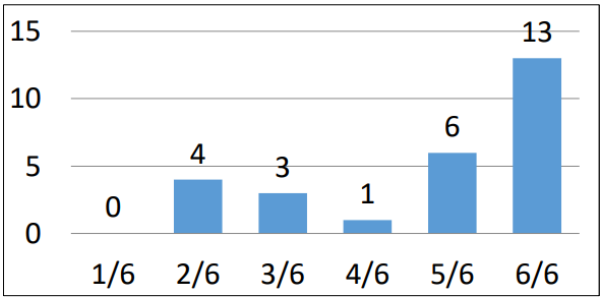

Figure 10: Occupancy Rate of the Intensive Care Unit

11. **Bacterial Flora :**

The most recent pathogens identified by blood cultures, catheter samples, or local specimens prior to death were primarily Klebsiella pneumoniae at 31%, followed by Acinetobacter baumannii at 15%, Staphylococcus aureus at 13%, and Enterococcus faecalis and Pseudomonas aeruginosa, each at 10%.

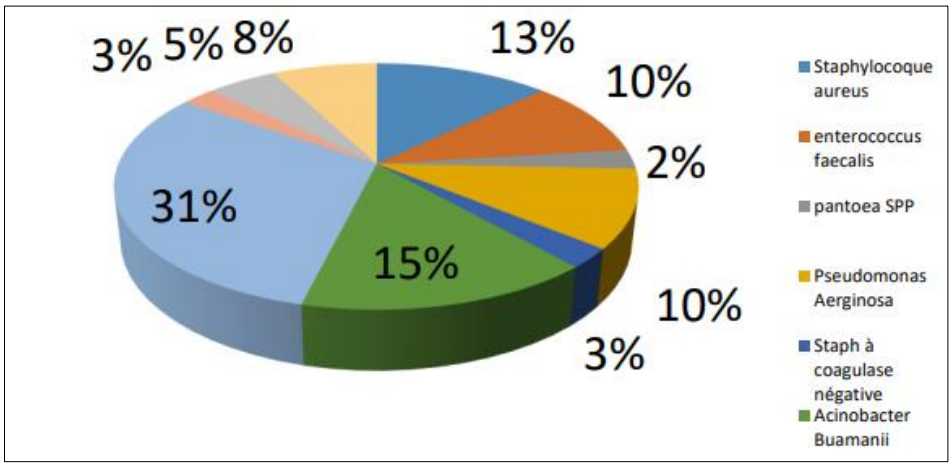

Figure 11: Bacterial Flora

12. **Nutritional Protocol for Our Patients:**

Caloric requirements are calculated using the most commonly used formulas according to recommendations, namely the Curreri formula for adults and the Schofield formula for children. The average caloric needs are 3600 Kcal/day for adults, while they are 4500 Kcal/day for children. These requirements are met through the administration of three hospital meal trays, each with a caloric value of 1200 Kcal, supplemented by Promax/Fortimel, which is rich in essential amino acids and micronutrients essential for healing and slowing down the hypercatabolism associated with burns.

4. DISCUSSION

Reorganization of Care

Staffing Issues:

The shortage of nursing staff poses a challenge in the management of patients admitted to the burn intensive care unit (ICU). We observed that when the number of hospitalized patients in the ICU is below three, the quality and effectiveness of care improve significantly. The staff can dedicate more time to each patient regarding the administration of general treatment (antibiotics, analgesics, etc.) and perform local care, such as dressing changes, more meticulously. The presence of two polyvalent nurses during the day and only one at night for six ICU beds seems insufficient for adequate patient care.

Possible Solutions to Address Staffing Shortages:

- Reassessment of Staffing Norms: Conduct a reassessment of staffing norms in the burn ICU, considering the complexity of care required. Propose an increase in nursing staff to ensure adequate and safe patient management.
- Staff Rotation: Develop a staff rotation plan to ensure an equitable distribution of the workload. This could involve flexible scheduling, replacement teams, or temporary reinforcements based on the number of admitted patients.
- Ongoing Training: Invest in ongoing training for staff to enhance their skills in burn ICU care. Well-trained teams can improve care efficiency, sometimes compensating for staffing shortages.
- Additional Recruitment: If resources permit, consider recruiting additional nursing staff to meet demand. This could be permanent or temporary based on activity fluctuations.
- Assistance Technologies: Explore the use of assistance technologies, such as patient management systems, to optimize processes and allow existing staff to work more efficiently.
- Communication and Collaboration: Strengthen communication and collaboration within the team. Smooth information exchanges can improve coordination and task distribution, even with limited personnel.
- Workload Analysis: Conduct a thorough analysis of the workload to identify specific areas needing attention. This can guide improvement efforts where they are most needed.
- Regular Assessment: Establish a mechanism for regular assessment of staffing situations to continually adjust resources according to current needs.

Goals of Implementation:

By implementing these solutions, the aim is to improve the quality of care in the burn ICU despite staffing constraints, while working towards a long-term solution to ensure optimal care standards.

Lack of Care Assistants:

The absence of care assistants affects the monitoring and administration of meals, hygiene, and toileting for burn patients. Consequently, we are often unable to track and monitor the nutrition of patients admitted to our ICU.

- Task Optimization: Review and optimize the distribution of tasks between nursing staff and care assistants. Identify the essential functions of care assistants and ensure they focus on high-value activities.
- Cross-Training: Offer cross-training for staff, enabling care assistants to handle specific tasks related to nutrition, hygiene, and toileting under nursing supervision.
- Simplified Protocols: Simplify feeding and care protocols to make procedures more efficient and less time-consuming. This could include streamlined feeding systems and more efficient hygiene methods.
- Assistance Technology: Explore the use of assistance technologies, such as specialized meal carts or automated monitoring systems, to facilitate certain tasks, reducing dependence on care staff.
- Additional Recruitment: If resources allow, consider recruiting additional care assistants to meet growing demand, particularly during peak periods.
- Inter-Team Collaboration: Encourage collaboration between nursing staff and care assistants to maximize efficiency. Regular briefings can help align teams on priorities and resolve emerging issues.
- Needs Assessment: Conduct a thorough assessment of staffing needs to determine critical moments when the lack of care assistants may have the most impact. This can help prioritize available resources.
- Patient and Family Education: Involve patients and their families in the care process as much as possible.
- Bathroom Facilities: The presence of only one bathroom for six beds is unreasonable in terms of hygiene and infection risk!
- Physical Layout: Consider reorganizing the space to create additional sanitary facilities. This may involve constructing extra bathrooms or modifying the layout to maximize access.
- Enhanced Cleaning Protocols: Implement stringent cleaning protocols for the existing bathroom. Ensure staff are trained to maintain high hygiene standards, especially in an environment where patient vulnerability is heightened.
- Priority Usage Policies: Develop usage priority policies for the bathroom based on medical and hygiene needs. This can help optimize the use of existing infrastructure.
- Mobile Facilities: Invest in mobile sanitary facilities that can be relocated as needed. This offers increased flexibility and can be particularly useful during peak activity.
- Planned Schedules: Establish planned schedules for bathroom usage, ensuring each patient has adequate access while maintaining hygiene standards.
- Communication and Awareness: Proactively communicate with staff, patients, and families about the importance of maintaining a clean and hygienic environment. Awareness can promote responsible use of facilities.
- Flow Study: Analyze patient and activity flows to identify peak usage times for the bathroom. This can guide facility adjustment decisions.
- Infrastructure Investments: If possible, consider long-term investments in infrastructure to create dedicated sanitary facilities for each ICU bed, reducing infection risk.
- Objective of Integration: By integrating these solutions, the goal is to ensure optimal sanitary conditions while minimizing infection risks in the burn ICU.

Dressing Materials:

The unavailability of petroleum jelly at the hospital hinders the preparation of vaseline-coated dressings. Consequently, dressings are sometimes performed using wet compresses while awaiting the unique supply of petroleum jelly and American-style dressings for all patients.

- Stock Management: Implement a more effective stock management system to ensure the constant availability of essential supplies like petroleum jelly. This could involve regular monitoring of stock levels, advance ordering, and close coordination with suppliers.
- Product Diversification: Explore the possibility of introducing alternatives to petroleum jelly that can be safely used in dressing preparation. Ensure these alternatives comply with medical standards and meet the specific needs of burn patients.
- Staff Training: Train staff on alternative dressing methods in the absence of petroleum jelly. Ensure they are aware of approved substitution protocols and best practices to ensure patient safety.
- Rapid Restocking: Establish protocols for rapid restocking in case of shortages. This may include expedited approval procedures for orders or agreements with local suppliers to ensure a consistent supply.
- Supplier Communication: Maintain regular communication with medical supply vendors to anticipate availability issues and develop contingency plans. Proactive collaboration can help avoid service interruptions.

- More Efficient Use: Encourage more efficient product use, including providing adequate quantities for each patient and avoiding unnecessary waste.
- Needs Assessment: Conduct periodic assessments of dressing material needs to adjust orders based on activity levels and specific patient requirements.
- Staff Hygiene Awareness: Raise staff awareness of hygiene best practices, especially when using shared materials. Encourage adherence to aseptic protocols to minimize the risk of cross-infection.
- Isolated Patients: Some patients without resources or family find themselves alone without companions, which diminishes the quality of their care. Companions facilitate patient management by monitoring and administering meals, maintaining hygiene, and providing psychological support.
- Social Assistance: Establish a social assistance program to identify patients without resources and family. Engage social workers to assess their needs and coordinate solutions, such as locating distant relatives or mobilizing community resources.
- Volunteer Collaboration: Collaborate with local volunteer organizations to provide support for isolated patients. Volunteers can help monitor and administer meals, as well as offer psychological support, thereby enhancing care quality. Companion Programs: Develop specific companion programs for disadvantaged patients. This could involve assigning volunteers or dedicated medical staff to these patients to ensure they receive special attention.
- Family Education: Implement educational initiatives to raise family awareness of the importance of accompanying patients. Explain the benefits of having a companion in terms of monitoring, meal administration, and psychological support.
- Psychological Support Programs: Establish internal or external psychological support programs for disadvantaged patients. This may include counseling sessions, support groups, or partnerships with mental health professionals.
- Coordination with Charities: Coordinate with local charities that may provide support to disadvantaged patients, whether financially, through companionship, or social services.
- Community Communication: Conduct awareness campaigns in the community to encourage neighbors, friends, or acquaintances to offer support to disadvantaged patients as volunteer companions.
- Individual Needs Assessment: Conduct thorough assessments of the specific needs of each disadvantaged patient to tailor solutions to their particular circumstances.

Mortality Rate:

Our mortality rate is 9%, with a prognostic element: the Lethal Area 50 (LA50) index evaluated at 47% in our study, compared to 36.5% in Brazil in Edvaldo Vieira de Campos study [1], and 55.5% at SHAHID MOTAHARI hospital in Iran[2]. The lower mortality figure in our study may be explained by the hospitalization of severe burn patients, whose prognosis is poor (SCB > 50%) in a surgical ICU rather than in a burn ICU that lacks full-time intensivists.

- Admission Criteria Assessment: Review the admission criteria for the burn ICU to ensure patients are directed to the appropriate unit based on the severity of their burns and their specific needs for intensive care.
- Strengthening Specialized Teams: Consider strengthening specialized medical teams in burn ICU care. Hire more full-time intensivists to ensure constant monitoring and intervention, especially for patients with poor prognoses.
- Ongoing Training: Invest in ongoing training for medical staff to improve the management of burn patients in intensive care. Ensure that staff is up-to-date with the latest advances

5. Reorganization of Care

Referring to the experience of three burn centers in Flores, Canada[3,4], France[5], and Belgium[6], this study offers a vision for a new organization of care for burn patients, which includes:

- The existence of classic peripheral hospitals that take care of burn patients, primarily treating superficial burns (1st and 2nd degree) and capable, thanks to their medical and paramedical staff trained in burn care, of assessing patients in emergencies and performing triage.
  - If the affected skin area is less than 10% of the total surface area, superficial without signs of severity, in a young adult, they will be admitted and treated in the same facility, then followed up in the nearest health center to their home.
  - If the patient has less than 10% affected with signs of severity or associated trauma, they will be hospitalized in the same facility.
- Transfer for management in a Burn Treatment Center if:
  - The burn surface area is greater than 20% of the total skin surface.
  - The burn is a deep 2nd degree or 3rd degree burn.
  - The burn is deep and affects the face or hands, or other specific locations.
  - The burn has not healed spontaneously after 2 weeks.
  - Or if surgical intervention is necessary.

The transfer of patients from one facility to another must go through a national computerized system that consolidates all medical data of the patient: their medical history, admission status, care and procedures performed in the first admission facility, accompanied by photographs. This software will allow for recorded communication between the different doctors taking care of the same patients: CHP, CHU, dispensaries, providing an idea of bed availability, receiving transfer approval after reviewing the file, and the treating surgeon can provide all types of information regarding the care received during their admission to burn centers, thus facilitating the follow-up of the patient after discharge through current updates in the software by the dispensary doctor. Ultimately, this will enable us to easily retrieve patients before complications arise.

6. What Should an Ideal Burn Center Look Like?

A burn center should be better equipped than a standard hospital. These centers provide all critical care, acute care, and some physical and psychological rehabilitation services (through the resident presence of a resuscitator, physiotherapist, psychologist, etc.).

- The burn patients' rooms should resemble a true operating room (with ventilators, monitoring equipment, medications, etc.) where resuscitators, anesthetists, and surgeons intervene; whether it is a dressing change performed under comfortable and aseptic conditions, excision of burned skin, or grafts.
- The lighting in the room should be pleasant, sometimes distinct from the more powerful treatment lighting, with dim lighting allowing for nighttime patient monitoring without waking them.
- The room is preceded by an ante-room allowing for handwashing by the care teams, disposal of waste from the room (sink, waste disposal), and control of thermal conditions.
- Entry into the room should only be for direct contact with the patient.
- When the patient is at risk of airborne infection, the room is placed under positive pressure (+15 Pa) compared to the ante-room, which itself is under positive pressure relative to the circulation (principle of progressive asepsis) to allow for protective isolation.
- When the patient carries infectious germs, then, following the same pressure gradient principle, the room is placed under negative pressure to allow for septic isolation.
- Depending on the risk class of the room (often class 4), air filtration is recommended using a high-efficiency terminal filter. The air renewal rate should be approximately 20 times the room volume.
- The disinfection and easy cleaning of the premises: Surfaces (flooring, walls, ceilings, work surfaces) should be smooth and non-porous. Their ease of maintenance is paramount. The floors, for example, are raised in a skirting board fashion, 10 cm high with a rounded edge.
- For optimal patient comfort: The room temperature should be adjustable between 19 and 37°C.
- The rooms can also be converted into bathrooms to ensure daily care, or into resuscitation rooms for maintaining vital functions and continuous monitoring of the injured.
- Dressing changes: The daily dressing changes, whether under general anesthesia or sedation, may involve 4 to 5 people around the bed, in a tropical atmosphere, and thus require sufficient non-shareable staff and equipment between rooms to reduce the risk of infection.

Discharge will then occur either to a rehabilitation center or home, with follow-up in outpatient or external care until complete healing, tracked by computer software.

7. CONCLUSION

In conclusion, a thorough analysis of the various aspects of our burn intensive care unit highlights several critical challenges, as well as opportunities for significant improvement.

Findings such as staff shortages, availability of dressing materials, lack of companions for certain patients, and the choice of admission to surgical intensive care rather than burn intensive care emphasize the need for strategic revision and the implementation of structural changes.

To address these issues, it is imperative to invest in holistic solutions, ranging from optimizing human and material resources to establishing standardized care protocols. Involving social workers, volunteers, and enhancing the continuous training of medical staff appear to be crucial levers for improving the quality of care.

Comparative evaluation with other international studies also underscores the necessity of drawing inspiration from global best practices to adjust our protocols accordingly.

Interdisciplinary collaboration, ongoing training, and regular protocol reviews should become essential components of our approach to burn patient care.

By implementing these recommendations, we aspire to transform our burn intensive care unit into a model of excellence, ensuring optimal, safe, and respectful care that meets the individual needs of each patient. This report serves as a foundation for a

continuous process of improvement and adaptation, placing the safety and well-being of patients at the core of our concerns.

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