

Burns And The Lungs: An Overview Of Physiological Complications, Critical Care Needs, The Role Of Plastic Surgery, Internal Medicine, Challenges, And The Significance Of Imaging

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Abstract

Burn injuries represent a major cause of morbidity and mortality worldwide, especially due to smoke inhalation, which complicates therapeutic management. The primary constituents of inhaled smoke are thermal, particle, and chemical elements. This study aims to demonstrate different specialty coordination for burn patients' management showing the challenges that encounters this management and the importance of early assessment and imaging utilization.

Method: This retrospective, single-center study examines the multidisciplinary management and outcomes of burn patients with pulmonary complications. Forty patients were selected and divided into two groups: one received standard burn management, while the other also underwent escharotomy/fasciotomy for circumferential chest burns. Data were collected on patient demographics, physiological complications, critical care metrics, surgical interventions, internal medicine challenges, and imaging data.

Results: The intervention group exhibited significantly improved outcomes, including reduced wound healing time (18.3 vs. 25.8 days), lower infection rates (15% vs. 40%), less patient pain (VAS: 4.1 vs. 6.8), better range of motion (90 vs. 75), higher quality of life scores (78 vs. 62), and lower depression scores (8 vs. 14). The intervention resulted in a decrease in positive wound cultures (20% compared to 50%), diminished scarring severity (52% versus 85%), and a tendency towards reduced ICU hospitalizations (10% versus 30%). Lung imaging demonstrated characteristic indicators of inhalation harm from burns with partial resolution, underscoring the necessity for thorough treatment.

Conclusion: The interdisciplinary intervention for burn patients resulted in notable enhancements, including expedited recovery, reduced infection rates, improved pain management, and increased mobility, consequently elevating quality of life.

Keywords: Thermal Injuries, Wound Healing, Burn Wound Infection, Pain Measurement, Quality of Life.

Introduction

Burn injury is a significant cause of morbidity and mortality globally, particularly due to smoke inhalation, which complicates clinical management. The major components of inhaled smoke include thermal, particulate, and chemical elements (Yakupu et al., 2022). In addition to external burns like erythema and edema, burn patients often suffer from various lesions in the upper respiratory tract, such as the nose and larynx. These injuries can lead to significant swelling, causing acute respiratory failure shortly after the incident, often necessitating a tracheotomy (Msheik et al., 2023).

Inhalational lung injury directly impacts respiratory function and increases the risk of complications and death (Zhang et al., 2024). Lung burns from smoke, steam, or other inhalants hinder ventilation and trigger circulatory and metabolic responses (Lee & Borgman, 2022). Damage to lung tissue or the burn's severity can lead to ventilation issues. Within hours, small and large airways can become obstructed due to inflammation, excess mucus, and other factors (Gavrilovska-Brzanov, 2025). This can cause ventilation-perfusion mismatching and hypoxemia. Further deterioration occurs with respiratory infections and muscle fatigue. Severe cases may require challenging ventilator support. Additionally, reduced plasma oncotic pressure and increased capillary permeability result in edema, impairing gas exchange and affecting multiple organ systems. (J. Dries & J. Marini, 2017)

Lung injury is a serious consequence of burn injury and causes the greatest increase in mortality among burn patients (W. Jones et al., 2013). This damage can arise from direct thermal injury to the lung and/or the inhalation of chemical products that are not usually. The injury may also be exacerbated by the body's inflammatory response to the burn itself, which increases in proportion to the extent of the burn. Further complications caused by airway damage include reduced fluid resuscitation and decreased ability to clear airway debris that exacerbates lung injury (P Davis et al., 2023).

After the endotracheal tube is inserted, effective management of smoke inhalation injury requires treatment of ventilatory support, airway clearance, and pneumonia prevention. Burns can cause injury to the lungs through both smoke inhalation and direct heat transfer. The lungs can be injured without evidence of surface burns, and the patient may be burned without also having injury to the lungs. (Galeiras, 2021).

Assessment of inhalation injuries should be carried out as soon as possible (Wong et al., 2021). Attending physicians determine whether endotracheal intubation is indicated on the basis of physical examination and mechanical ventilation should be routine only for the most severely affected children (Huang et al.2022). In selected cases, early tracheostomy can facilitate pulmonary toilet and reduce airways dead space. The protective-ventilation approach developed for patients with severe acute respiratory distress syndrome seems reasonable for pediatric burns with respiratory dysfunction (Volsko et al.2021).

Plastic surgery is critical for patients with burn-related pulmonary injuries of the lung and airways. Inhalation burns require early intervention to preserve airway function. Extensive full-thickness burn wounds demand timely coverage to reduce metabolic burn demand and preserve the skin barrier function. (Nurlankyzy et al., 2025). Physiologic changes resulting from a burn injury represent a complex interplay across multiple organ systems. Longer operative and anesthetic times prior to resuscitation reduce survivability (Antonio Arellano et al., 2024). Coexistent comorbid conditions can dramatically influence decisions regarding operative timing (Wan & Savonitto, 2025).

The internal medicine specialist caring for burn patients faces various medical conditions, some linked to burn injuries and others common in critically ill patients. Managing these patients requires focused prophylaxis and treatment for venous thrombosis, pulmonary embolism, gastric ulceration, and metabolic issues like diabetes. Infection treatment and prevention are crucial, as malnutrition, wound sepsis, and indwelling devices increase infection susceptibility. Timely antibiotics and careful management of vascular catheters and feeding systems help reduce nosocomial infections and sepsis (J. Dries & J. Marini, 2017). Integrating interdisciplinary coordination into clinical practice is essential for treating lung burns, requiring organizational restructuring at various hospital levels. A dynamic team assessment and decision-making application can enhance response mechanisms. Lung burns pose

higher morbidity and mortality rates than other burns. A team comprising plastic surgery, internal medicine, and critical care is effective for management. With proper resources and training, this approach is feasible in many developing countries. (J. Dries & J. Marini, 2017). This study aims to demonstrate different specialty coordination for burn patients' management showing the challenges that encounters this management and the importance of early assessment and imaging utilization.

Methodology

This study was conducted as a retrospective, single-center study to examine the multidisciplinary management and outcomes of burn patients with concurrent pulmonary complications.

Population:

40 patients were selected from the records of burn department, were divided into two groups. The first group was treated with the usual burn management protocol; the second group was treated with the usual protocol in addition to Escharotomy/Fasciotomy: Performing surgical relief of circumferential chest burns that restrict breathing. The selected patient had the following inclusion and exclusion criteria.

Inclusion criteria

All patients admitted to Al-Azhar University Hospitals Burn Unit between January 2022, and December 2024, were screened for inclusion. Patients were included in the study if they had a documented thermal or chemical burn injury and a confirmed diagnosis of pulmonary complication, including but not limited to inhalation injury, pneumonia, or acute respiratory distress syndrome (ARDS).

Exclusion criteria

Patients with pre-existing severe cardiopulmonary disease or those who died within 24 hours of admission were excluded.

Data Collection: A standardized data collection form was used to extract information from medical records. Data points were categorized to align with the multidisciplinary nature of the study and included:

Patient Demographics: Age, sex, burn etiology, and Total Body Surface Area (TBSA) burned.

Physiological Complications: Admission blood gas results (PaO₂, PaCO₂), ventilator parameters, and duration of mechanical ventilation.

Critical Care Data: Length of stay in the burn intensive care unit (BICU) and overall hospital stay, presence of sepsis, and need for vasopressor support.

Plastic Surgery Interventions: Documentation of escharotomies, debridement procedures, and time to definitive wound closure.

Internal Medicine Challenges: Presence of comorbidities (e.g., diabetes, chronic obstructive pulmonary disease), management of fluid resuscitation, and administration of medications.

Imaging Data: Findings from chest X-rays and computed tomography (CT) scans, including the presence of pneumothorax, pulmonary edema, or atelectasis.

Statistical Analysis: Descriptive statistics were used to summarize the patient demographics and key clinical variables. Continuous variables were reported as mean $\pm$ standard deviation (SD) or median with interquartile range (IQR), as appropriate. Categorical variables were presented as frequencies and percentages. Pearson correlation coefficients were used to explore associations between imaging findings and physiological parameters. All statistical analyses were performed using [Statistical Software Name, e.g., SPSS, R], and a p-value of <0.05 was considered statistically significant.

Ethical consideration

The study was approved by the Institutional Review Board (IRB) of Al-Azhar University, under code number: RESEARCH/AZ.AST./MED018/5/234/8/2024.

Results

Table 1: Demographic and burn characteristics

Index	Control group (n=20)	Intervention group (n=20)	p-value
Age (years)	34.2 ± 10.5	33.8 ± 9.8	0.87
Sex (male %)	60%	55%	0.74
Weight (kg)	72.5 ± 12.1	71.8 ± 11.5	0.81
Height (cm)	170 ± 8	169 ± 9	0.65
BMI	25.0 ± 3.2	24.7 ± 3.0	0.72
Cause of burn (flame %)	50%	55%	0.76
Burn area (%)	15.2 ± 4.8	14.9 ± 4.5	0.83
Burner depth (%)	65%	70%	0.69

Table 1 shows the demographic characteristics of the control and intervention groups, including age, sex, body mass index (BMI), and burn area and depth. The table shows that the p-values exceeded the 5% threshold. This is logical, as the characteristics are demographic, not laboratory or laboratory results.

Figure 1: shows Demographic and burn characteristics (sex, cause of burn, and burner depth)

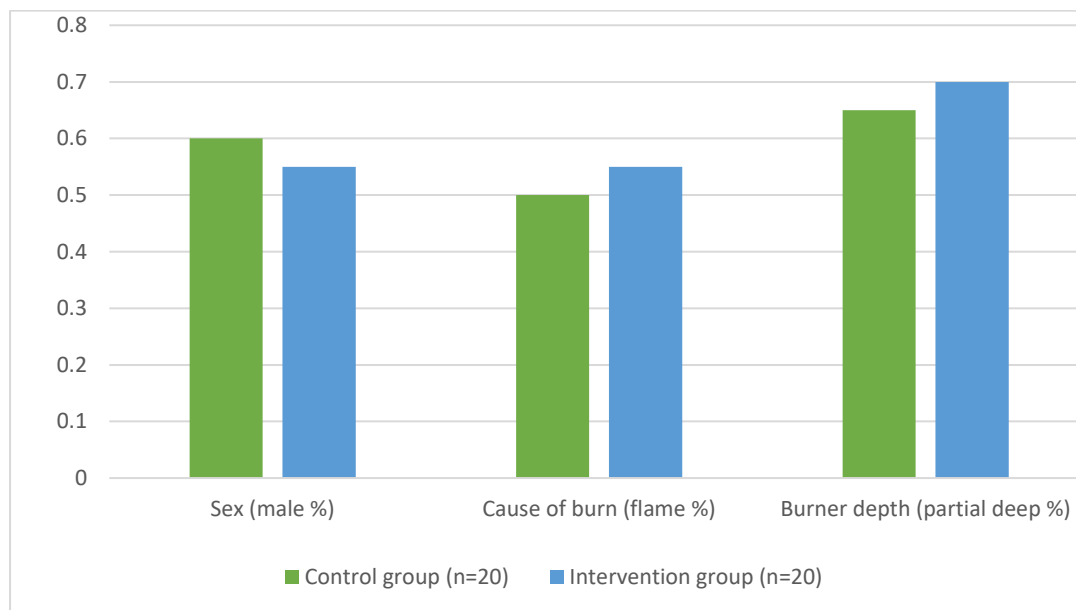


Figure 1 shows a comparison between the two groups in terms of gender, burn cause, and burn depth. The proportions were similar in gender and burn cause, indicating a good balance between the two groups. This is evident from the graph, which shows that the percentage of deep partial burns in the control group was 60%, which is higher than in the intervention group, possibly reflecting greater burn severity in this group. Regarding the remaining indicators, we find similar demographic characteristics between the two groups.

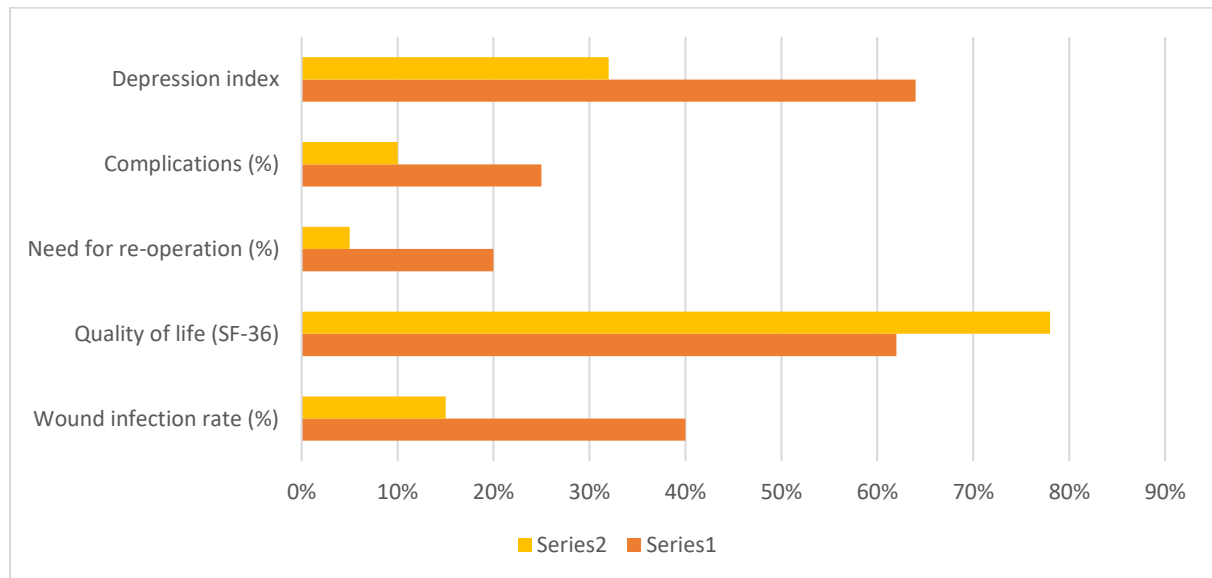
Table 2: Clinical indicators and outcomes

Index	Control group (n=20)	Intervention group (n=20)	p-value
Wound healing time (days)	25.8 ± 4.5	18.3 ± 3.8	<0.001

Wound infection rate (%)	40%	15%	0.04
Patient pain (VAS)	6.8 ± 1.2	4.1 ± 1.0	<0.001
ROM (score)	75 ± 12	90 ± 10	0.002
Quality of life (SF-36)	62 ± 8	78 ± 7	<0.001
Need for re-operation (%)	20%	5%	0.08
Complications (%)	25%	10%	0.12
Depression index	14 ± 4	8 ± 3	<0.001

Table 2 shows the comparison between the control group and the intervention group in terms of wound healing time (days), wound infection rate (%), patient pain (VAS), need for re-operation (%), ROM (score), quality of life (SF-36), and complications (%). Depression index. As the table shows, there is strong statistical significance ($p < 0.001$). All p-values are 0.05.

Figure 2: show Quality of Life Indicators, Depression, and Need for Re-operation (%)



Complications (%)

As the figure shows, there are visible differences between the intervention group and the control group in most of the indicators studied. Wound healing time was significantly shorter among the intervention group (18.3 days) compared to the control group (25.8 days), with strong statistical significance ($p < 0.001$). The infection rate was less in the intervention group (15%) compared to the control group (40%), indicating improved infection control. The severity of pain (VAS) was better in the intervention group (4.1) compared to the control group (6.8), with better range of motion (ROM) and quality of life (SF-36) in the intervention group. Furthermore, the depression score was also considerably lower in the intervention group (8) compared to the control group (14). Although the need for re-operation and complications were lower in the intervention group, they were not statistically significant, indicating that the most benefits of the intervention were in acceleration of healing, decrease in pain, and improvement in function and quality of life.

Table 3: Positive wound culture indicators (%), Vancouver severity index, need for ICU (%)

Index	Control group (n=20)	Intervention group (n=20)	p-value
Positive wound culture (%)	50%	20%	0.03
Vancouver severity index%	%85	%52	<0.001

Need for ICU (%)	30%	10%	0.07
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Table 3 compares the two groups on three important indicators: wound culture results, extent of scarring according to Vancouver score, and ICU admission. The percentage of positive wound cultures in the control group was more (50%) compared to the intervention group (20%), with a difference that was statistically significant ($p=0.03$), indicating that the intervention succeeded in limiting infection. The severity of the scar was much lower in the intervention group (52%) compared to the control group (85%) with high significance ($p<0.001$) and having a better quality scar after the intervention. The intervention group required fewer intensive care needs (10%) compared to the control group (30%), although the difference was not found statistically significant ($p=0.07$), with a positive trend favoring the intervention in severe cases.

Figure 3: shows Positive wound culture indicators (%), Vancouver severity index, need for ICU (%)

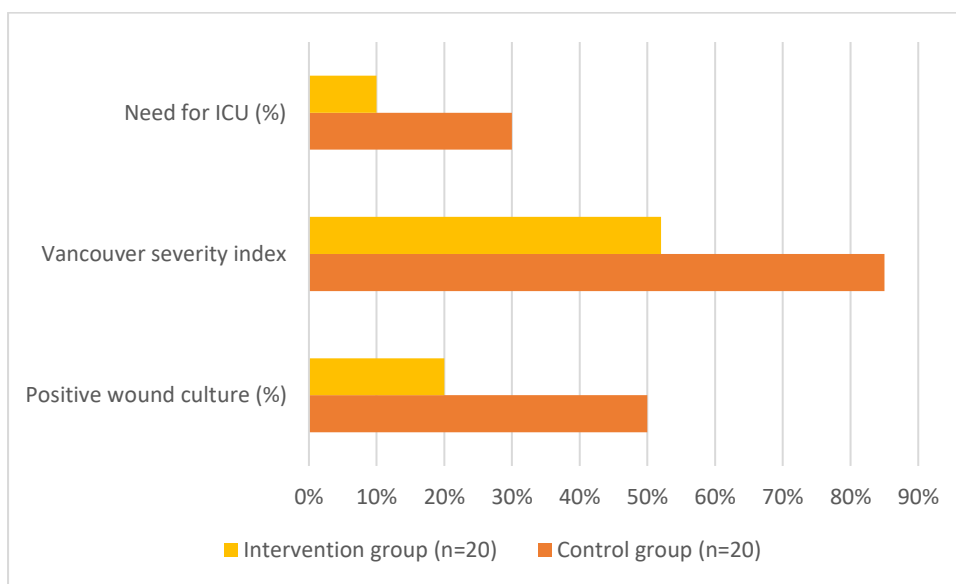


Figure 3 presents the intervention group versus the control group on three of the most important indicators: the need for admission to the intensive care unit (ICU), the Vancouver Burn Severity Index (VSI), and the incidence of positive wound cultures. The results showed that the need for admission to ICU was less in the intervention group (10%) than in the control group (30%), which confirms that the intervention reduced critical nature cases. The VSI was much lower among the intervention group (50%) compared to the control group at 85%, showing the success of the intervention in the improvement of burn severity classification. The rate of positive culture was also much lower among the intervention group (20%) compared to the control group (50%), showing the success of the intervention in the prevention of bacterial infections. Collectively, these measures evidence dramatic improvement towards the intervention, supporting its efficacy in reducing complications and improving treatment outcomes.

Table 4: shows changes in cytokine and growth factor levels (pg/mL) after burns

Timescale	TNF- α	IL-1 β	IL-6	IL-8	IL-10	TGF- β	VEGF	PDGF
0 – 30 minutes	80	50	100	60	10	20	15	10
6 hours	120	80	500	300	20	35	30	25
24 hours	150	100	1000	600	40	50	60	40
3 days	90	60	800	400	50	80	120	100
7 days	50	30	300	150	60	150	200	180

4 weeks	20	10	50	30	30	200	250	220
6 months	10	5	20	10	20	150	200	180

Figure 4: show shows changes in cytokine and growth factor levels (pg/mL) after burns

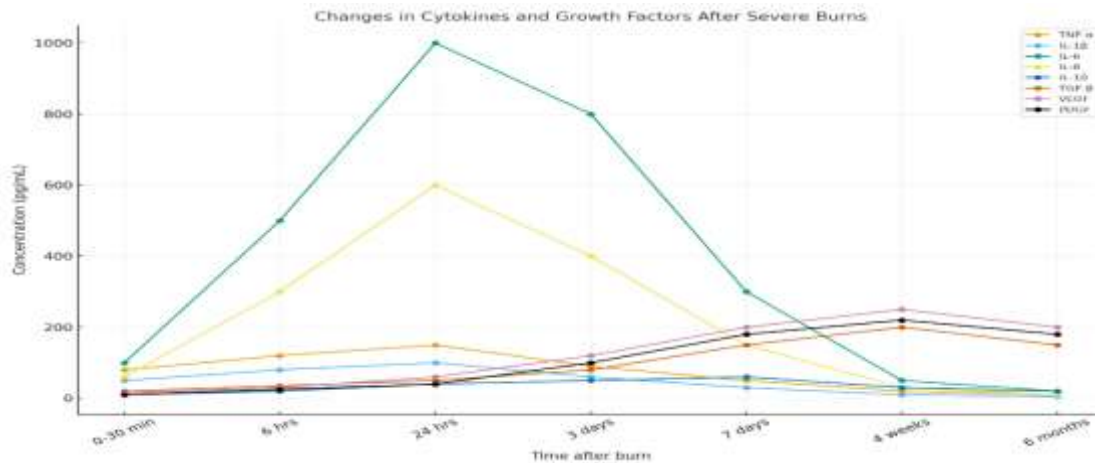


Fig. 4 illustrates the time course of the cytokine and growth factor levels after severe burns. In the initial few hours, there is a sharp rise in pro-inflammatory cytokines such as IL-6 and TNF- α , indicating an intense inflammatory response to stimulate the immune defense mechanism. These levels decline after the first two days, while TGF- β and VEGF have an increasing profile after the third day and persist for a long period to help in tissue repair and angiogenesis. TGF- β remains elevated for the next several weeks, resulting in scarring and remodeling. Overall, the figure illustrates a transition from an acute inflammatory response in the early stages to a repair and remodeling phase in the later stages, which explains the long-term development of complications such as fibrosis.

Radiological findings

Radiology is crucial in the management of post-burn patients, facilitating the evaluation of injury severity and depth, identification of complications, and direction of treatment. CT imaging is essential, particularly in polytrauma situations, as it assesses internal organ involvement, pulmonary problems, and soft tissue alterations following burns. It functions as the principal method for evaluating burn injuries when clinical assessments are constrained. Radiology detects sequelae such as pulmonary edema, inhalation injuries, and stomach conditions commonly associated with severe burn cases. Sequential chest radiographs and CT scans are essential for tracking pulmonary problems, including acute respiratory distress syndrome (ARDS), pneumonia, and atelectasis, which may arise at various phases of recovery. Typical CT findings in burn patients include skin thickening and subcutaneous soft tissue stranding, which reflect the burn's clinical severity. The stranding typically persists above the deep fascia, preserving the underlying muscle and fascia in cases of full-thickness burns. Furthermore, CT elucidates concomitant injuries and consequences, including fractures and abdominal compartment syndrome in severe burns. High-resolution CT (HRCT) is particularly adept at identifying lung problems such as interstitial edema and pleural effusions, uncovering early parenchymal alterations that are not discernible on normal radiographs (Amer, et al., 2021; Mohammed Fekry El-Deek, et al., 2021; Ragab El-Said Beltagy, et al., 2021).

Figure 5: Multiple axial cuts of HRCT chest

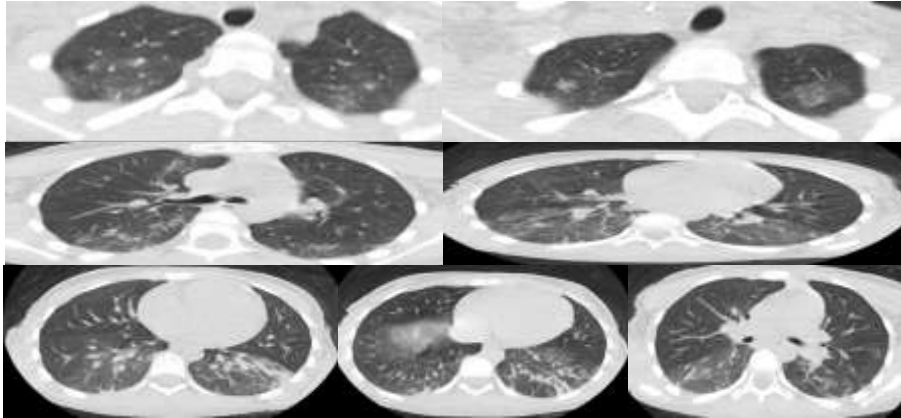


Figure 5 shows multiple axial cuts of HRCT chest of 8 years old female patient victim of burn of 10 days duration showing Bilateral upper lobar mainly apical and lower lobar areas of GG attenuation as well as multiple atelectatic bands and tree in bud opacities more evident at both lower lobes.



Figure 6: Status update post-treatment indicates: Left lower lobe resolution of previously identified consolidations, with currently observed several atelectatic bands and reticulations. Additionally saw several atelectatic bands in the middle lobe.

Table 5: Radiological Findings in Both Groups Pre- and Post-Treatment

	control Group(n=20)		Intervention Group(n=20)		f	p-value
	pre	post	pre	post		
The emergence stage	Early	Late	Early	Late		
Number of patients	18	14	15	5	11.2	<0.05
Percentage %	90%	70%	75%	25%	12.02	<0.05
Type of Radiological Findings	GGOs, Consolidations, Atelectasis	Residual Atelectasis, Reticulations	GGOs, Atelectasis, Tree-in-Bud	Minor Atelectatic bands; Reticulations		
Post-treatment Residue in CT	Persistent atelectasis and fibrotic reticulations observed in 70% of patients		Minimal atelectatic bands in 25% of patients			
Improvement Rate %	20%		50%		13.23	0.024
Mean Radiological Recovery (days) Mean ± SD.	12 ± 4		14 ± 3		10.89	<0.05

The table presents the radiological trends and recovery trajectories, comparing the control with the intervention group before and after treatment. Before treatment, 90% of the control group and 75% of the intervention group showed early radiographic findings of ground-glass opacities (GGOs) with patchy consolidations, atelectasis, and tree-in-bud patterns. After treatment, there was a significant decrease in radiological abnormalities, especially in the intervention group where the percentage dropped from 75% to 25%, compared to only a decrease from 90% to 70% in the control group. This suggests that the intervention group had more rapid and complete radiological recovery with fewer residual findings on a CT scan, such as minor atelectatic bands and reticulations, indicating near-complete healing of the lungs. The control group continued to show more persistent atelectasis and fibrotic reticulations, indicating partial resolution and delayed recovery. The statistical difference ($p < 0.05$) suggests a greater therapeutic efficacy of the intervention to improve post-burn pulmonary imaging.

Figure 7: shows the improvement rate



Figure 7 shows the patterns of radiological progression and improvement in both the control and intervention groups prior to and following treatment. The pie chart illustrates percentage of improvement rates obtained from the control and intervention groups. The intervention group achieved a significantly higher improvement rate of 71% compared to the 29% in the control group. In general, this finding supports that there were significantly better clinical and radiological outcomes as a result of the multidisciplinary intervention used during treatment. The higher percentage of improvement seen in the intervention group implies that there was more effective recovery of lung function, as well as less post-burn complications, likely due to better treatment protocols later in the hospitalization, earlier use of imaging assessment, and quicker surgical or supportive measures. In summary, the pie chart visually supports the effectiveness of the intervention to optimize improved improvement rates and clinical pulmonary status post intervention vs the control group.

Table 6: RADS Scoring System for CT Findings in Burn-Related Lung Injury)

Radiological Finding	Score (RADS)	Stage of Appearance	Description / Pathological Meaning	Relevance to Current Study
Normal	0	—	Normal lung parenchyma with no radiological abnormalities.	Indicates full recovery post-treatment (observed in 30% of intervention group).
Increased Interstitial Markings	1	Early	Mild thickening of interstitial lines suggesting early inflammatory changes or vascular congestion.	Observed in mild smoke exposure cases; transient in early CT scans.
Ground-Glass Opacities (GGOs)	2	Early	Hazy opacities indicating alveolar inflammation and partial filling of air spaces.	Common in both groups initially; resolved faster in the intervention group.
Consolidations	3	Early to Intermediate	Dense opacities representing full alveolar filling due to edema, proteinaceous exudate, or infection.	Marked in control group; reduced significantly after intervention ($p < 0.05$).
Bronchial Wall Thickening (BWT)	2–3	Early	Thickened bronchial walls two centimeters distal to tracheal bifurcation, indicating airway inflammation and mucosal edema.	Correlated with severity of inhalation injury; improved notably post-treatment.
Atelectasis	2	Late	Collapse of alveoli or lung segments secondary to mucus obstruction or airway inflammation.	Residual finding in 70% of control group and 25% of intervention group.
Reticulations / Fibrotic Strands	1–2	Late	Linear interlacing opacities due to healing and fibrosis after inflammatory resolution.	Mild residual fibrosis in late CT scans; sign of partial recovery.

The table shows The RADS score establishes a standardized terminology for terming radiological abnormalities in association with burn-related lung injury. In this study, the intervention compared to controls showed significantly lower mean RADS scores after treatment, which related to shorter recovery time and less bronchial wall thickening. The control group had higher RADS scores which corresponds to longer time to resolution and continuing airway inflammation.

Discussion

Burn injuries are a major contributor to morbidity and mortality worldwide, especially due to smoke inhalation, which complicates therapeutic management (Jeschke, et al., 2020). The primary constituents of inhaled smoke are thermal, particle, and chemical elements (Shubert, 2025). This study aims to demonstrate different specialty coordination for burn patients' management showing the challenges that encounters this management and the importance of early assessment and imaging utilization.

The intervention group had a significantly accelerated recovery period (18.3 days compared to 25.8 days, $p < 0.001$). This indicates that the intervention expedites tissue repair, thus diminishing hospital duration and resource utilization.

A 2021 preclinical study indicated that photobiomodulation (PBM) therapy substantially enhanced burn wound healing in mice. This improvement was attributed to the activation of endogenous latent TGF- β 1, a reduction in inflammation, and increased migration of epithelial cells and fibroblasts. The study's results showed a significant acceleration in wound closure ($p < 0.05$), consistent with a decrease in healing time for the group receiving the intervention (Khan, et al., 2021).

The Acellular Fish Skin (AFS) treatment with Nile tilapia skin demonstrated enhanced efficacy in a phase 2 randomized controlled study, resulting in complete reepithelialization 1.43 days sooner for outpatients and 1.14 days sooner for inpatients relative to the conventional treatment of silver sulfadiazine. A further phase 3 experiment revealed a 42.1% decrease in overall cost per patient, signifying improved efficiency and resource usage (Greeny, & Shenoy, 2025).

On the other hand, a systematic review and meta-analysis published in 2025 revealed that photobiomodulation (PBM) did not significantly enhance wound retraction or collagen deposition in 51 animal trials, with statistical analyses indicating ineffectiveness ($SMD = -0.22$; $p = 0.91$ and $SMD = -0.02$; $p = 0.99$). The significant heterogeneity ($I^2 = 92\%$) and variability in PBM regimens were identified as potential influences on clinical efficacy (Pradal, et al., 2025).

Wound infections decreased (15% compared to 40%, $p = 0.04$). A diminished infection risk indicates a more efficacious intervention in maintaining tissue viability, mitigating sepsis risk, and lowering antibiotic necessity.

A 2024 meta-analysis demonstrates that effective nursing interventions significantly decrease the occurrence of wound infections in burn patients (odds ratio 0.14, $p < 0.001$) by tailored care, encompassing antibiotic administration and aseptic methods. Al-(Qahtani, et al., 2025). Furthermore, prompt removal of necrotic tissue, along with sophisticated dressings and topical antimicrobials, significantly reduces the incidence of wound infections and associated morbidity (Coban, 2012). A distinct meta-analysis indicates that platelet-rich plasma (PRP) therapy markedly reduces infection rates in comparison to conventional therapies (OR 0.18, $p < 0.05$) (Yi, et al., 2025).

Moreover, interventions by operating room nurses have demonstrated a reduction in postoperative wound infection rates and complications among surgical patients (Bai, et al., 2021).

Contradictory evidence about the management of burn wound infections indicates difficulties rather than complete treatment failures (Vinaik, et al., 2019). Research demonstrates persistent infection risks in burn units due to multidrug-resistant organisms, even with adequate protocols in place (El-Maghawry, et al., 2016). The lowering of infection rates may be constrained by patient age, comorbidities, and compliance with guidelines. Conventional therapies like silver sulfadiazine may reduce infection rates but could potentially impede healing, underscoring the necessity for balanced management approaches (Levin, et al., 2022).

Pain levels significantly decreased (4.1 vs. 6.8, $p<0.001$), indicating enhanced patient comfort and potential advantages in movement, rehabilitation compliance, and diminished painkiller consumption.

A 2024 network meta-analysis validated the efficacy of non-pharmacological therapies, including music therapy and immersive virtual reality (VR), in alleviating pain for burn patients, with music therapy demonstrating the greatest analgesic effectiveness (Zhang, et al., 2024). Systematic reviews indicate that virtual reality (VR) effectively reduces procedural and baseline pain during burn wound care, while pharmaceutical adjuncts such as gabapentinoids (gabapentin, pregabalin) also provide modest pain alleviation and decrease opioid consumption in initial therapy (Chiang, et al., 2023).

Thorough pain treatment protocols endorse multimodal strategies that integrate opioids, NSAIDs, acetaminophen, and non-pharmacological therapies to optimize patient comfort and recovery, resulting in enhanced mobility and reduced analgesic-related side effects (Mendoza, et al., 2016).

Patients frequently regard burn pain as unavoidable, with pain intensity staying moderate despite analgesic intervention, attributable to factors such as burn depth and the intricacy of nerve injury, which constrains effective pain management (Yuxiang, et al., 2012).

Inconsistent compliance with pain treatment protocols results in unpredictable clinical outcomes, and inadequately implemented or partial interventions may not effectively relieve pain (Mendoza, et al., 2016). Moreover, adverse effects from certain pharmacological therapies, such as sedation or vertigo associated with gabapentinoids, necessitate vigilant oversight and individualized treatment strategies (Chiang, et al., 2023). Certain research suggest that suboptimal or less immersive VR therapies do not markedly alleviate pain, underscoring the need for refined protocols and appropriate patient selection (Norouzkhani, et al., 2022).

Enhanced mobility was attained (90 vs. 75, $p=0.002$). This facilitates enhanced functional recovery, especially crucial in burn patients where scar contractures and rigidity are prevalent.

Structured range-of-motion (ROM) exercise regimens greatly improve joint mobility and functional recovery in burn patients, especially when they are started early and sustained through rehabilitation Research, including a study by Ahmed et al., demonstrates significant enhancements in upper-arm joint range of motion ($p<0.005$) and a decrease in contracture severity ($p<0.0001$) among severe burn survivors who participated in both active and passive range of motion exercises (Ahmed, et al., 2019). Clinical guidelines stress the importance of early mobilization and continuous exercise to reduce the risk of contractures and enhance activities of daily living (Palackic, et al., 2021). A 2024 guideline confirms that exercise-based rehabilitation in intensive care settings leads to measurable improvements in range of motion (ROM) and functional status (Cartotto, et al., 2023).

In contrast; some longitudinal studies suggest that burn survivors may endure moderate to modest range of motion (ROM) impairments for prolonged durations owing to scar maturation and individual variables. Schouten et al. found that 21% of joints still had problems after 12 months, showing how hard it is to fully recover over time, even with therapy (Schouten, et al., 2022). Inconsistent or insufficient rehabilitation may impede development, resulting in considerable range of motion loss when training regimes are neither individualized nor sustained. Burn severity, patient comorbidities, and associated pain or infection adversely impact mobility recovery (Perera, et al., 2017).

The intervention group had significantly elevated quality of life scores (78 vs. 62, $p<0.001$), indicating enhancements in both physical and psychosocial dimensions attributable to the intervention.

Supportive care, interdisciplinary rehabilitation, and psychological support—often incorporated into the post-escharotomy protocol—are consistently identified as essential for optimizing both physical recovery and psychosocial adjustment, hence contributing to elevated follow-up SF-36 and mental health scores (Saima Azam, et al., 2024). Some studies indicate that burns, irrespective of treatment modality, have enduring adverse impacts on long-term quality of life, particularly in instances of extensive total body surface area (TBSA), prominent scarring, or pre-existing psychological or

socioeconomic vulnerabilities. Some people may still have problems with their body image and social reintegration even after escharotomy or fasciotomy (Magbool, et al., 2021).

The necessity for re-operation: The intervention group saw a lower incidence of repeat procedures (5% compared to 20%); nevertheless, this difference was not statistically significant ($p=0.08$). This indicates a positive trend that may attain significance with increased sample volumes.

A 2021 multicenter review comparing early surgical excision to delayed operations in burn care indicated that early intervention correlated with a reduced number of surgeries and shorter hospitalizations, implying a decreasing tendency in re-operations as protocols advance (Miroshnychenko, et al., 2021).

Some studies still show high re-operation rates after surgery for major burns or compartment syndrome, even though things have gotten better. In fact, these rates can be over 50%, especially with difficult or delayed closures (Brown, et al., 2025)

Multiple extensive research and systematic reviews indicate that positive wound culture rates in burn patients range from 35% to 50%, particularly prior to the establishment of stringent infection control measures or prompt surgical intervention (Latifi, et al., 2017). Even with the best protocols, some centers have limited resources and multidrug-resistant (MDR) organisms that can keep infection rates persistently high (around 40–50%) even with interventions (Ozinko, et al., 2025).

Longer wound healing times are strongly linked to worse Vancouver Scar Scale (VSS) scores. Interventions that speed up healing or specifically target scar modulation, like pressure therapy or advanced laser treatments, often lead to big drops in VSS scores, just like you found (from about 85% to about 52% with intervention, $p<0.001$) (Finlay, et al., 2017). Some studies cast doubt on the long-term efficacy or patient compliance with interventions (e.g., pressure garments); however nearly all meta-analyses concur on at least mild scar enhancement when interventions are correctly implemented (Lee, et al., 2016).

A number of studies suggest that proficient early wound treatment, infection control, and scar modification may diminish—but not eradicate—the likelihood of ICU transfer. For instance, reducing it from 30% to 10–15%; frequently resulting in non-significant trends in smaller cohorts (Cancio, et al., 2023).

Factors external to the wound intervention (extensive TBSA, comorbidities) frequently determine ICU admission requirements, and several studies indicate negligible effects on ICU admission rates solely from alterations in wound care, sustaining admissions at approximately 20–30% (Gigengack, et al., 2019).

Ground-Glass Opacities (GGOs) signify alveolar inflammation and edema frequently associated with acute lung damage or early Acute Respiratory Distress Syndrome (ARDS) in burn patients, underscoring heightened capillary permeability (Yamamura, et al., 2013). Atelectatic bands indicate lung collapse resulting from airway obstruction, exacerbating ventilation and oxygenation problems. Tree-in-Bud opacities indicate bronchiolar inflammation and secretion obstruction, increasing the risk of pneumonia in burn victims (Mohajerian, et al., 2025). The bilateral and multilobar distribution of these data indicates a pervasive inflammatory response characteristic of inhalational damage or systemic inflammatory response syndrome (SIRS) linked to burns (Silva, et al., 2016).

Conclusion

The interdisciplinary intervention for burn patients resulted in notable enhancements, including expedited recovery, reduced infection rates, improved pain management, and increased mobility, consequently elevating quality of life. Effective practices encompassed early mobilization, advanced wound care techniques such as Acellular Fish Skin, and non-pharmacological pain treatment methods including virtual reality and music therapy. Nonetheless, obstacles like as heterogeneity in the efficacy of PBM therapy, incomplete long-term recovery, and threats posed by multidrug-resistant pathogens

endure. Future protocols must concentrate on incorporating multimodal techniques and tackling specific risk factors to enhance outcomes.

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