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Efficacy of transfer form implementation for adult burn patients between institutions to the Israeli National Burn Center

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ABSTRACT

Burns are serious injuries associated with significant morbidity and mortality. In Israel, burn patients are often transferred between facilities. However, unstructured and non-standardized transfer processes can compromise the quality of patient care and outcomes. In this retrospective study, we assessed the impact of implementing a transfer form for burn management, comparing two populations: those transferred before and after the transfer form implementation. This study included 47 adult patients; 21 were transferred

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before and 26 after implementing the transfer form. We observed a statistically significant improvement in reporting rates of crucial information obtained by Emergency Room clinicians and inpatient management indicators. Introducing a standardized transfer form for burn patients resulted in improved communication and enhanced primary management, transfer processes, and emergency room preparation. The burns transfer form facilitated accurate and comprehensive information exchange between clinicians, potentially improving patient outcomes. These findings highlight the importance of structured transfer processes in burn patient care and emphasize the benefits of implementing a transfer form to streamline communication and optimize burn management during transfers to specialized burn centers.

1. Introduction

Burn injuries are a common and often severe injury that can lead to significant physical and psychological harm, necessitating prolonged hospitalization and rehabilitation [1]. In Israel, burn injuries account for approximately 5% of all Emergency Room (ER) trauma-related admissions [2]. Between 2015 and 2019, the Israeli National Burn Center (INBC) at Sheba Medical Center (SMC) treated over 120 adult burn patients every year with burns of various sizes and depths [3]. In Israel, with only a single burn center and four burn units located throughout the country [4], the need for frequent patient transfers between facilities arises.

Israel's limited number of specialized burn units often results in burn patients being initially assessed by non-burn unit personnel [5]. For example, from 2015 to 2019, over 15% of patient admissions to the INBC at SMC were referred from other institutions [3]. Optimal patient outcomes and recovery rely on thorough primary assessment, management, and stabilization [6,7], and the handover of patients is a critical step in patient care [8]. However, an unstructured and non-standardized transfer process may lead to less efficient care and reduce optimal care in a dedicated facility [9].

The SMC-INBC introduced a comprehensive, short, and concise transfer form in 2020 for all referrals to the Center (Fig. 1) [3]. The form includes demographic data and clinically essential information such as total burn surface area (TBSA), depth, airway management, and circulatory parameters. It serves as a checklist that may assist in managing the burn patient, which can be complex, particularly for non-burn clinicians [10]. The transfer form aims to ensure a detailed and standardized transfer process, which will enhance the ability of the SMC-INBC Burn Center personnel to provide optimal patient care [11–13].

This study continues our previous work, where we proposed implementing a specialized transfer request form for burn patient transfers between medical centers [3]. We aim now to evaluate the efficacy of the transfer form implementation on the primary management of burn patients before transfer.

2. Methods

This retrospective study compared two populations of adult burn patients who transferred to the INBC at SMC before and after implementing the transfer form. The first population consisted of 21 patients who transferred from May 2018 to November 2019 and served as the control population. The second population consisted of 26 patients transferred between May 2020 and November 2021 and served as the test population. The study protocol was approved by the SMC institutional review board (8800–21 and 1544–14).

The transfer form is available in English (Fig. 1) and Hebrew and may be translated into other languages per request. The form contains demographic data and clinically significant information (e.g., TBSA, airway management, hemodynamic parameters, consciousness, fluid resuscitation, radiology, additional workup, and laboratory results); the form also has a diagram in which the ER clinicians are instructed to indicate the TBSA and depth of the burn. For each patient, we collected demographic data (gender, age), burn-related data (inhalational injury, anesthesia status, antibiotic administration, outcome, and mechanism of injury), and transfer-related data on the following reporting rates (tetanus status (ADT), TBSA calculation, catheter placement, transfer coordination, Parkland's formula calculation, time spent in the ER, and the need for additional workup in the ER). All data were taken retrospectively from electronic hospital registries.

2.1. *Statistical methods*

Statistical analysis was performed using Fisher's exact test for frequency comparison, and an unpaired t-test was used to analyze continuous variables. Statistical significance was assumed at the conventional 5% level. The data in the results section is presented as mean standard deviation (SD) ± and valid percent (i.e., only reported cases are included in the denominator).

3. Results

This study included 47 adult patients, 21 of whom transferred before the transfer form implementation and 26 after the implementation. As shown in Table 1, both groups, with and without the transfer form, have similar recorded clinical characteristics.

The study essentially analyzed differences in the reporting rate of 5 items shown in Tables 2 and 3: Tetanus (status and vaccination), TBSA calculation, Parkland's formula calculation, catheter placement, and transfer coordination. Table 2 demonstrates data on the management and information obtained by the ER clinician before and after

Burn patient transfer request form

Sheba medical center hospital, Tel Hashomer 52621
The burn unit, Tel. 035302405, Fax: 035302246

SHEBA Tel HaShomer City of Health

Patient Name:	I.D.	Age	M / F / other	Medical History:	Chronic Medications:
Allergies:	**Tetanus:** Administered / Unnecessary	**Smoking** Yes / No / NA		**Drug abuse** Yes / No / NA	**Alcoholism** Yes / No / NA

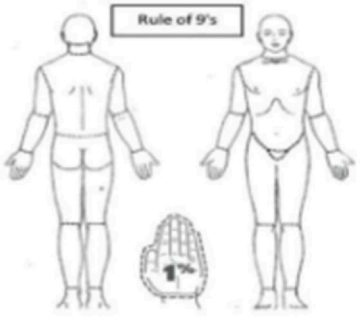
BURNS

Date of injury __/__/____		Time __:__	Date of arrival __/__/____	Time __:__
TBSA% _____	Conscious Yes / No Body temperature _____	Mechanism of injury: Flame/Water/Electric/Chemical/Scalding/Other_____		Circumferential Yes / No Escharotomies Yes / No If yes, Location_____
Inhalational Injury Yes / No If Yes, COHb _____%		Additional Injuries: (Examination by Surgeon/Neurologist/Orthopedist/Ophthalmologist/ENT) **Attach any additional findings separately.**		
Burn dressing with_____		Initial irrigation and debridement Yes / No		Antibiotics Yes / No, Indication_____
In case of electrical burns – urine alkalinization Yes / No In case of chemical burns – type of chemical agent _____ Prolonged irrigation Yes / No				

AIRWAY

Intubated Yes / No Endotracheal tube size _____	Notes regarding intubation_____
Respiratory stable Yes / No	Bronchoscopy/BAL Yes / No

Please mark burn area on figure:



BREATHING

O2 support Yes / No	O2 Sat.___% (including assessment of affected limbs)

CIRCULATION

Fluid resuscitation (24H) Yes / No	Amount of fluid administered _____		Type of fluids _____
Parkland: Weight (Kg) _____ **X** TBSA% _____ **X** 4 ml = Total _____ ml/Kg/%/24 H			
Central / Peripheral lines	Arterial location _____ Venous location _____	NGT Yes / No	Urine catheter Yes / No, Urine output _____ml/hr
Vasoactive agents support Yes / No, if Yes _____			Blood products given Yes / No

IMAGING & LABS

ECG Yes / No	X-ray Yes / No	CT scan Yes / No	BHCG/Pregnancy Yes / No
Hb__, WBC__, CRP__, Cr.___, UREA___, AST___, ALT___, Bilirubin ____, ALK-PHOS_____, BHCG/Pregnancy Yes/No ___, If electric burn: CPK____, Troponin. ____.			

Notable events during initial hospitalization in referring institution _____.
Preparation for patient transfer (Burn dressings, Fluid resuscitation, Temperature maintenance, Urine output) _____

Referring hospital _____ Referring Dr._____ Signature_____

Mobile no._____ Date __/__/____, Time __:__

**After approval all transfers will be conducted to the Emergency room in the medical center unless otherwise specified.

Fig. 1 – Burn transfer form to the Israeli Burn Center, English version.

Table 1 – Clinical characteristics of the study population.

		Before the transfer form (2018-2019) (n = 21)		After the transfer form (2020-2021) (n = 26)		p-value
		Frequency	Valid percent[a]	Frequency	Valid percent[a]	
Female		5	23.8%	4	15.4%	0.486
Age (years), mean ± SD.		41.1 ± 15.7		41.5 ± 15.7		0.931
TBSA (%), mean ± SD		23.7 ± 28.1		22.2 ± 21		0.835
Inhalational injury		2	10%	4	16%	0.678
Anesthetized		5	23.8%	9	34.6%	0.356
Antibiotic administration		6	30%	8	33.3%	> 0.999
Death from hospitalization		1	4.8%	2	7.7%	> 0.999
Death in 48 h		1	4.8	0	0%	0.447
Mechanism of injury	Fire injury	6	28.6%	11	42.3%	0.375
	High voltage injury	1	4.8%	5	19.2%	0.193
	Hot water injury	3	14.3%	4	15.4%	> 0.999
	Blast injury	5	23.8%	3	11.5%	0.437
	Hot oil injury	4	19%	1	3.8%	0.158
	Hot object injury	1	4.8	1	3.8%	> 0.999
	Chemical injury	1	4.8%	0	0%	0.447
	Mechanism unknown	0	0%	1	3.8%	0.447

Statistical analysis – Performed Fisher's exact test for frequency comparison.

[a] Valid percent: Only reported cases are included in the denominator.

the transfer form implementation. We observed a marked improvement in the ER clinicians' reporting after introducing the transfer form in all recorded parameters. The completeness of reporting with the form was between 85% and 100% as opposed to 29% and 67% before introducing the form. In addition, all individual indices recorded a statistically significant improvement ($p < 0.05$).

As shown in Table 3, the proportion of reported transfers administered ADT increased from 50% to 92%, a statistically significant 84% increase ($p < 0.05$). Additionally, an increase of 244.6% in the calculation of Parkland's formula when needed (i.e., over 20% TBSA of burns) was observed after the implementation of the transfer form ($p < 0.05$). The mean time spent in the ER was ~128 min before and ~130 min after the form's implementation ($p = 0.921$). Lastly, the data suggests that the transfer form led to a 39.5% decrease in the need for additional workup in the ER before patients were admitted to the ward. However, the difference did not reach statistical significance ($p = 0.072$).

4. Discussion

Our study analyzed 47 burn patients, 21 between 2018 and 2019 and 26 between 2020 and 2021. It is important to note that this sample represents a subset of the total number of burn patients treated at the SMC-INBC. This burn center receives many referrals from various institutions, including peripheral hospitals in Israel, the Palestinian Authority, the Gaza Strip, and other countries such as Cyprus and Romania. As a tertiary facility and primary trauma center, SMC is crucial in providing initial assessments for most burn patients.

The transfer of burn patients between facilities is essential for their clinical management. A transfer form can significantly enhance communication between non-burn clinicians and burn centers by providing a standardized way to record important patient information. This retrospective study explored the outcomes of implementing a novel transfer form for burn patients transferred to the SMC-INBC [3]. The completeness of the information received by SMC

Table 2 – The difference in the reporting rate of information by the ER clinicians before and after the transfer form was suggested.

	Before the transfer form (2018-2019) (n = 21)		After the transfer form (2020-2021) (n = 26)		p-value
	Frequency	Percent	Frequency	Percent	
TBSA calculation rate	14	66.7%	26	100%	**0.002**
Tetanus vaccination status	14	66.7%	25	96.1%	**0.015**
Catheter placement	6	28.6%	22	84.6%	**< 0.001**
Transfer coordination[a]	12	57.1%	25	96.1%	**0.003**

Statistical analysis – Performed Fisher's exact test for frequency comparison.
Statistically significant values appear in bold ($p < 0.05$).

[a] Informing Sheba's Burn Center personnel before transfer.

Table 3 – Difference between data transferred and management of the patient by the ER clinician before and after the transfer form suggested.

	Before the transfer form (2018-2019) (n = 21)		After the transfer form (2020-2021) (n = 26)		p-value
	Frequency	Valid percent[a]	Frequency	Valid percent[a]	
Tetanus vaccination	7	50%	23	92%	**< 0.001**
Parkland's formula calculation[b]	2	22.2%	13	76.5%	**0.004**
Additional workup in the ER[c]	16	76.2%	12	46.1%	**0.072**
Time spent in the ER (minutes), mean ± SD	127.6 ± 86.5		129.9 ± 71.2		0.92

Statistical analysis – Performed Fisher's exact test for frequency comparison.
Statistically significant values appear in bold ($p < 0.05$).
[a] Valid percent: Only reported cases are included in the denominator.
[b] Only patients with TBSA≥ 20% were included in this calculation.
[c] Including escharotomies, wound debridement, intubation, central IV lines, arterial line insertion, laboratory studies, ADT, nasogastric tube and urinary catheter, imaging studies, and expert consultants performed in Sheba's ER before the ward administration.

with the transfer form was higher after introducing the transfer form. This improvement highlights the engagement of primary medical teams in facilitating a more complete and accurate transfer process, which is crucial for effective patient management and outcomes [8,14].

One of the critical areas where the transfer form made a significant difference was the primary management of burn patients prone to secondary infections. In particular, tetanus, caused by the spores of Clostridium tetani contaminating wounds, is a potentially lethal yet preventable non-communicable disease. Severe burn patients, who are categorized as immunocompromised, are strongly recommended to receive ADT upon arrival at the hospital to minimize the risk of tetanus-related complications. The administration of ADT to transferred patients between 2018 and 2020 increased significantly, at least partly attributable to the introduction of the transfer form. ADT administration findings align with the recently reported Australian data collected after implementing a similar transfer form [14].

Additionally, the transfer form increased the rate of ADT status reports, which is particularly important for sedated patients. This finding indicates that the transfer form improved the reporting of key information about burn patients, enabling ER clinicians to gather vital details before sedation. The availability of this information before sedation can significantly contribute to the safe and effective management of burn patients during the initial stages of their care.

As per the American Burn Association Practice Guidelines Burn Shock Resuscitation, adults with burns greater than 20% TBSA should receive fluid resuscitation using estimates based on body size and surface area burned using Parkland's formula [15]. Increased volume requirements should be anticipated in those with full-thickness injuries, inhalation injuries, and resuscitation delays [15]. Burns sustained to greater than 20% TBSA experience increased capillary permeability and deficits in the intravascular volume that are reported to be most critical within the first 24 h post-burn [15]. Therefore, appropriate fluid resuscitation is crucial to reduce mortality, maintain patients' hemodynamic stability [16], and prevent complications such as hypovolemic shock [15]. Conversely, over-resuscitation can lead to worsening edema, compartment syndromes, ARDS, and multiple organ failure [17].

Nevertheless, miscalculations often occur during transfer, leading to discrepancies between the estimated %TBSA burned at the referring facility and the actual calculation upon arrival [18]. To mitigate this error, a visual diagram based on the validated Wallace Rule of Nines used to assess the TBSA divides the body into regions, allowing for a quick and dependable estimation of %TBSA burned [19–21] was implemented in the transfer form as an alternative to the traditional Lund and Browder Chart [22], commonly considered the gold standard for estimating %TBSA. Using this visual diagram within the form significantly increased the accuracy of Parkland's formula calculation in relevant cases. A similar technique was shown to be effective by Haines and colleagues [14]. They used a specialized app that reinforced the importance of using transfer forms and visual aids such as supporting tools and diagrams [14]. These resources effectively assist clinicians in following clinical protocols and guidelines, enhancing patient management and care [14]. While it is acknowledged that the "Parkland's formula" traditionally recommends 4 cc/kg/%TBSA for fluid resuscitation, recent literature has provided insights into the potential benefits of a range of 2–4 cc/kg/%TBSA starting at the lower end of this range. A retrospective review by Kahn et al.[23] demonstrated a reduction in fluid administration using an adjusted ideal body weight (AIBW) index, resulting in further reductions without an increase in clinically significant acute kidney injury (AKI) and the need for dialysis. Additionally, the American Burn Association (ABA) changed its fluid resuscitation guideline in 2011, recommending a starting point of 2 mL per kilogram body mass per percent total body surface area (%TBSA) affected for adult thermal burn injury patients to reduce the incidence of over-resuscitation. Furthermore, the phenomenon of "fluid creep" has been documented, indicating that modern burn patients often receive far more resuscitation fluid than predicted by the traditional Parkland formula [24]. This has led to a revaluation of resuscitation strategies, with a focus on avoiding over-resuscitation and its associated complications. It is important to emphasize that while the range of 2–4 cc/kg/% TBSA is a guide, individualized considerations, such as inhalation injury, cardiac elderly patients and pediatric resuscitation, may warrant adjustments to the resuscitation volume to maintain urine output between

0.5 and 1 mL/kg per hour (30 to 50 mL/hour in adults). Therefore, we maintain that there is a growing body of evidence supporting the initiation of resuscitation at the lower end of the traditional range, with a focus on tailored and judicious fluid administration based on specific patient factors, yet we have left the traditional Parkland's formula on the sheet for clinical consideration.

A positive change was seen in the transfer process itself. The introduction of the transfer form led to a considerable increase in coordination between medical facilities, facilitating better preparation of the burn center at SMC for incoming patients. A noticeable example would be increased venous access presence and location reporting. Accurate documentation of venous access is crucial for ensuring timely and appropriate administration of medications and fluids, whether changed, repositioned, or used, regardless of complicated access. The improved reporting suggests that the transfer form facilitated better documentation practices, enhancing patient safety during the transfer process. This improvement in coordination aligns with other findings that highlighted the importance of accurate and comprehensive information exchange during burn patient transfers, minimizing information loss [14].

Two key parameters were examined regarding treating burn patients in SMC's ER and their preparation for admission to the INBC. First, there was a 40% decrease in the rate of patients requiring additional workup in the ER after implementing the transfer form. Although this decrease did not reach statistical significance, it indicates a trend toward a more accurate and comprehensive assessment of patient's needs during their initial evaluation in the ER. Second, the mean time spent in the ER did not show a significant difference between the groups before and after the introduction of the transfer form. This suggests that the transfer form did not cause significant delays in transferring patients to the next level of care. The authors of this study proposed that the time spent in the ER will be shortened due to efficient workup and information transfer. However, it is important to note that the COVID-19 pandemic may have influenced the time spent in the ED during the study period, as patients had to wait for negative PCR test results before being admitted to the ward, potentially causing delays of 1–2 h at that time [25].

Implementing the transfer form for burn patient transfers to the SMC-INBC demonstrated significant improvements in primary management, transfer coordination, reporting practices, and patient care and outcomes. These findings support the importance of standardized transfer protocols and effective communication in enhancing the quality of care for burn patients before and during the transfer process. The transfer form was valuable in facilitating accurate TBSA calculation, ADT administration, Parkland's formula calculation, and improved documentation practices. Moreover, it contributed to better coordination between facilities and potentially more precise patient assessment in the ER, thereby improving patient management and care.

This study has several limitations warranting careful interpretation of the findings. The single-center retrospective design and modest sample size limit generalizability and introduce potential sources of bias. Standardizing analyses across heterogeneous institutional settings and patient populations poses inherent difficulties. While the transfer form contains visual aids for estimating TBSA, this study did not evaluate the impacts on assessment accuracy between referring sites and our specialist center. Although the transfer form aims to optimize communication pathways, the patients' benefits are also expected regarding improved healing. Future comparisons of burn characteristics with and without the transfer forms can quantify improvements in continuity of care and patient benefits, including faster healing,

Nonetheless, missing data on referring fluid administration precluded analysis of treatment consistency and protocol adherence before transfer. Prospective multi-center studies with integrated data collection are warranted to corroborate these initial results. By establishing a foundation highlighting the communication and coordination benefits of transfer forms for burn patients, this study helps inform future directions.

Future research should aim for larger sample sizes, foster multi-center collaborations, and adopt prospective study designs. These approaches are necessary to validate the findings, evaluate the generalizability of the results, and assess the long-term impact of utilizing the transfer form in burn patient transfers, thereby advancing the knowledge and applicability of this communication tool in diverse healthcare settings.

5. Conclusion

These findings underscore the significance of organized transfer procedures in caring for burn patients and highlight the advantages of introducing a transfer form to enhance communication efficiency and optimize burn treatment during transfers to specialized burn centers. Implementing a standardized transfer form across medical facilities has the potential to greatly facilitate continuity of care, coordination and improve potentially patient outcomes in these critical scenarios.

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CRediT authorship contribution statement

Conceptualization: Ideas; formulation or evolution of overarching research goals and aims: MH; UA; JH. Methodology: Development or design of methodology; creation of models: UA; MH. Software: Programming, software development; designing computer programs; implementation of the computer code and supporting algorithms; testing of existing code components: N/A. Validation: Verification, whether as a part of the activity or separate, of the overall replication/ reproducibility of results/experiments and other research outputs: UA; MH; JH. Formal analysis: Application of statistical, mathematical, computational, or other formal techniques to analyze or synthesize study data: EB; JL; UA. Investigation: Conducting a research and investigation process, specifically performing the experiments, or data/evidence collection: UA; JL; MH. Resources: Provision of study materials, reagents, materials, patients, laboratory samples, animals, instrumentation, computing resources, or other analysis tools: JL; UA; MH. Data Curation: Management activities to annotate

(produce metadata), scrub data and maintain research data (including software code, where it is necessary for interpreting the data itself) for initial use and later reuse: JL; UA; MH. Writing - Original Draft: Preparation, creation and/or presentation of the published work, specifically writing the initial draft (including substantive translation): UA; JL; DB; MH. Writing - Review & Editing: Preparation, creation and/or presentation of the published work by those from the original research group, specifically critical review, commentary or revision – including pre-or post publication stages: UA; DB; JL; EB; RK; MC; YS; JH; MH. Visualization: Preparation, creation and/or presentation of the published work, specifically visualization/ data presentation: UA; JL; RK; EB; DB. Supervision: Oversight and leadership responsibility for the research activity planning and execution, including mentorship external to the core team: MH; UA. Project administration: Management and coordination responsibility for the research activity planning and execution: MH; UA. Funding acquisition: Acquisition of the financial support for the project leading to this publication: N/A.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper: Efficacy of transfer form implementation for adult burn patients between institutions to the Israeli National Burn Center.

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