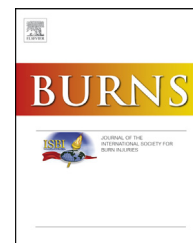


Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/burns

A third of referrals are unnecessary: Critical review of burn outpatient clinic data

A. Cherukupalli^{a,*}, N. Duan^a, A. Papp^{a,b}

^a Faculty of Medicine, University of British Columbia, 317-2194 Health Sciences Mall, Vancouver, BC, V6T 1Z3, Canada

^b Division of Plastic Surgery, Vancouver General Hospital, 2775 Laurel Street, 11th Floor, Vancouver, BC, V5Z 1M9, Canada

ARTICLE INFO

Article history:

Accepted 26 March 2019

Keywords:

Burns
Outpatient
Clinic
Referrals
Treatment

ABSTRACT

Objectives: The purpose of this study was to establish patterns in types of burns referred to the Outpatient Clinic (OP) at Vancouver General Hospital (VGH).

Methods: A 2-year retrospective chart review was conducted of patients presenting to the OP Clinic from June 1, 2016–June 1, 2018. Data collected included: patient demographics, depth of burn, Total Body Surface Area (TBSA), anatomical location of burn, geographical location of referral, and operative versus non-operative management.

Results: The OP Clinic served 470 patients for burn injuries with a total of 1852 visits. Of these, 20% were follow-up visits post-admission, and 73.6% were primary referrals from the emergency department (ED) or elsewhere. The vast majority (69.6%) of burns were less than 5% TBSA. Half involved the hands (50.9%), and half were superficial dermal in depth (45.1%). A third of patients attended only one appointment with the OP Clinic before discharge and 15% did not receive any treatment.

Conclusions: The results of our study demonstrate gaps in current provincial referral guidelines leading to a significant number of “unnecessary referrals.” Further research could correlate the results to current provincial referral guidelines to estimate their current efficacy in practical use.

© 2019 Elsevier Ltd and ISBI. All rights reserved.

1. Introduction

Burn injuries are a serious medical emergency worldwide, with approximately 180 000 deaths each year being attributed to burns [1]. In the United States alone, an estimated 500 000 people sustain burn injuries each year, with 40 000 cases being severe enough to receive medical treatment [2]. These injuries can range from minor burns acquired in the household to major inhalation and body injuries undergoing admission to an Intensive Care Unit. This breadth of presentation presents a conundrum regarding initial management: should physicians

treat these injuries locally or refer patients to more specialized care, such as a major burn centre? Often it is safer to refer to specialists due to limited multi-disciplinary burn care expertise and the threat of injury escalation. However, over-triage increases burn centre load and can be a wasteful use of limited resources [3]. Reflecting this is the fact that an average of over 200 burn cases are admitted to each of the 128 burn centres in the US annually, while the other 4500 acute care hospitals average less than three [2].

Canada faces a unique situation with regards to burn treatment due to its large territory and low population density. For example, in British Columbia (BC), there are two major

* Corresponding author at: 10738 Dunlop Rd, Delta, BC, V4C8B7 Canada.

E-mail address: abhiram.c@alumni.ubc.ca (A. Cherukupalli).

<https://doi.org/10.1016/j.burns.2019.03.013>

0305-4179/© 2019 Elsevier Ltd and ISBI. All rights reserved.

adult burn care centres: The Royal Jubilee Hospital Burn Unit in Victoria and the Burns, Trauma & High Acuity Unit (BTHA) at Vancouver General Hospital (VGH) in Vancouver. Royal Jubilee provides burn care for Vancouver Island Health Authority and handles select provincial referrals [4]. In contrast, the BTHA serves as the quaternary referral centre for major burn trauma for the entire province, and approximately 50% of major burn patients referred there over the last 10 years came from outside the Lower Mainland [4].

With only two burn centres serving an area of approximately 950 000 square kilometres, it is quite evident there is a significant discrepancy in the availability of specialized burn care across the province. This discrepancy can lead to a significant burden on healthcare resources at these two centres. However, there is limited data to help estimate this burden. This specifically includes the characteristics (location, surface area, and depth) of burns referred to the outpatient clinic, the extent of care each patient received before discharge, such as number of clinic appointments and whether non-operative or operative management was required, and where these burns were referred from.

The goal of this study was to establish the types of burns seen in the VGH Outpatient Burn Clinic over the last 2 years, their referral patterns, and the corresponding management received.

2. Methods

A 2-year retrospective chart review was conducted of patients presenting to the VGH Burn Clinic from June 1, 2016–June 1, 2018. A comprehensive list of all patients seen was obtained from the Burn OP department and all patients were screened for eligibility in this study. Patients were included if they presented to the OP clinic between the dates listed above, regardless of whether or not their chief complaint was a burn injury. Patients were not included if they did not have a physical chart for data collection or if they were listed as a burn clinic patient but presented with a musculoskeletal hand injury and received care from a hand surgeon.

Data was extracted from physical charts as well as electronic health records. Data collected included: patient characteristics, burn characteristics such as anatomical location of burn, depth, and Total Body Surface Area (TBSA); city of burn and city of referral; management such as number of appointments, non-operative treatment, and operative intervention. With regards to operative intervention, detailed data was collected only for the first surgery the patient received for the given indication and subsequent surgeries were qualitatively noted. During data analysis, TBSA recorded as less than 1% was estimated to be equivalent to 0.5%. For the city of referral, patients who followed up at the OP Burn Clinic after direct transfer and admittance to VGH from another city were considered to be referred from the city of transfer. An “unnecessary referral” was defined as one where the patient only attended one appointment before being discharged from the clinic and were not admitted as an in-patient during their care. Data was analyzed with descriptive analysis to draw comparisons between the multiple variables collected from qualifying patients.

3. Results

3.1. Patient demographics

A total of 583 patients were seen at the OP Burn Clinic during the study period, meaning the clinic cared for an average of 291 patients per year in that time. Overall, 521 patients who visited the Burn Clinic a cumulative total of 2175 times met the inclusion criteria, while 63 were excluded. Of those included, 470 (90.4%) were seen for burn injuries over a total of 1852 visits and 50 (9.6%) were seen for non-burn complaints, which included scar revision, skin cancer excisions, and skin grafting for chronic wounds. Burn patients were mainly referred to the Burn Clinic from various Emergency Departments (307; 65.3%); other sources included follow-up after discharge as an inpatient (94; 20.0%), referral from general practitioners (33; 7.0%), other specialists (6; 1.3%), or not reported (30; 6.4%) (Table 1).

Among the 470 patients seen for burn injuries, 195 (41.5%) were female and 275 (58.5%) were male (Table 1). Patient age had a unimodal distribution; the largest group of patients were between the ages of 31–50 (172; 36.6%) while few were below the age of 18 (3; 0.6%) or above the age of 70 (25; 5.3%). In each age group, males were more likely to suffer from burn injuries compared to females. There was a total of 120 (25.5%) patients admitted as inpatients to the VGH Burn Unit sometime during their care, whether this was before or after their first visit to the OP Burn Clinic. Therefore, 350 (74.5%) burn patients were only seen in the clinic and never admitted. When stratified by inpatient versus only outpatient only care, the male-to-female ratio differed. Of those who only received care as an outpatient, 54.9% (192/350) were male and 41.5% (158/350) were female. In those who were admitted at any time during their care, 69.2% (83/120) were male and 30.8% (37/120) were female.

Figs. 1 and 2 show the geographical spread of locations where burns occurred. Just under half of all burn injuries occurred in Vancouver (216/470; 46.0%), and the five cities with the next highest number of burns were Burnaby (28), Richmond (14), Abbotsford (14), Surrey (12), and Mission (10). Burns were reported as occurring in 65 different locations in British Columbia. Relatively few burns occurred outside BC including the rest of Canada (1) and internationally (11). The furthest community where a burn seen at the OP Burn Clinic was reported to have occurred was Telegraph Creek, which is 1093 km away from Vancouver. Cities of referral were similar to cities of burn occurrence but more skewed towards Vancouver. A total of 41 cities in British Columbia referred burns to the OP Burn Clinic, with 300 (63.8%) patients being referred from within Vancouver. The next highest numbers of referrals were from Abbotsford (14), Burnaby (9), Chilliwack (9), Surrey (7), and New Westminster (7), and the furthest referral was a direct transfer to VGH from Fort Nelson 1060 km away.

3.2. Burn characteristics

With respect to mechanism of injury, the majority of patients suffered from heat-induced burns (424/470; 90.2%) which included injuries from flames, hot liquids, and hot objects (Table 2). Within these burns, scalds were the most common, followed by flame burns. Other less common reasons for injury

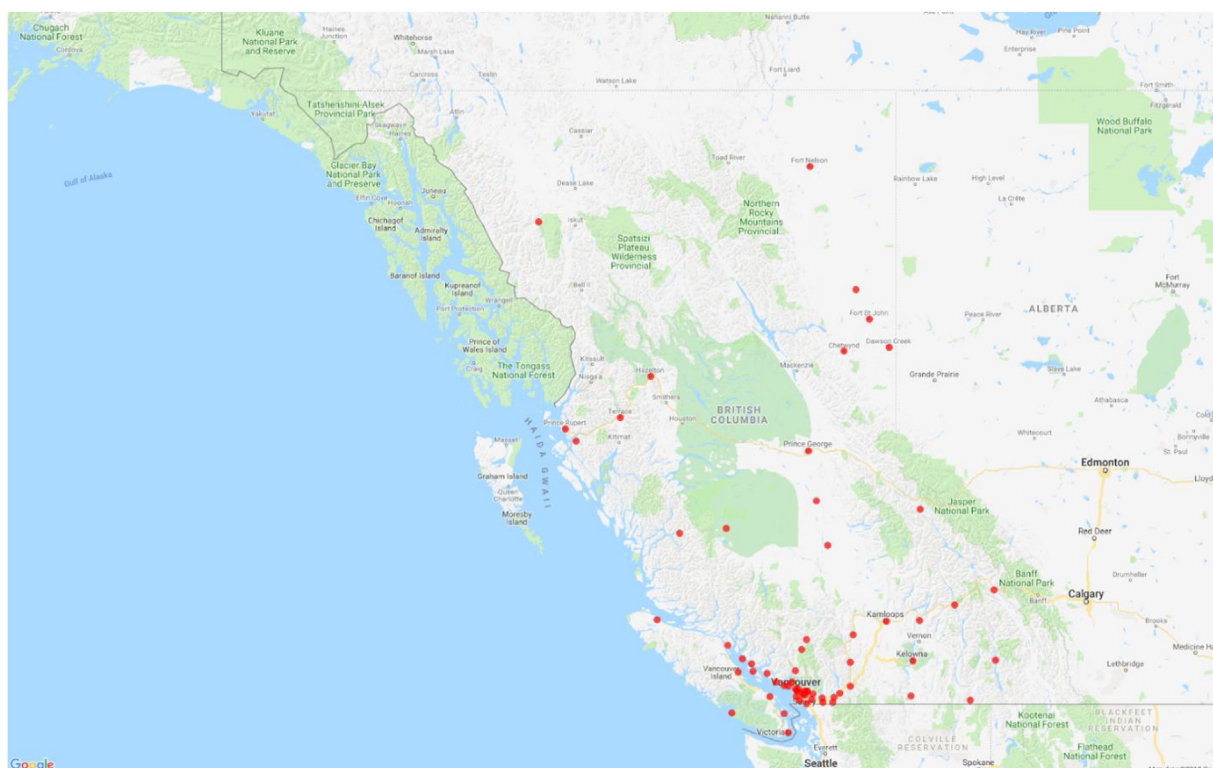
Table 1 – Characteristics of patients seen for burn injuries. Percentages are shown as % of row total.

Case Characteristics	Age (years)											
	Total		> 18		18-30		31-50		51-70		70+	
	470		3 (0.6%)		134 (28.5%)		172 (36.6%)		136 (28.9%)		25 (5.3%)	
	n	%	n	%	n	%	n	%	n	%	n	%
Gender												
Female	195	41.5%	1	0.5%	61	31.3%	66	33.8%	57	29.2%	10	5.1%
Male	275	58.5%	2	0.7%	73	26.5%	106	38.5%	79	28.7%	15	5.5%
Referred from												
Emergency Department	307	65.3%	1	0.3%	89	29.0%	119	38.8%	81	26.4%	17	5.5%
Hospital after discharge	94	20.0%	2	2.1%	22	23.4%	37	39.4%	29	30.9%	4	4.3%
General Practitioner	33	7.0%			12	36.4%	8	24.2%	11	33.3%	2	6.1%
Other	6	1.3%			3	50.0%	1	16.7%	2	33.3%		
Not reported	30	6.4%			8	26.7%	7	23.3%	13	43.3%	2	6.7%
Admitted as In-patient												
Yes	120	25.5%	2	1.7%	25	20.8%	48	40.0%	38	31.7%	7	5.8%
No	350	74.5%	1	0.3%	109	31.1%	124	35.4%	98	28.0%	18	5.1%
Received Surgery												
Yes	154	32.8%			41	26.6%	61	39.6%	45	29.2%	7	4.5%
No	316	67.2%	3	0.9%	93	29.4%	111	35.1%	91	28.8%	18	5.7%

were chemical burns, electrical burns, friction burns, frostbite, and radiation.

Table 3 shows characteristics of the burns seen at the OP Burn Clinic. The majority of patients suffered injuries of less than 1% TBSA (170/ 470; 36.2%) or between 1 and 4% TBSA (157; 33.4%). Only 53 patients suffered injuries 20% TBSA or greater (11.3%) and the most extensive burn seen was 76% TBSA. The average surface area of all patients presenting with burn injuries was 6.6% TBSA. In regard to anatomical site of burn, many burns occurred in multiple locations. The

hands were most commonly injured (239; 50.9%), followed by the lower extremities (185; 39.6%) and upper extremities (180; 38.3%). The neck was the least often burned (53; 11.3%). Many injuries also involved burns of various depths; reported here are the worst burn depths. Almost half of burn injuries were at most superficial dermal (212; 45.1%). The remaining burns were relatively equally divided between mid-dermal, deep dermal, and full thickness. Very few burns were purely epidermal (10; 2.1%). When stratified by inpatient versus only outpatient care, burns to the hands and lower extremities

**Fig. 1 – Geographic distribution of locations of burn injury occurrence.**

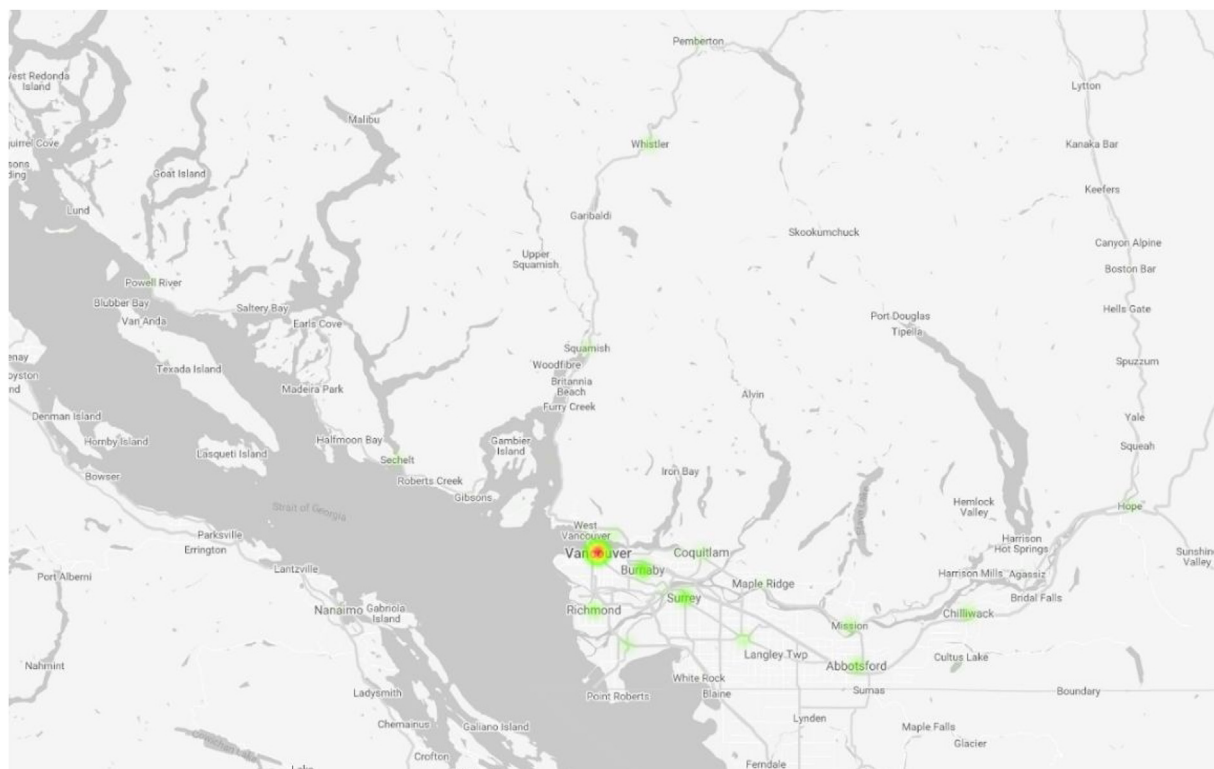


Fig. 2 – Heat map of burns occurring in various geographical locations in the Lower Mainland.

Table 2 – Mechanism of burn injuries. Percentages are shown as % of row total.

Etiology	Number of Appointments											
	Total Burns		1		2-5		6-10		11-20		20+	
	470		145 (30.9%)		220 (46.8%)		70 (14.9%)		30 (6.4%)		5 (1.1%)	
	n	%	n	%	n	%	n	%	n	%	n	%
Heat	424	90.2%	123	29.0%	203	47.9%	65	15.3%	28	6.6%	5	1.2%
Chemical	16	3.4%	9	56.3%	5	31.3%	2	12.5%		0.0%		
Electric	14	3.0%	5	35.7%	7	50.0%	1	7.1%	1	7.1%		
Friction	8	1.7%	1	12.5%	4	50.0%	2	25.0%	1	12.5%		
Frostbite	4	0.9%	4	100.0%								
Radiation	1	0.2%	1	100.0%								
Not reported	3	0.6%	2	66.7%	1	33.3%						

were more common in outpatients (72.8% and 63.8%, respectively), while other anatomical locations were divided more evenly (Table 4).

A sizeable number of burn patients only visited the OP Burn Clinic once (145/470; 30.9%), and the majority had 2-5 appointments (220; 46.8%) (Table 3). The average number of visits to the Burn Clinic before discharge was 3.9. Relatively few patients had greater than 20 visits (5; 1.1%) and these individuals all received long-term care that included scar revision procedures for hypertrophic scars or keloids secondary to their burn(s). The patient who had the greatest number of appointments with the Burn Clinic visited 35 times in a period of 3.5 years. Among the 145 burn patients who received

only one appointment, 75 (51.7%) had less than 1% TBSA burns, 82 (56.6%) had hand involvement, and 104 (71.7%) had injuries that were at most superficial dermal. 15 of these patients received in-patient care at some time during their burn management; of the 130 patients who received only outpatient care and one appointment, 74 (56.9%) had less than 1% TBSA burns, 75 (57.7%) had hand involvement, and 96 (73.8%) had injuries that were at most superficial dermal. Average number of visits for TBSA, anatomical site, and worst burn depth are presented in Table 3. As the number of appointments increased, it was more likely for the burn to cover a greater TBSA, involve areas other than the hands, and present as deeper in depth.

Table 3 – Burn characteristics. Note the same burn could have occurred at multiple anatomical sites. Percentages are shown as % of row total.

Burn Characteristic	Avg # of Appts		Number of Appointments									
	Total Burns											
	470											
	n	%	1		2-5		6-10		11-20		20+	
			n	%	n	%	n	%	n	%	n	%
TBSA												
< 1	170	36.2%	75	44.1%	79	46.5%	13	7.6%	3	1.8%		
1-4	157	33.4%	43	27.4%	70	44.6%	32	20.4%	12	7.6%		
5-9	46	9.8%	8	17.4%	24	52.2%	8	17.4%	3	6.5%	3	6.5%
10-19	37	7.9%	4	10.8%	19	51.4%	7	18.9%	6	16.2%	1	2.7%
20-49	31	6.6%	3	9.7%	19	61.3%	6	19.4%	3	9.7%		
50+	22	4.7%			2	28.6%	2	28.6%	2	28.6%	1	14.3%
Not reported	7	1.5%	12	54.5%	7	31.8%	2	9.1%	1	4.5%		
Anatomical Site												
Head	121	25.7%	32	26.4%	52	43.0%	23	19.0%	11	9.1%	3	2.5%
Neck	53	11.3%	7	13.2%	25	47.2%	13	24.5%	5	9.4%	3	5.7%
Hands	239	50.9%	82	34.3%	109	45.6%	29	12.1%	14	5.9%	5	2.1%
Upper Extremities	180	38.3%	37	20.6%	83	46.1%	40	22.2%	18	10.0%	2	1.1%
Lower Extremities	185	39.4%	32	17.3%	96	51.9%	39	21.1%	16	8.6%	2	1.1%
Trunk	115	24.5%	19	16.5%	61	53.0%	21	18.3%	11	9.6%	3	2.6%
Worst Burn Depth												
Epidermal	10	2.1%	10	100.0%								
Superficial Dermal	212	45.1%	104	49.1%	92	43.4%	12	5.7%	3	1.4%	1	0.5%
Mid-Dermal	77	16.4%	9	11.7%	46	59.7%	14	18.2%	8	10.4%		
Deep Dermal	72	15.3%	3	4.2%	38	52.8%	21	29.2%	8	11.1%	2	2.8%
Full-Thickness	77	16.4%	7	9.1%	38	49.4%	20	26.0%	10	13.0%	2	2.6%
Not reported	22	4.7%	12	54.5%	6	27.3%	3	13.6%	1	4.5%		

3.3. Management

Table 5 shows whether or not patients received non-operative treatment, excluding those who received surgery or were admitted at any time during their care. Of these 289 patients, 73 (25.3%) did not receive any treatment from the OP Burn Clinic, and among those, 67 patients only visited the burn clinic once. For the 216 patients in this cohort who received non-operative treatment, ACTICOAT™ (Smith&Nephew, England) antimicrobial dressings were used 65.7% of the time. Other treatments included Mepilex® Absorbent Foam Dressing (Mölnlycke Health Care, Sweden), ALLEVYN® wound dressings (Smith&Nephew, England), Viaderm-K.C.® (Taro Pharmaceutical Industries LTD, Israel), and silver nitrate stick treatments.

Table 6 shows which burns were more likely to receive surgery. Out of 470 burns, 154 (32.77%) received surgery during their care. Burns of less than 1% and 1-4% TBSA were unlikely to undergo operative intervention (84.7% and 71.3% did not receive surgery, respectively), while burns 10-19% and 20-49% TBSA were more likely to undergo surgery (64.9% and 90.3% underwent surgery, respectively), and all patients with greater than 50% TBSA received surgery. Burns on the hands were less likely to receive surgery compared to burns in other anatomical locations (73.1% of hand burns did not undergo surgery). The deeper the burn depth, the greater proportion of burns that underwent operative intervention. Only 4.3% of patients with superficial dermal burns received surgery, most likely due to incorrect initial diagnoses or delayed healing secondary

Table 4 – Frequency of anatomical site of burn in inpatients and outpatients. Note the same burn could have occurred at multiple anatomical sites. Percentages are shown as % of row total.

Burn Characteristic	Total Burns		Inpatient		Outpatient	
	470		120 (25.5%)		350 (74.5%)	
	n	%	n	%	n	%
Anatomical Site						
Head	121	25.7%	60	49.6%	61	50.4%
Neck	53	11.3%	29	54.7%	24	45.3%
Hands	239	50.9%	65	27.2%	174	72.8%
Upper Extremities	180	38.3%	79	43.9%	101	56.1%
Lower Extremities	185	39.4%	67	36.2%	118	63.8%
Trunk	115	24.5%	65	56.5%	50	43.5%

to infection, while 84.4% of patients with full-thickness burns did. Reasons for patients with full-thickness burns not receiving surgery included burns with very small TBSA, late presentation to clinic (healing having occurred by secondary intention), lack of operating room time resulting in healing with non-operative treatment, and lack of patient consent for surgery. The most common operative procedure for burns was excision with split-thickness skin grafting (STSG) which was performed 83.1% of the time; other procedures included full-thickness skin grafting, escharotomy, and primary closure.

Out of a total of 194 patients who received surgeries, 22 (11.3%) were indicated for non-burns and 17 (8.8%) were indicated for scar revisions. A significant number of patients received day surgeries (79; 40.7%) and were discharged on the same day as their procedure. Burns less than 5% TBSA were most likely to receive day surgery. Out of 26 patients receiving surgery for less than 1% TBSA burns, 22 (84.6%) received day surgery. Out of 46 patients receiving surgery for 1–4% TBSA burns, 26 (56.5%) received day surgery. In contrast, all patients with burns of 20–76% TBSA were admitted for one or more days following their surgery, with the majority being admitted for greater than 30 days. No scar revision cases were admitted for more than 8 days.

Burn patients were also stratified by burn TBSA, depth, and location of injury, and compared to number of appointments received (Table A1). For burns less than 1% TBSA, epidermal burns in any location only attended one visit to the OP Burn Clinic before discharge. Almost all superficial dermal burns received 5 or fewer visits, with the majority of burns to the head and hands attending only one visit. The majority of mid-dermal

Table 6 – Characteristics of burns treated operatively versus non-operatively. Note the same burn could have occurred at multiple anatomical sites. Percentages are shown as % of row total.

Burn Characteristic	Total Burns		Surgery		No Surgery	
	470		154 (32.8%)		316 (67.2%)	
	n	%	n	%	n	%
TBSA						
< 1	170	36.2%	26	15.3%	144	84.7%
1–4	157	33.4%	45	28.7%	112	71.3%
5–9	46	9.8%	19	41.3%	27	58.7%
10–19	37	7.9%	24	64.9%	13	35.1%
20–49	31	6.6%	28	90.3%	3	9.7%
50+	7	4.7%	7	100.0%		
Not reported	22	1.5%	5	22.7%	17	77.3%
Anatomical Site						
Head	121	25.7%	49	40.5%	72	59.5%
Neck	53	11.3%	28	52.8%	25	47.2%
Hands	239	50.9%	69	28.9%	170	71.1%
Upper Extremities	180	38.3%	83	46.1%	97	53.9%
Lower Extremities	185	39.4%	90	48.6%	95	51.4%
Trunk	115	24.5%	63	54.8%	52	45.2%
Worst Burn Depth						
Epidermal	10	2.1%			10	100.0%
Superficial Dermal	212	45.1%	9	4.2%	203	95.8%
Mid-Dermal	77	16.4%	21	27.3%	56	72.7%
Deep Dermal	72	15.3%	53	73.6%	19	26.4%
Full-Thickness	77	16.4%	65	84.4%	12	15.6%
Not reported	22	4.7%	5	22.7%	17	77.3%

burns had 2–5 visits, and there were no mid-dermal burns to the trunk, upper extremities, or lower extremities that were discharged after only one visit. All hand burns of deep dermal depth had 2–5 visits. Deep dermal burns of the trunk were more varied; the majority had 2–5 visits, but some only received one visit and others greater than six. Results after stratification of burn characteristics for burns of 1–4% TBSA, 5–19% TBSA, and 20% or greater TBSA can be seen in Tables A2, A3, and A4 respectively. The tables in the appendices serve as a general guideline to illustrate the number of appointments patients attended with the OP Burn Clinic for different types of burns.

4. Discussion

As demonstrated by the data above, the VGH Outpatient Burn Clinic serves a large population and a wide variety of burn and

Table 5 – Number of patients who received non-operative treatment, excluding those who received surgery. Percentages are shown as % of row total.

Non-operative Treatment	Total Burns		Number of Appointments							
	289		1		2–5		6–10		11–20	
	n	%	n	%	n	%	n	%	n	%
Yes	216	74.7%	63	29.2%	130	60.2%	19	8.8%	4	1.9%
No	73	25.3%	67	91.8%	6	8.2%				

other injuries. During the two-year study period, 521 patients were seen and treated in the clinic, 470 of which were for primary burns and received an average of 3.9 appointments with the OP Burn Clinic. Although they varied greatly with regards to severity and the amount of care received from a burn specialist, it was most common for the burns to encompass less than 1% TBSA, involve the hands, and be superficial dermal in depth.

There was a noted difference in the male-to-female ratio of burn patients when stratified by inpatient versus outpatient only care. In our patient population, males were 1.3 times more likely to have received inpatient care for their burn injury compared to females. A study from Korea showed similar results where a higher proportion of men (20.5%) were admitted for inpatient burn treatment compared to women (18.7%, $p < 0.001$). They also identified a greater proportion of upper extremity burns in women compared to men [5]. Another study from Taiwan showed a higher rate of overall burn injuries in women, but a higher rate of severe burns, admission to hospital, and burns undergoing reconstructive surgery in men [6]. These results bring into question the cause behind the association between sex and severity of burn injury and could be related to risk-seeking behavior associated with sex. Further investigation would be necessary to determine the factors involved in this association and could provide insight into targeted interventions to reduce serious burn injuries in the male sex.

TBSA was correlated with number of appointments for patients seen in the Burn Clinic up to a point. In our patient population, approximately half of burns less than 1% TBSA only attended one appointment, and half were seen in the clinic 2–5 times with an average of 2.5 visits. In contrast, only about a quarter of 1–4% TBSA burns saw the clinic once, half had 2–5 visits, and another quarter had 6–10 visits, for an average of 4.1 visits. Beyond this, burns 5–9% and 10–19% TBSA received an average of 6.1 visits, while burns 20–49% TBSA received an average of only 4.7 visits. This may be partly due to the fact that the larger the TBSA of a burn, the more likely it was for the patient to have been admitted as an in-patient, where they received aggressive and time-consuming burn care not recorded in this study.

Data from this outpatient population can be used to estimate duration of follow-up for patients when burn injuries are stratified not only by TBSA, but also by depth and anatomical location of burn. This may be useful especially for patients presenting to the clinic from outside the city limits, as it allows them to anticipate and plan travel and accommodations accordingly to ensure proper follow-up for specialized burn care.

After stratifying burn patients seen during the study period based on location of referral, we found a significant portion of referrals (83%) were sent from the Greater Vancouver area. As VGH is in close proximity, it may be an assurance for referring physicians to send patients seen in the Emergency Department (ED) or in the community to the OP Burn Clinic for follow-up to rule out gaps in treatment and to assess need for operative management. The large population VGH serves is a factor to consider. Sozen et al. found the major burn centre in Ankara, Turkey received progressively more referrals each year, which they attributed to an increasing urban population

[7]. It could also result from physicians' lack of comfort managing burns in the community. For example, another study found that 32% of patients transferred to a burn care centre did not meet referral criteria but were referred due to physician discomfort in caring for burns [8]. Another factor is the convenience of a direct clinic referral from the VGH ED to the OP Burn Clinic for patient follow-up. Physicians from teaching hospitals (such as VGH) have been shown to refer significantly more burn patients to burn centres for assessment of minor burns compared to physicians in the community [9]. This could account for the large number of referrals the OP Burn Clinic received from the ED (65.3%), most of which were for follow-up from the VGH ED after initial treatment had already been initiated. Many of these referrals could be redirected to primary care physicians rather than overburdening the Burn Clinic. Efforts should be made to improve education of the management of minor burn injuries amongst primary care providers to ensure sufficient treatment for minor burns in the community instead of referring the patient to a specialist, prolonging potential waitlists.

Additionally, telemedicine has been shown to improve the accuracy of burn triaging and thus unload minor cases from burn specialists by avoiding unnecessary transfers [10]. This method also eliminates the inconvenience and cost of frequent journeys taken by patients to specialized centers and may be used for consultation on appropriate treatment for minor burns to provide good clinical care [11]. This is best supported by a study in Australia where pediatric burn patients were followed up for acute burn injuries through telemedicine. Overall, the median travel distance saved for patients was 600 km and total distance saved for clinical follow-up exceeded 1.4 million kilometers [12]. This could be further enhanced in British Columbia with the addition of tele-communicative educational modules on burn management to local physicians. Ultimately the integration of telemedicine into remote burn care management and outpatient follow-up could help save patients hours of travel and the medical system thousands of dollars.

Almost one third (145/470) of all burn cases seen by the OP Burn Clinic attended only one appointment prior to discharge. Exclusion of patients who received in-patient care for their burn injuries from this group resulted in 130 (28%) cases that were considered unnecessary. In this cohort of 130 patients, 56.9% of the burns were less than 1% TBSA, 57.7% involved the hands, and 73.8% were at most superficial dermal. This is similar to findings from a study done by Sozen et al., where among 1795 patients seen in the outpatient clinic during their study period, 29.5% only attended one appointment, and 17.9% did not receive follow-up after 2 appointments [7]. It is evident that a significant portion of burns referred to the clinic do not actually undergo long term follow-up. This is further supported by the fact that 46.2% (67/130) of the patients who only had one appointment in clinic and were not admitted at any time during their care did not receive any treatment (operative or non-operative) on assessment whatsoever. Many of these referrals could be considered inappropriate and a burden on the increasing volume of patients treated annually at VGH. Even if one were more conservative and restricted the definition of "inappropriate referral" to burns of less than 5% TBSA, this represents 24.0% (113/470) of cases that were

discharged from care after their first clinic visit. The current BC Burn Guidelines, as others, state that a referral should be made to a tertiary burn care centre if the injury involves the hand (Table 7) [4]. However, these results beg the question whether strong adherence to the current guidelines reflects adequate patient care and consideration of barriers to access of specialized treatment. Additionally, not every hand burn needs to be sent to a burn clinic, and small superficial burns with minor blistering can easily be treated elsewhere as well.

When comparing anatomical location of burns, it was evident that hands were the most often subjected to injury. In our study, half of burns involved the hands. Of the hand burns that were less than 5% TBSA, 63.8% (102/ 160) were at most superficial dermal in nature and of those, half (53/ 102) only attended one appointment with the burn clinic. This represents 11.3% (53/ 470) of all burns seen at the Burn Clinic. The large number of hand burns seen may indicate overreliance on anatomical site of injury as referral criteria for burns from both Emergency Departments and Primary Care physicians; anatomic site has been shown to be by far the most commonly identified criterion followed by age for referral to a major burn centre [13]. With the hand having a significant impact on quality of life and function in the workplace, expedited referral and treatment with the Burn team is logically preferred, especially in the cases of Worker's Compensation. This can also be demonstrated by a global phenomenon of increase in lower percentage superficial burns admitted to burn centres [14]. However, in our study, the majority of hand burns seen were superficial dermal and did not undergo operative management. This means many were seen in clinic for follow-up and often only minimally or not treated, aside from what had already been done for the patient acutely. These results demonstrate an environment of significant over-referral and could stipulate a change in the specifics of referral guidelines to ensure more serious injuries are seen by a specialist while others are managed in the community with multidisciplinary support and consults to specialized help only when needed.

There was a noted difference when comparing anatomical location of burn injury between the inpatient and outpatient populations. Our study showed burns to the hands and lower extremities were less likely to be treated as inpatients (for example, 72.8% of hand burns were treated solely in the outpatient clinic), while burns to the neck and trunk were more likely to be treated as inpatients. An epidemiologic review of

cases in Korea showed similar results: the majority of outpatient injuries involved the upper limbs (82.7%) and head (80.6%) with the majority of inpatient injuries involving multiple sites (31.5%) and the trunk (25.7%) [5]. These differences most likely relate to the mechanism of injury and stipulates severity of associated tissue damage with distinct treatment regimens. This further supports the notion of pursuing management of isolated upper limb injuries in the community rather than referring to major burn centres based on an assumed mechanism of injury.

Several of the patients seen in the outpatient clinic did undergo operative excision and grafting due to the extent of their injury or non-healing injuries. Out of the 154 burn patients who underwent operative treatment, 57 (37.0%) received day surgeries. Furthermore, 22 of these cases were burns of less than 1% TBSA. Such a high volume of day surgeries in the minor burns population creates an opportunity to treat this subset of patients in the minor procedure suite, thus allowing outpatient burn centres to provide adequate care to a larger volume of burn cases without the restriction of operative room time. It has been shown that there is no apparent difference in infectious complications among patients with minor burn injuries if managed as an inpatient versus as an outpatient [15]. Furthermore, the cost for treatment of a burn injury in an outpatient facility was estimated at \$2397 +/- 222 USD compared to \$17 220 +/- 410 USD for inpatients [15]. In a public healthcare system, these differences in cost can motivate the treatment of minor burns in outpatient facilities rather than in hospitals. Reductions in cost can redirect funds elsewhere for more effective healthcare expenditure.

Burn Guidelines were developed to provide clear recommendations for the identification of burn injuries that require referral to a burn specialist. However, these guidelines are still open to clinician interpretation, and research in other countries has shown persistent differences in referral patterns despite available guidelines. For example, Carter et al. found that of the 952 burns treated in non-burn centres in the UK, 48% met burn referral criteria but were not transferred [16]. Due to the dynamic nature of burn injuries, under-referral can be quite deleterious with regards to patient outcomes. On the other hand, over-referral is also a financially costly issue for the healthcare system. In addition to the unnecessary burden they place on specialized burn centres, over-referrals may significantly inconvenience patients with minor burns who find it difficult to travel long distances to specialist centres for periodic follow-up [11]. From our data, it appears many minor burns that could be treated in the community are referred due to adherence to current guidelines with limited clinical interpretation. Considerations should be made in amending the current guidelines to accommodate for these discrepancies and allow for more appropriate referrals to tertiary burn care centres.

There were several limitations to our study. As this is a retrospective review, data collected from some patient records were incomplete; for example, city of referral, burn TBSA, and burn depth were not always available in charts or electronic records. This creates some gaps in knowledge that may have skewed our findings. As well, we examined only the last two years of outpatient clinic visits and were limited to data from one centre, though this centre serves the majority of the province. Decisions about burn treatment and operative management

Table 7 – British Columbia clinical practice guidelines for criteria requiring referral to a major burn care center.

British Columbia Clinical Practice Guidelines
for Major Burn Referrals

- >20 % TBSA partial and/or full thickness any age
- >10 % TBSA partial and/or full thickness age <10 or >50
- Burns to hands, face, feet, genitalia, joints
- Full thickness burns > 5% TBSA any age
- Electrical burns
- Chemical burns
- Inhalation injury
- Burns associated with major trauma

were all primarily made by the Burn Director at VGH and therefore do not take into consideration variations in practice between providers. However, our study demonstrates the volume and characteristics of outpatient cases seen at the VGH Burn Clinic from across the province. Future directions include expanding the period of study from the past two years to the past 5–10 years in order to better understand trends in this patient population and to either corroborate or challenge the findings reported here. Furthermore, work can be done to investigate referral patterns behind the cases identified in this study as “inappropriate referrals” and their correlation to current BC Burn Guidelines adherence. Lastly, future investigations can be conducted on the high volume of Emergency Department burn referrals and methods to counteract or alleviate pressure on burn centres from ED visits requiring follow-up.

5. Conclusion

Vancouver General Hospital is the major tertiary burn centre in British Columbia and serves much of its population. As a result, the Outpatient Burn Clinic receives a high volume of referrals for assessment by a burn specialist. Our data demonstrates the majority of these referrals are from within the Vancouver area, primarily as follow-up from various Emergency Department visits. The majority of burns involved the hands, were less than 5% TBSA, and were superficial dermal in depth. Almost one third of burn injuries only attended one appointment before discharge, and of these, almost half received no treatment from the clinic. Overall, our data demonstrates the demographics, characteristics, and management patterns of outpatient burn cases served by the Vancouver General Hospital. Future directions from this project include a larger retrospective analysis of patients treated in the OP Burn Clinic and investigating the efficacy of current BC Burn Referral Guidelines with respect to this cohort of burn patients.

Contributions

All authors made substantial contributions to the literature search, study design, data collection, data analysis and interpretation, and drafting of article or revising it critically for important intellectual content. All authors approved the final version to be submitted.

Conflict of interest

None.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Ethics approval

Ethics approval was obtained from the University of British Columbia Clinical Research Ethics Board.

Acknowledgements

We would like to acknowledge the contributions of Tesnim Sairi and Kero Yeun for assistance in literature review and statistical analysis as well as Maria Vivas for assistance in development of the Burn Registry.

Appendix A.

Table A1 – Number of appointments for burns <1% TBSA, stratified by depth and location. UE = upper extremities, LE = lower extremities. Note the same burn could have occurred at multiple anatomical sites.

Burns <1% TBSA		Number of Appointments					
		Total		1	2–5	6–10	11–20
		170		75 44.1%	79 46.5%	13 7.7%	3 1.8%
		n	%	n	n	n	n
Epidermal	Head	3	1.8%	3			
	Neck						
	Hands	6	3.5%	6			
	UE						
Superficial	LE						
	Trunk						
	Head	12	7.1%	9	3		
	Neck						
	Hands	68	40.0%	39	28	1	
	UE	17	10.0%	8	8	1	
	LE	23	13.5%	9	14		
	Trunk	1	0.6%		1		

(continued on next page)

Table A1 (continued)

Burns <1% TBSA		Number of Appointments					
		Total		1	2-5	6-10	11-20
		170		75 44.1%	79 46.5%	13 7.7%	3 1.8%
		n	%	n	n	n	n
Mid-dermal	Head	2	1.2%	1	1		
	Neck						
	Hands	9	5.3%	3	5	1	
	UE	2	1.2%		1	1	
	LE	2	1.2%		2		
Deep dermal	Trunk	3	1.8%		2	1	
	Head						
	Neck						
	Hands	6	3.5%		6		
	UE	1	0.6%			1	
Full Thickness	LE	8	4.7%	2	5		
	Trunk	25	14.7%	2	16	6	1
	Head	2	1.2%		1	1	
	Neck						
	Hands	7	4.1%	1	4	1	1
Not reported	UE	4	2.4%		2	2	
	LE	8	4.7%		4	2	2
	Trunk	2	1.2%		1	1	
	Head	1	0.6%		1		
	Neck	1	0.6%	1			
	Hands	3	1.8%	2	1		
	UE	1	0.6%	1			
	LE	4	2.4%	1	1	2	
	Trunk	2	1.2%	1	1		

Table A2 – Number of appointments for burns of 1–4% TBSA, stratified by depth and location. UE = upper extremities, LE = lower extremities.

Burns 1-4% TBSA		Number of Appointments					
		Total		1	2-5	6-10	11-20
		157		43 27.4%	70 44.6%	32 20.4%	12 7.6%
		n	%	n	n	n	n
Epidermal	Head	1		1			
	Neck	1	0.6%	1			
	Hands		0.6%				
	UE						
	LE						
Superficial	Trunk						
	Head	17		8		3	
	Neck	5	10.8%	2	6		1
	Hands	34	3.2%	14	2	3	
	UE	25	21.7%	15	17	2	1
	LE	25	15.9%	5	7	4	
	Trunk	16	15.9%	7	16		1
	Head	7	10.2%	1	8	3	1
	Neck	1	4.5%		2	1	

Table A2 (continued)

Burns 1-4% TBSA		Number of Appointments					
		Total		1	2-5	6-10	11-20
		157		43 27.4%	70 44.6%	32 20.4%	12 7.6%
		n	%	n	n	n	n
Deep dermal	Hands	17	0.6%	2		5	2
	UE	15	10.8%	1	8	3	1
	LE	10	9.6%	1	10	4	2
	Trunk	7	6.4%	2	3	1	
			4.5%		4		
	Head						
	Neck						
	Hands	4				4	
	UE	7	2.5%			5	1
	LE	20	4.5%		1	7	4
Full Thickness	Trunk	3	12.7%		9		
						1	1
	Head	4	1.9%	1	1	2	
			2.5%				
	Neck						
	Hands	5		1		1	
	UE	10	3.2%		3		
	LE	10	6.4%	1	6	3	
	Trunk	3	6.4%		6	2	1
			1.9%		3		
Not reported	Head						
	Neck						
	Hands	1					1
	UE	2	0.6%	1			1
	LE		1.3%				
	Trunk	1					
			0.6%		1		

Table A3 – Number of appointments for burns of 5-19% TBSA, stratified by depth and location. UE = upper extremities, LE = lower extremities.

Burns 5-19% TBSA				Number of Appointments				
		Total		1	2-5	6-10	11-20	20+
		83		12 14.5%	43 51.8%	15 18.1%	9 10.8%	4 4.8%
		n	%	n	n	n	n	n
Superficial	Head	17	20.5%	4	8	2	2	1
	Neck	9	10.8%	2	6	1		
	Hands	15	18.1%	4	7	2	1	1
	UE	18	21.7%	3	11	2	2	
	LE	8	9.6%	4	2			
	Trunk	13	15.7%	4	5	1	1	1

(continued on next page)

Table A3 (continued)

Burns 5-19% TBSA				Number of Appointments				
		Total		1	2-5	6-10	11-20	20+
		83		12 14.5%	43 51.8%	15 18.1%	9 10.8%	4 4.8%
		n	%	n	n	n	n	n
Mid-dermal	Head	14	16.9%	1	8	3	2	
	Neck	8	9.6%		5	3		
	Hands	13	15.7%	1	9	1	2	
	UE	16	19.3%		10	3	3	
	LE	11	13.3%		7	2	2	
	Trunk	9	10.8%		6	2	1	
Deep dermal	Head	9	10.8%	1	5	2		1
	Neck	6	7.2%		2	2	1	1
	Hands	8	9.6%		3	2	1	2
	UE	12	14.5%	1	6	4	1	
	LE	11	13.3%	1	7	2		1
	Trunk	11	13.3%	1	6	2	1	1
Full Thickness	Head	6	7.2%	1	2	2	1	
	Neck	5	6.0%		1	3		1
	Hands	5	6.0%		2	1	1	1
	UE	12	14.5%	1	4	4	2	1
	LE	9	10.8%	2	4	2	1	
	Trunk	13	15.7%	1	6	4	1	1

Table A4 – Number of appointments for burns $\geq 20\%$ TBSA, stratified by depth and location. UE = upper extremities, LE = lower extremities.

Burns ≥20% TBSA				Number of Appointments				
		Total		1	2-5	6-10	11-20	20+
		38		3 7.9%	21 55.3%	8 21.1%	5 13.2%	1 2.6%
		n	%	n	n	n	n	n
Superficial	Head	3	7.9%	1	2			
	Neck	1	2.6%		1			
	Hands	1	2.6%		1			
	UE	2	5.3%	1	1			
	LE	3	7.9%	1	2			
	Trunk	1	2.6%	1				
Mid-dermal	Head	6	15.8%	1	4	1		
	Neck	4	10.5%	1	2	1		
	Hands	7	18.4%	1	4	2		
	UE	8	21.1%	1	5	2		
	LE	7	18.4%		5	2		
	Trunk	6	15.8%	1	3	2		
Deep dermal	Head	6	15.8%		3	2	1	
	Neck	1	2.6%		1			
	Hands	6	15.8%		3	3		
	UE	9	23.7%		5	3	1	
	LE	6	15.8%		2	3	1	
	Trunk	8	21.1%		4	3	1	
Full Thickness	Head	10	26.3%		3	2	4	1
	Neck	9	23.7%		4	1	3	1
	Hands	9	23.7%		3	2	4	1
	UE	15	39.5%	1	6	3	4	1
	LE	14	36.8%	1	7	3	2	1
	Trunk	15	39.5%	1	7	2	4	1

REFERENCES

- [1] Burns: Fact sheet. World Health Organization, Web site. <http://www.who.int/mediacentre/factsheets/fs365/en/>. [Accessed February 25, 2018].
- [2] Burn incidence and treatment in the United States. American Burn Association; 2016 Web site. <http://ameriburn.org/who-we-are/media/burn-incidence-fact-sheet/>. [Accessed February 25, 2018].
- [3] Saffle JR, Edelman L, Theurer L, Morris SE, Cochran A. Telemedicine evaluation of acute burns is accurate and cost-effective. *J Trauma Inj Infect Crit Care* 2009;67(2):358–65.
- [4] Gregory S, Vu M, Sweet D, et al. Provincial clinical practice guidelines for the management of major burn trauma. *BCM J* 2012;54(9):456–8.
- [5] Oh H, Sunjoo. Burns in South Korea: an analysis of nationwide data from the health insurance review and assessment service. *Burns* 2015;42(3):675–81.
- [6] Chen Shih-Han, Chen Yi-Chun, Chen Tzeng-Ji, Ma Hsu. Epidemiology of burns in Taiwan: a nationwide report including inpatients and outpatients. *Burns* 2014;40(7):1397–405.
- [7] Sözen İ, Guldogan CE, Kismet K, Sabuncuoğlu MZ, Yasti AÇ. Outpatient burn management and unnecessary referrals. *Ulus Travma Acil Cerrahi Derg* 2015;21(1):27–33.
- [8] Vercruysse GA. The demographics of modern burn care: Should most burns be cared for by non-burn surgeons? *Am J Surg* 2011;201(1):91–6.
- [9] Bezuhly M, Gomez M, Fish JS. Emergency department management of minor burn injuries in ontario, canada. *Burns* 2004;30(2):160–4, doi:<http://dx.doi.org/10.1016/j.burns.2003.10.006>.
- [10] Atiyeh B, Dibo SA, Janom HH. Telemedicine and burns: an overview. *Ann Burns Fire Disasters* 2014;27(2):87.
- [11] Sagraves SG, Phade SV, Spain T, et al. A collaborative systems approach to rural burn care. *J Burn Care Res* 2007;28(1):111.
- [12] Smith AC, Kimble RM, O'brien A, Mill J, Wootton R. A telepaediatric burns service and the potential travel savings for families living in regional australia. *J Telemed Telecare* 2007;13(3 suppl):76–9.
- [13] Boissin C, Hasselberg M, Kronblad E, et al. Adherence to referral criteria at admission and patient management at a specialized burns centre: The case of the red cross war memorial children's hospital in Cape Town, South Africa. *Int J Environ Res Public Health* 2017;14(7):E732, doi:<http://dx.doi.org/10.3390/ijerph14070732>.
- [14] Anwar U, Majumder S, Austin O, Phipps AR. Changing pattern of adult burn referrals to a regional burns centre. *J Burn Care Res* 2007;28(2):299.
- [15] Gore DC. Outcome and cost analysis for outpatient skin grafting. *J Trauma* 1997;43(4):2.
- [16] Carter JE, Neff LP, Holmes 4th JH. Adherence to burn center referral criteria: are patients appropriately being referred? *J Burn Care Res* 2010;31(1):26–30, doi:<http://dx.doi.org/10.1097/BCR.0b013e3181cb8efb>.