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12 Years of ablative fractional CO_2 laser Practice: Logistics, lessons and evolving model of care

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ABSTRACT

Introduction: Ablative fractional CO_2 lasers ($AFCO_2L$) have been shown to improve burn hypertrophic scars significantly. In this paper we describe the journey of setting up the laser service for burns patients, considerations in patient selection, treatment algorithms, and lessons learned.
Methods: This study is a retrospective cohort study including all patients who received $AFCO_2L$ at the Western Australian (WA) Statewide Adult Burn Unit since the start of the program in 2013–2024. Descriptive statistics present the number, timing and settings of $AFCO_2L$ events, as well as patient, injury, and treatment characteristics. Further, the profile of patients who underwent laser treatment was compared to those who did not, during the study period.
Results: Since the introduction of the AFCO2L, a total of 4005 laser sessions involving 837 burns patients has been completed in WA. The majority were performed as an outpatient (66 %), with the proportion and total numbers increasing with time to 2021. Compared to those not receiving laser for their scars, AFCO2L was more likely applied to younger ($p < 0.0001$), female ($p < 0.0001$) patients with higher %TBSA burns ($p < 0.0001$) involving multiple anatomic areas ($p = 0.001$), more often requiring surgery ($p < 0.0001$) and longer times to heal ($p < 0.0001$). In 2013, 100 % of all lasers were provided as an inpatient, under general anesthetic with an average age of scar > 5000 days. By 2023/4, only 18 % required an inpatient stay and the average age of scar was 111 days.
Conclusions: The SABU team evolved $AFCO_2L$ therapy into the model of care over time to achieve earlier, more equitable delivery of laser treatments to 80 % of patients as outpatients, supported by extensive multidisciplinary team involvement.

1. Introduction

Laser therapy, specifically, ablative fractional CO_2 lasers ($AFCO_2L$) has been shown to effectively improve hypertrophic burn scars (HBS) [1–5]. $AFCO_2L$ improves scar function (softness, pliability) and stiffness, symptoms (pruritus), and aesthetic concerns [6–12].

The $AFCO_2L$ was first introduced in the Western Australian (WA) State-wide Adult Burn Unit (SABU) for the treatment of HBS in 2013; the first not only in Australia but the whole Southern Hemisphere. Information gathered in the first few years of treating burn patients with lasers has created a paradigm shift in how we approach the treatment of scars [3,4]. How we view the reconstructive ladder (or elevator) has changed with the addition of this modality to our reconstructive toolbox. This work represents the largest dataset for $AFCO_2L$ in HBS in adult burn survivors in Australia.

Currently, there are few resources that describe the logistics and evolution of setting up a laser service; or, which patients to treat, when, and how. Hultman et al. [13] described how to create a laser practice by

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focusing on the aspects that are needed to create one. This study amalgamates our twelve years of clinical practice data, combined with reflections on aspects of service development. The aim of this retrospective review was to present our change in practice and lessons learned, to inform other laser clinicians of the practical and clinical aspects that we have found helpful. In this report, we describe the journey of setting up the laser service for burns patients, considerations in patient selection, treatment algorithms, and lessons learned. The results may assist to reduce variation in practice and lead to a more evidence-based service.

2. Materials and methods

2.1. Study design and approval

This study is a retrospective cohort study including all patients who received laser therapy from the start of the WA program from January 1, 2013 to April 30, 2024. It was approved by South Metropolitan Health Service (SMHS) Human Research and Ethics Committee (HREC), as a sub-project (value-based health care studies [14]) of the long-term registry study (RGS0000002233).

2.2. Patient Population

All adult patients (16 years and above) who had a burn scar treated with $AFCO_2L$ as an outpatient or inpatient, were included in this study.

2.3. Preprocedural care

All patients undergo a standardized consent process, supported by an information package. Consent includes the risks of infection, pigmentation changes, dissatisfaction with the resulting treatment, post-procedural pain, and prolonged wound healing. Patient's scars are recorded at baseline and over time through standardized photographs and comprehensive occupational therapy assessments including POSAS and modified VSS [15]. Patients undergoing outpatient $AFCO_2L$ will be given EMLA to apply to their treatment area and cling film at home approximately one hour before their treatment appointment.

2.4. Laser settings

The laser used is a $AFCO_2L$ (Ultrapulse, Lumenis Corporation, Santa Clara, CA). Laser settings used depend on the goal of therapy. To decrease scar height, improve pliability, and decrease itch, the SCAARFx and DeepFX settings are used. SCAARFx is commonly used for scars of greater than 2 mm in height (80–120 mJ, 250 Hz, 3 % density). DeepFX is commonly used for scars less than 2 mm in height or flat scars that are pruritic or tight (30–50 mJ, 300 Hz, 5 % density).

2.5. Postoperative care

A silicone dressing is applied post-treatment and stays intact for 48 h after which the patient removes it. Patients then apply a topical steroid ointment (1 % hydrocortisone acetate) twice a day for two weeks to hydrate the scar, assist in steroid delivery, and reduce risks of post-inflammatory hyperpigmentation.

2.6. Resources

Requirements for laser licenses and qualification of laser operators differs between states in Australia and internationally. In WA, $AFCO_2L$ is a class IV laser requiring delivery by a licensed doctor and presence of a laser safety officer (generally a nurse). Personal protective equipment ('PPE') required includes laser safety googles and N95 masks to prevent inhalation of laser plumage. Appropriate signage outside the laser room is essential to prevent accidental walk-ins by individuals not wearing appropriate PPE. Patient-specific PPE includes eye protection as well as wet gauze around the ETT for intubated patients to minimize fire risk.

2.7. Multidisciplinary team and timing

Follow-up for all burns patients occurs in a routine manner (generally at 6 weeks, 3-, 6-, and 12- months post-burn injury). The team consists of surgeons, nurses, and occupational therapists and physiotherapists. Patients are assessed pre-laser as well as after one (1) laser cycle which consists of three (3) laser sessions.

2.8. Data analyses

Descriptive statistics were used to assess the number and timing of $AFCO_2L$, as well as patient, injury, and treatment characteristics. Patients who underwent laser treatment were compared to those who did not receive $AFCO_2L$. Continuous variables were analyzed using Mann-Whitney U-tests, while categorical variables were compared using chi-square tests.

The acute burn time to healing was defined as the number of days between injury and at least 95 % healing, as recorded in the electronic medical record. The mean time (days) between injury and first laser treatment and the number of lasers received was calculated for each year our service was in operation. Patient, injury, and treatment characteristics were compared between those who received laser within ≤ 18 months post-burn and those treated > 18 months post-burn as a marker of immature and mature burns. Furthermore, the number of laser treatments per %TBSA burned was analyzed.

Predictive factors of receiving laser therapy were analysed using univariate and multivariate analyses. Factors with a significance level of $p < 0.20$ in univariate analyses were checked for collinearity (>0.8 or < -0.8) and entered the generalized linear model. The level of significance was set at $p < 0.05$. Regression coefficients and the corresponding standard errors (SE) were reported.

3. Results

3.1. Patient Demographics

The WA patients, who were burn injured in 2002 or after, and received AFCO2L therapy for their scars, were more likely to be female (54 %) with a median age of 31 (21–45) with no recorded comorbidities (82 %) (Table 1). The majority lived in the metro region (74 %) and were Fitzpatrick 2 (fair) skin type (46 %). The median % TBSA burned was 2.5 (0.9–9.6) with scald being the most common mechanism of injury (22 %). Most laser patients had received a skin graft (48 %) with burns to multiple anatomic locations (44 %). The median time to 95 % healing was 22 days (IQR of 15–35 days).

3.2. Patient setting

Sixty-six percent (66 %) of all lasers were performed as an outpatient. In 2013, 100 % of all lasers were provided as an inpatient setting ($n = 17$) in comparison to only 57 (18 %) outpatients in 2023 (Fig. 1, Supp Table A). It was three years (276 patients) before laser therapy was available as an outpatient. Once outpatient laser was introduced in 2016, this rapidly became our preferred treatment setting (Fig. 1).

3.3. Factors associated with receiving laser treatment

Patient characteristics predisposing patients to receiving laser therapy were younger age ($p < 0.0001$), female gender ($p < 0.0001$), higher TBSA percentage ($p < 0.0001$), multiple anatomic areas affected ($p = 0.001$), longer time to wound healing ($p < 0.0001$), and surgery ($p < 0.0001$). A patient was less likely to receive laser treatment if the burn was on the head ($p = 0.024$), hand ($p < 0.0001$), or leg ($p < 0.0001$); an

Table 1
Demographics of patients who underwent AFCO$_2$L treatment, compared to all others who were treated by the SABU team (2013–2024).

Variable (Median (IQR) unless otherwise stated)	**Laser (n = 837)**	**No laser (n = 5351)**	**p-value** *
Gender: male [n(%)]	383 (45.8 %)	3641 (68.0 %)	**<0.001**
Age	31.0 (21.0–45.0)	38.0 (26.0–53.0)	**<0.001**
Comorbidities [n(%)]	690 (82.4 %)	4426 (82.7 %)	0.718
No comorbidity	71 (8.5 %)	479 (9.0 %)	
One comorbidity	76 (9.1 %)	446 (8.3 %)	
Two or more comorbidities			
%TBSA burned	2.5 (0.9–9.6)	1.4 (0.5–3.7)	**<0.001**
%TBSA burned	191 (22.8 %)	2114 (39.5 %)	**<0.001**
<=1%	189 (22.6 %)	1770 (33.1 %)	
>1–5 %	75 (9.0 %)	472 (8.8 %)	
>5–10 %	66 (7.9 %)	196 (3.7 %)	
>10–20 %	76 (9.1 %)	82 (1.5 %)	
>20 %	240 (28.7 %)	717 (13.4 %)	
Unrecorded			
%TBSA full thickness	0.0 (0.0–0.0)	0.0 (0.0–0.0)	**<0.001**
Length of hospital stay (days)	5.0 (1.0–12.0)	3.0 (1.0–7.0)	**<0.001**
Surgery events	1.0 (0.0–1.0)	1.0 (0.0–1.0)	**<0.001**
Grafting event count [n(%)]	270 (32.3 %)	2408 (45.0 %)	**<0.001**
No grafts	402 (48.0 %)	2669 (49.9 %)	
One grafts	165 (19.7 %)	274 (5.1 %)	
Two or more grafts			
Intensive care unit admission [n(%)]	75 (9.0 %)	140 (2.6 %)	**<0.001**
Mechanical ventilation [n(%)]	56 (6.7 %)	102 (1.9 %)	**<0.001**
Agent [n(%)]	29 (3.5 %)	312 (5.8 %)	**<0.001**
Chemical	77 (9.2 %)	926 (17.3 %)	
Contact	5 (0.6 %)	35 (0.7 %)	
Cooling	5 (0.6 %)	48 (0.9 %)	
Electrical	49 (5.9 %)	381 (7.1 %)	
Explosion/Flash	162 (19.4 %)	1125 (21.0 %)	
Flame	22 (2.6 %)	139 (2.6 %)	
Friction	1 (0.1 %)	2 (0.0 %)	
Hot gas	8 (1.0 %)	89 (1.7 %)	
Radiant heat	187 (22.3 %)	1431 (26.7 %)	
Scald	0 (0.0 %)	43 (0.8 %)	
Sunburn	292 (34.9 %)	820 (15.3 %)	
Unrecorded			
Time to healing (days)	22.0 (15.0–35.0)	15.0 (6.0–20.0)	**<0.001**
Skin type [n(%)]	65 (7.8 %)	360 (6.7 %)	**<0.001**
Type 1 Pale white skin	387 (46.2 %)	2919 (54.6 %)	
Type 2 Fair skin	128 (15.3 %)	901 (16.8 %)	
Type 3 Darker white / Light	120 (14.3 %)	612 (11.4 %)	
brown skin	65 (7.8 %)	311 (5.8 %)	
Type 4 Medium brown skin	40 (4.8 %)	176 (3.3 %)	
Type 5 Rich brown skin	32 (3.8 %)	72 (1.3 %)	
Type 6 Very dark brown / black skin			
Unrecorded			
Anatomic Area Burned [n(%)]	302 (36.1 %)	1475 (27.6 %)	**<0.001**
Arm	58 (6.9 %)	268 (5.0 %)	**<0.001**
Buttock	129 (15.4 %)	988 (18.5 %)	0.908
Foot	255 (30.5 %)	1517 (28.3 %)	**<0.001**
Hand	167 (20.0 %)	850 (15.9 %)	**<0.001**
Head	295 (35.2 %)	1948 (36.4 %)	**<0.001**
Leg	231 (27.6 %)	1008 (18.8 %)	**<0.001**
Trunk	367 (43.8 %)	1999 (37.4 %)	**<0.001**
Multiple locations			
Location patient living [n(%)]	621 (74.2 %)	3611 (67.5 %)	**<0.001**
Metro	58 (6.9 %)	498 (9.3 %)	
Remote	133 (15.9 %)	993 (18.6 %)	
Rural	25 (3.0 %)	249 (4.7 %)	
Unrecorded			

* p-values in bold are statistically significant at $p < 0.05$.

accident at work ($p = 0.004$), motor vehicle accident ($p = 0.008$), or self-harm ($p = 0.002$); and rural or remote living ($p < 0.0001$)(Table 1). Increased odds of AFCO2L therapy were also associated with increased median occupational therapy, physiotherapy, clinical psychology, and dietetics treatment occasions (all $p < 0.001$) (Table 2).

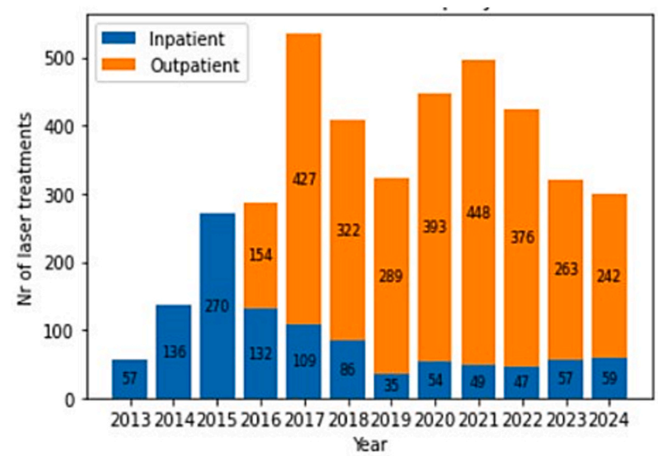

Fig. 1. Proportion of cases receiving AFCO2L in inpatient or outpatient settings, by year.

Table 2
Median allied health occasions of service, comparing those who received and did not receive AFCO$_2$L therapy, in addition to routine care.

Allied Health Discipline	**Occasions of service** [median (IQR)]		
	Laser	**No laser**	**p-value***
Dietetics	3.1 (0.0–1.0)	0.8 (0.0–0.0)	**<0.001**
Occupational therapy	18.7 (1.0–17.0)	5.1 (0.0–7.0)	**<0.001**
Physiotherapy	31.1 (1.0–24.8)	10.1 (1.0–11.0)	**<0.001**
Clinical Psychology	1.7 (0.0–0.0)	0.2 (0.0–0.0)	**<0.001**

* p-values in bold are statistically significant at $p < 0.05$.

3.4. Factors associated with increased laser treatments

Once laser therapy was commenced, a patient was more likely to receive a greater number of laser sessions if they were younger ($p < 0.0001$), female ($p < 0.0001$), had a higher %TBSA ($p = 0.016$), multiple locations affected ($p = 0.007$), longer time to wound healing ($p < 0.0001$), and surgery ($p < 0.0001$) (Table 3). In addition, more lasers were associated with patients who had been treated as an inpatient for their acute burn ($p < 0.0001$), had Type 4 Medium brown skin ($p < 0.0001$), and had an accident at work ($p < 0.0001$). Less laser sessions were associated with buttock ($p = 0.007$), foot ($p = 0.018$), leg ($p = 0.025$) burns as well as rural ($p = 0.038$) and remote ($p < 0.0001$) living.

3.5. Timing of laser treatments

While most patients received their first laser treatment within 18 months or less of their injury (73 %) in comparison to more than 18 months after injury (27 %) though Fig. 2 demonstrates the progressive shortening of the time between burn and first laser treatment. In 2013, a patient in SABU the average age of the scar was 15 years old, while in 2017 it was 248 days, and then 111 days in 2024 (Fig. 2). Receiving laser within 18 months of injury, was associated with older age ($p < 0.001$), longer length of stay ($p < 0.001$), and presence of grafts ($p < 0.001$) (Table 4).

3.6. Number of laser treatments

Across the whole cohort, patients receiving AFCO2L therapy underwent an average of 4.8 sessions (SD of 4.1) with the median number being 3.0 (IQR 2.0–6.0) (Fig. 3). The median number of lasers per patient by year of injury was variable over the study period, with a sharp decline since 2020 (Fig. 4). As expected, in all patients who received laser therapy, as %TBSA increased, the median number of treatments

Table 3
Multivariable model of factors associated with number of laser treatments.

Variable	Regression coefficient[α]	SE	p-value [*]	95 % CI
Age	−0.0085	0.001	**<0.001**	[−0.011, −0.006]
%TBSA burned	0.0166	0.006	**0.016**	[0.005, 0.028]
Comorbidities (Elixhauser score)	−0.0065	0.008	0.432	[−0.023, 0.01]
Number of surgeries	0.5188	0.033	**<0.001**	[0.454, 0.584]
Time to healing (Days)	0.0102	0.002	**<0.001**	[0.007, 0.014]
Female gender	0.5455	0.050	**<0.001**	[0.447, 0.644]
Skin type (Pale white)	0.0411	0.096	0.667	[−0.146, 0.228]
Skin type (Darker white / Light brown)	0.0447	0.066	0.500	[−0.085, 0.175]
Skin type (Medium brown)	0.2727	0.074	**<0.001**	[0.127, 0.418]
Skin type (Rich brown)	0.0846	0.102	0.405	[−0.114, 0.284]
Skin type (Very dark brown / black)	−0.0704	0.136	0.605	[−0.337, 0.197]
Accident (at work)	0.2924	0.054	**<0.001**	[0.187, 0.397]
Accident (not at work)	−0.0812	0.167	0.627	[−0.409, 0.247]
Accident (motor vehicle)	−0.0858	0.136	0.528	[−0.352, 0.181]
Accident (other)	0.0162	0.064	0.801	[−0.109, 0.142]
Non accident (assault)	0.1256	0.282	0.655	[−0.426, 0.677]
Non accident (self-harm)	−0.4803	0.25	0.055	[−0.97, 0.01]
Non accident (suicide)	−0.1422	0.533	0.789	[−1.186, 0.901]
Scar reconstruction	0.8982	1.062	0.398	[−1.184, 2.98]
Inpatient	0.3426	0.066	**<0.001**	[0.213, 0.472]
ICU admission	0.1675	0.158	0.290	[−0.142, 0.478]
Remote living	−0.3504	0.086	**<0.001**	[−0.52, −0.181]
Rural living	−0.152	0.062	**0.038**	[−0.274, −0.03]
Multiple locations affected	0.187	0.075	**0.007**	[0.04, 0.334]
Trunk burn	0.0836	0.071	0.239	[−0.056, 0.223]
Hand burn	−0.0942	0.058	0.105	[−0.208, 0.02]
Arm burn	−0.0181	0.064	0.777	[−0.143, 0.107]
Buttock burn	−0.2899	0.116	**0.007**	[−0.517, −0.063]
Foot burn	−0.1499	0.067	**0.018**	[−0.281, −0.019]
Leg burn	−0.1331	0.057	**0.025**	[−0.245, −0.021]
Head burn	0.081	0.074	0.274	[−0.064, 0.226]

[α] Negative coefficients indicates association with a lesser number of laser treatments, and conversely, positive coefficients are associated with greater treatment count.
[*] p-values in bold are statistically significant at $p < 0.05$.

also increased (Fig. 5).

3.7. Multidisciplinary team impact

Resources required when assessing and treating patients with burn injuries using laser versus no laser (standard care) showed higher resource utilization of all allied health groups (Table 2). The associated increased use of resources for those requiring laser therapy, was also reflected in the overall costings per case (Table 5). However, with the integration of the SABU AFCO2L service, the overall number of formal reconstructive surgeries decreased (Fig. 6).

4. Discussion

This study represents the largest cohort of individuals receiving laser therapy in Australia, and this study crystalized multiple data-driven and observational lessons learned over the twelve-year time frame. Currently, AFCO2L therapies are employed in nearly all burn centers in Australia and New Zealand indicating its acceptance, utility and perceived value by burns clinicians. Thus, we believe, this study achieved the aim to inform, and help, others establishing and growing their own laser service to treat scarring.

Equity of access to the confirmed benefits of AFCO2L treatment for burn scarring was improved markedly, by a shift from delivering laser primarily in theatre to provision of ≥ 80 % in the outpatient setting since 2017 and burgeoning numbers after the COVID pandemic (Fig. 1 and Supp Table A). Further, this study confirmed that delivering laser therapy was not impeded by the presence of comorbidities (Table 1). Secondly, this study showed that the benefits of laser therapy can be accessed much earlier in the scar maturation journey without an increase in adverse events, as supported by our two laser trials [3,4] and reducing median time between burn and first laser and number of lasers required (Figs. 2 and 4).

4.1. Evolution of SABU laser service

This study has shown that the SABU team streamlined outpatient laser processes over time, with most cases completed in the outpatient setting (66 %). Further, the study numbers showed that local laser can be completed safely and was tolerated well, with relative comfort while awake under the influence of oral analgesia and topical anesthetic cream. In 2025, our practice is to use a topical anesthetic (Lidocaine 2.5 % and Prilocaine 2.5 %) self-applied by the patient or carer, about one (1) hour before the local laser outpatient appointment. Operative laser cases are now prioritized for patients with large %TBSA (large laser treatment areas) or for very sensitive areas such as the face.

The shift to outpatient laser provision, has enabled the SABU team to offer a more patient-centric, five-day service delivering more patient choice, schedule flexibility, and increased the capacity, and efficiency, allowing prioritised access for more patients in the clinic-based morning or afternoon sessions, than could be achieved in an operative setting. Concurring with other reports, adverse events were rare despite a diverse cohort [16]. In that, the risks of general anesthetic are removed in the outpatient setting, allowing more elderly and medically comorbid patients to be treated safely. Anecdotally, by moving more laser treatments to the outpatient setting, we observed reduced pressure on SABU inpatient capabilities. By reducing the overall number of multiday reconstructive surgery cases each year (Fig. 6), elective and emergency surgical lists had more capacity. Additional positive effects of maximising the use of the outpatient setting, were that AFCO2L treatment was: more readily available as the SABU managed the bookings, resulting in shorter time on the waitlist in comparison to other scar reconstructions; did not require an anesthetist to be present; and, less likely to be rescheduled compared to when performed under a general anesthetic. While not the focus of this study, this is likely to lead to a reduction in costs to the service, the hospital, and the environment [17,18], and may may also reduce the environmental impact of theater with fewer cases under anesthetic [19–22] as well as improving overall bed flow for the hospital.

SABU practice ethos has changed, with a low threshold to early identification of patients who may benefit from laser as we firmly

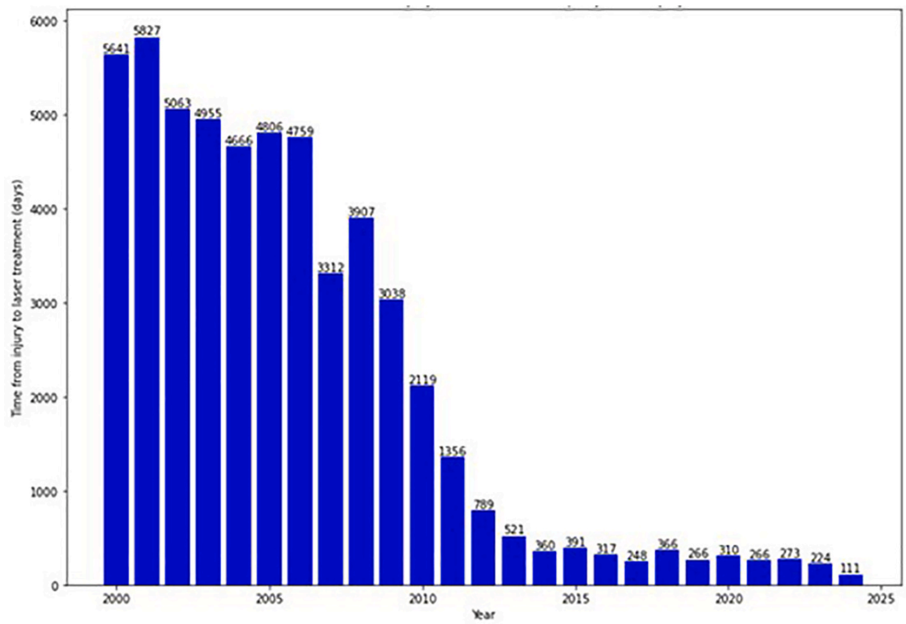

Fig. 2. Mean number of days between burn injury and first AFCO2L treatment, by year.

Table 4
Comparison of characteristics of those who received their first laser therapy treatment ≤ 18 months, or > 18 months after burn.

Variable (Median (IQR) unless otherwise stated)	**≤18 months (n = 613)**	**>18 months (n = 224)**	**p-value** *
Gender: male [n(%)]	288 (47.0 %)	95 (42.4 %)	0.336
Age	34.0 (24.0–48.0)	20.0 (11.0–35.0)	**<0.001**
Comorbidities [n(%)]	496 (80.9 %)	194 (86.6 %)	0.104
No comorbidity	59 (9.6 %)	12 (5.4 %)	
One comorbidity	58 (9.5 %)	18 (8.0 %)	
Two or more comorbidities			
%TBSA burned	2.7 (0.9–9.6)	2.0 (1.0–8.3)	0.797
%TBSA full thickness	0.0 (0.0–0.0)	0.0 (0.0–0.3)	0.188
Length of hospital stay (days)	6.0 (1.0–14.0)	1.0 (1.0–8.0)	**<0.001**
Surgery events	1.0 (1.0–1.0)	0.0 (0.0–1.0)	**<0.001**
Intensive care unit admission [n(%)]	62 (10.1 %)	13 (5.8 %)	0.072
Mechanical ventilation [n (%)]	46 (7.5 %)	10 (4.5 %)	0.161
Time to healing (days)	21.0 (15.0–34.0)	27.5 (16.2–40.5)	0.050
Skin type [n(%)]	43 (7.0 %)	22 (9.8 %)	**<0.001**
Type 1	293 (47.8 %)	94 (42.0 %)	
Type 2	110 (17.9 %)	18 (8.0 %)	
Type 3	90 (14.7 %)	30 (13.4 %)	
Type 4	43 (7.0 %)	22 (9.8 %)	
Type 5	21 (3.4 %)	19 (8.5 %)	
Type 6	13 (2.1 %)	19 (8.5 %)	
Unrecorded			
Anatomic Area Burned [n	272 (44.4 %)	30 (13.4 %)	0.371
(%)]	52 (8.5 %)	6 (2.7 %)	0.993
Arm	117 (19.1 %)	12 (5.4 %)	0.529
Buttock	233 (38.0 %)	22 (9.8 %)	0.106
Foot	147 (24.0 %)	20 (8.9 %)	0.834
Hand	265 (43.2 %)	30 (13.4 %)	0.490
Head	200 (32.6 %)	31 (13.8 %)	0.228
Leg	329 (53.7 %)	38 (17.0 %)	0.462
Trunk			
Multiple locations			
Location patient living [n	456 (74.4 %)	165 (73.7 %)	0.786
(%)]	43 (7.0 %)	15 (6.7 %)	
Metro	94 (15.3 %)	39 (17.4 %)	
Remote	20 (3.3 %)	5 (2.2 %)	
Rural			
Unrecorded			

* p-values in bold are statistically significant at $p < 0.05$.

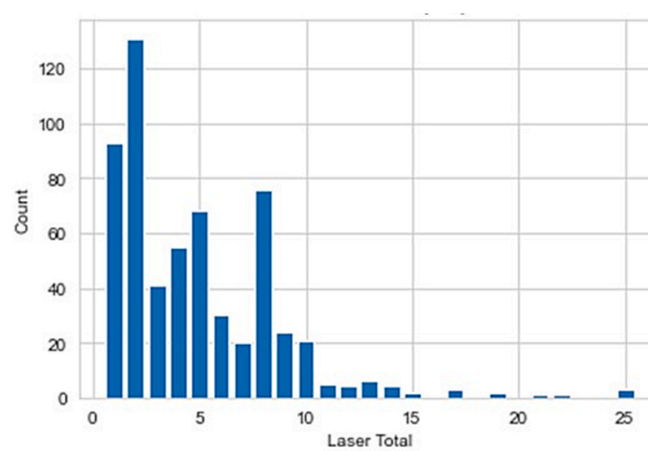

Fig. 3. Distribution of the count of AFCO2L sessions per patient.

believe they should be offered this therapy in the immature stages to improve their scars, and evidence is burgeoning to support this approach [4,23,24]. The value of allied health members of the MDT (such as OT, physios) cannot be underestimated in this process. It is our observation, that scars often worsen in the first six months post-injury and any scar which appears thick or vascular identified by any member of the team can be referred for laser in our practice. Given the improvements shown in scar symptoms [23] and outcomes [4,8] as well as quality of life [1], the earlier this is identified, the better so treatment can commence.

Whilst surgical reconstruction remains firmly in the SABU surgeon's armamentarium, operating early on burn scars can be challenging due to thick, stiff, and bleeding scar tissue. This study showed that laser can be used from an early point in the scar journey as neoadjuvant improvement prior to scar revision surgery (Fig. 2). In the example of the patient with sheets of skin graft over expansive burn areas, limited surgical options for effective release, or resurfacing, exist, particularly prior to maturation of the scar. Laser therapy represents a paradigm shift, providing options for early treatment, particularly for large surface areas of scar, and in this study was also shown to be used more often for scars on the trunk, arm and head (Table 1) but required higher numbers of laser sessions on legs and buttocks (Table 3).

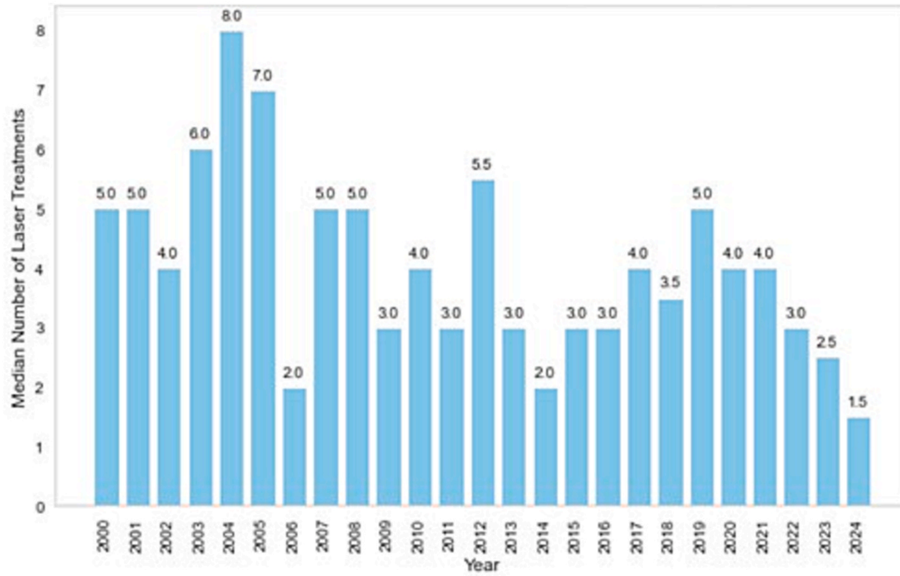

Fig. 4. Median number of laser treatments per patient by year since burn (NB reference year is year of injury).

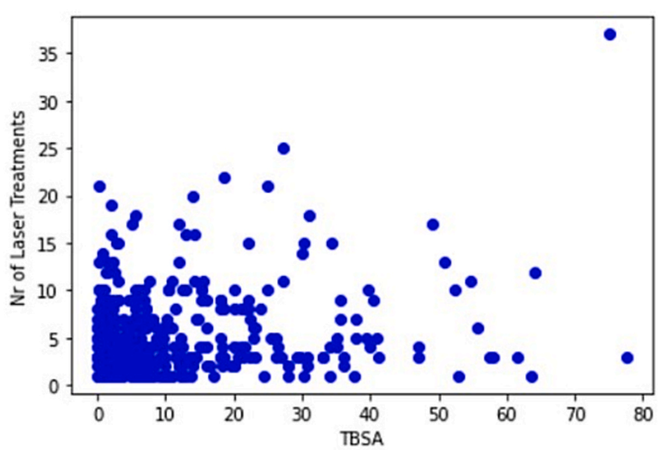

Fig. 5. Median number of laser treatments by percentage TBSA.

Table 5
Case costs (categorised) for burn patients who underwent $AFCO_2L$ treatment, compared to all others who were treated by the SABU team (2013–2024).

Costings	No laser (n = 5351)	Laser (n = 837)	p-value *
Total costs [median (IQR)]	1156.0 (578.0–3524.0)	23291.0 (8955.5–54874.0)	**<0.001**
			<0.001
1. 0 AUD	15 (0.1 %)	1 (0.1 %)	
2. 1–1000 AUD	7302 (34.6 %)	19 (2.3 %)	
3. > 1000–5000 AUD	5447 (25.8 %)	94 (11.2 %)	
4. > 5000–10,000 AUD	928 (4.4 %)	94 (11.2 %)	
5. > 10,000–20,000 AUD	1062 (5.0 %)	142 (17.0 %)	
6. > 20,000–50,000 AUD	1181 (5.6 %)	192 (22.9 %)	
7. > 50,000–100,000 AUD	285 (1.4 %)	101 (12.1 %)	
8. > 100,000 AUD	127 (0.6 %)	108 (12.9 %)	
9. Unrecorded	4735 (22.5 %)	86 (10.3 %)	

* p-values in bold are statistically significant at $p < 0.05$.

4.2. Timing of laser

As such, the SABU service initiated laser therapy for older scars at establishment, and as the team learned more about the impacts and variations in prescription, they became more comfortable with lasering immature scars (Figs. 2 and 4). The compounding benefit of timely laser therapy was confirmed during the ELIPSE trial [4], whereby earlier laser improves overall scar outcome. Most past studies involved a minimum wait of 6 months after injury before beginning laser therapy [16]. However, in keeping with the ELIPSE trial [4] commencing laser therapy at three (3) months post-burn, some researchers have started as early as one month post-injury in pediatric [25] and surgery scar [24] cohorts.

4.3. Patient factors associated with laser

In this study, individuals receiving laser treatment were more likely: younger, female; have higher %TBSA; multiple anatomic areas; longer times to wound healing; and, require surgery (Table 1). This may represent worse scars as larger areas that require surgery will likely need skin grafts and leave permanent scarring. This was further reinforced as the group also required increased input from dietetics, occupational therapy, physiotherapy, and clinical psychology (Table 4). These results are not surprising as large injuries with poorer scars tend to receive more SABU MDT involvement [26]. Whether younger, female patients tend to seek or accept laser therapy more readily than other individuals is unknown and warrants further investigation. Once laser therapy has commenced, more lasers sessions were associated with those factors above as well as being an inpatient, having Type 4 medium brown skin, and an accident that occurred at work (Table 3). Little data is available regarding predictive data for $AFCO_2L$ in the literature.

4.4. Cost impact and future studies

The aggregated case costs for those receiving laser therapy were generally higher than those who did not have the treatment (Table 5). However, the characteristics of both cohorts differed markedly, and a comprehensive economic analysis was out of scope for this study. Thus, future analyses are warranted to explore the nett cost implications and patient impacts since the instigation and establishment of the SABU $AFCO_2L$ service. To be considered in the health economic analyses is the: fact that the establishment and expansion of the SABU $AFCO_2L$ service has been achieved through reallocation, rather than expansion of staff

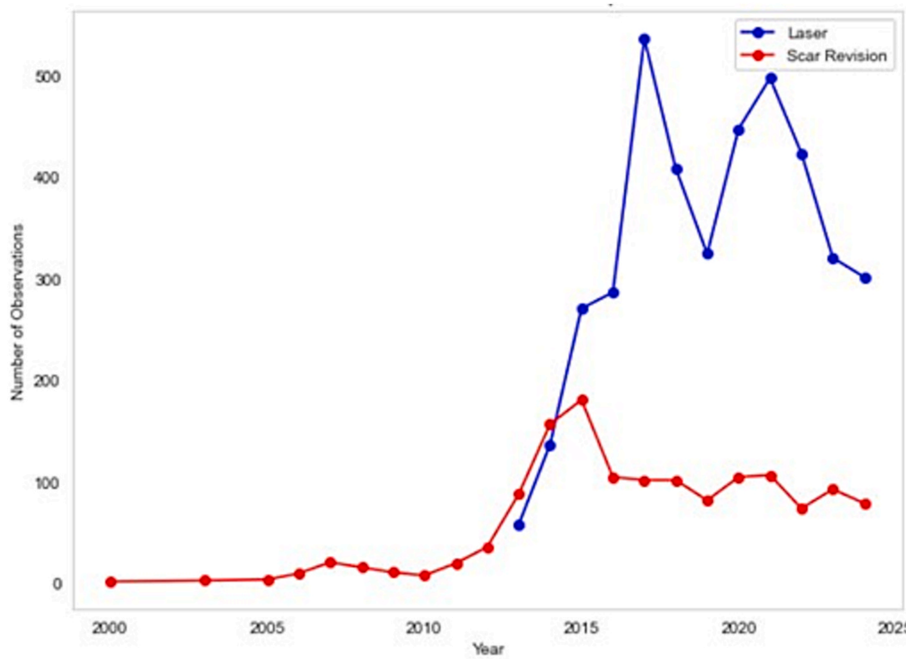

Fig. 6. Presentation of the counts of laser and surgical scar revision events by year of operation of the SABU Laser Service (NB the SABU moved to Fiona Stanley Hospital in 2015).

complement; significant and ongoing reduction of inpatient scar reconstruction procedures demonstrated since 2015 (Fig. 6); marked increase of primarily outpatient laser service events (Fig. 1); and, reducing total numbers of laser treatments delivered after the peak in 2021 (Fig. 1). Reducing operative time, in an Australian context, potentially saves an estimated average, gross cost of $42/min or $2500/hour [27]. This is a key factor in determining the past, and future cost and resource implications for the SABU service, and the tertiary hospital organization as a whole. Thus, this study warrants a future balanced assessment of the direct and indirect impact of acute practices and post-epithelialisation scar interventions, on overall duration and costs of care per patient or per percent of burn area.

5. Conclusion

The laser service in Western Australia has grown as a learning system over time and is now an integral and valued part of our standard of care for burn scar treatment. The study confirmed the strategies to enhance access to laser; provide regular, flexible treatment schedules; and, deliver MDT support are pillars of our scar care, and this has taken years to refine.

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Patient Consent

The patient information included in analyses for this study report was approved for presentation in aggregated, deidentified form, under waiver of consent provisions for the WA Burn Clinical Data Registry Program (Ethics approval RGS2233).

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.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.burnso.2025.100435.

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