



Australian Society  
of Plastic Surgeons



**Mapping Burn Surgery in Australia**

---

## Contents

---

|   |    |
|---|----|
| About this Report.....  | 2  |
| Specific issues for consideration and analysis .....                                | 2  |
| Report Methods .....  | 3  |
| Key Findings.....   | 4  |
| Patient Burn Needs.....   | 4  |
| Activity based funding and the cost of burn surgery care.....                       | 4  |
| Major Burn Unit surgeons, model of care and leadership .....                        | 5  |
| Burn surgery training and trainees .....  | 5  |
| Career and future work expectations of Surgical Trainees and Burn Surgeons .....    | 6  |
| Key issues for consideration .....  | 6  |
| Model of Care .....   | 8  |
| Burns Registry of Australia and New Zealand.....                                    | 9  |
| Burn Surgery Activity in Australia .....  | 15 |
| Funding of burn injury care .....   | 16 |
| Current bed capacity and projections .....  | 18 |
| Burn surgery training .....   | 21 |
| International experience .....  | 21 |
| Burn surgery training in Australia.....   | 22 |
| Paediatric Surgery .....  | 22 |
| General Surgery .....   | 23 |
| Plastic & Reconstructive Surgery .....  | 24 |
| Major Burn Unit facilities, organisation, leadership and workforce .....            | 26 |
| Facilities and infrastructure .....   | 26 |
| Burn unit surgical workforce.....   | 27 |
| Burn Unit head.....   | 28 |
| Burn Unit workforce planning, recruitment and retention .....                       | 28 |
| Surgeon and trainee burnout.....  | 30 |
| Plastic surgery trainee work intentions .....                                       | 32 |
| Other members of the Multidisciplinary Burn Unit team.....                          | 34 |
| Appendix 1 – surgical training curricula.....                                       | 36 |
| General Surgery Trauma Module Competencies .....                                    | 36 |
| Plastic and Reconstructive Surgery - burn and cold injury module competencies ..... | 38 |
| Appendix 2 - Major Burn Unit survey .....   | 40 |
| References.....   | 46 |

## About this Report

---

The safe and successful management of serious burn injuries is a major challenge at any time for each patient and their family, the specialist workforce, major burns units, and the health and welfare system as a whole. Recent mass casualty burns events with major bushfires in Australia and volcanic eruptions in New Zealand have again highlighted the pressure under which services must work to manage routine caseload and a significant number of cases at one time due to regular, but unpredictable disasters.

In Australia, as with other western Nations including New Zealand, Canada, United States of America and the United Kingdom, burns services face a number of ongoing but evolving challenges, including ensuring that there is:

- nationwide access to specialist burns care routinely and during mass casualty events;
- a current workforce available and able to provide highly specialised multidisciplinary care covering all aspects of management, recovery and rehabilitation;
- the development and training of a replacement and future workforce;
- system development, research and leadership consistent with service demands and societal expectations; and
- funding that accurately matches the real cost of providing complex burn injury services.

At the moment there is some uncertainty about how well Australia is placed in meeting these challenges, therefore the Australian Society of Plastic Surgeons (ASPS) working jointly with the Australian and New Zealand Burns Association (ANZBA) and in collaboration with the Australian and New Zealand Paediatric Surgeons (ANZAPS) and General Surgeons of Australia (GSA) proposes to undertake this Project of mapping research of Burns Surgery in Australia.

### Specific issues for consideration and analysis

The Sponsors and collaborating partners for this Project have identified the following key issues to be researched and analysed:

1. What are the different patient needs for burns surgery and related care and support in Australia?
2. Are there serious gaps in service provision in any part of Australia?
3. Which subspecialty surgeons (Plastic & Reconstructive surgeons / General Surgeons / Paediatric Surgeons) are treating major burns and in what proportion?
4. Which of these surgical subspecialties undertake advanced training in burns? Do all PRS trainees have substantive training in major burns units. What proportion of Paediatric and General surgical trainees have access to training in major burns units. Do surgical trainees only have some exposure to treating major burns during training instead?
5. Emergency Management of Severe Burns (EMSB) is the basic training course for immediate management of severe burns. Are surgical trainees completing this course?
6. Is there a current work force shortfall and if so, what is being done to train and recruit the next generation? Are there any Australian surgeons currently doing advanced burn training in Australia or overseas?
7. What are the options for organisational and workforce structure of major units? Do they need full time burns consultants to lead them?

8. What are the appropriate training, qualifications and expertise for junior and senior burns surgeons?
9. How is a career in burn surgery viewed by the prospective workforce?

## Report Methods

The principal method of identifying and generating data and information for this report is through a comprehensive survey sent to the major Australian Burn Services, which report data to the BurnRegistry of Australia and New Zealand (BRANZ). The survey was developed based on the findings of the search of the literature, and analysis of local, national and international burn service guidelines and having regard for the various jurisdictional burn injury management plans and professional guidance.

The key terms used in the search were, largely grouped as follows:

Burn service:

- model of care;
- equipment, facilities, infrastructure;
- usual workforce.

Burn service workforce:

- surgical trainee burn surgery exposure and training;
- surgical trainee burn surgery career intention;
- burn surgeon future career intention.

An abbreviated questionnaire was emailed to the nominated head of major Burn Units which had not responded to an initial and second invitation to participate in the survey.

The webpages of the major burn units were scanned for information about models of care, usual caseloads and key workforce appointments. The grey literature was also searched as well as general media publications.

Australian Institute of Health Welfare (AIHW) data cubes for principal diagnoses and main procedures for hospital admissions and the National Hospital Cost Data Collection (NHCDC) were analysed for burn related admissions.

## Key Findings

---

### ***Patient Burn Needs***

1. The network of major Burn Units in Australia and New Zealand, with models of care based on comprehensive multidisciplinary (MD) teams with access to up-to-date infrastructure, equipment and skin laboratories provides a strong and stable foundation to ensure access to high quality burn care.
2. The Major Burn Units in Australia manage about 45% of all burn injuries, and all paediatric major burns and almost all adult major burn injuries.
3. Substantial and ongoing community and professional education program ensures that patients are appropriately referred to both paediatric and adult Major Burn Units.
4. The number of designated and dedicated adult ward beds in Australian Major Burn Units per million population varies substantially between jurisdictions, with a rate in the range of 4.3 to 5.6 in Queensland, Tasmania, Western Australia and South Australia, but only 1.6 in Victoria and 3.1 in New South Wales (including ACT). The Victorian Adult Burn Service is based in a shared surgical ward, so has ready access to overflow capacity, but now almost occupies at least as many overflow beds as designated beds.
5. All paediatric Major Burn Units share ward space with other paediatric surgical wards, albeit utilising isolation and temperature and pressure-controlled rooms. These arrangements also allow the flexibility to manage mass casualty events.
6. First Nations people are about three times more likely to be admitted to a BRANZ hospital compared with other Australians and recent research has identified some gaps in cultural competencies and understanding in major Burn Units.
7. Significant advances in modern care have led to high rates of survival from major burn injuries, which in turn requires careful but sophisticated management to prevent scarring and has led to the development of complex treatment regimens requiring access to expensive lasers and other technologically advanced modalities and therapies.
8. The number of Burn Unit ward beds, based on adjustment to the current Victorian situation to bring it into line with NSW and with medium growth population projections, will need to increase to 85-91 from the current 69 beds to meet demand in 2033. The number of occupied paediatric beds is also projected to increase by about 20% to 23-24 beds.

### ***Activity based funding and the cost of burn surgery care***

9. In Australia public hospital Major Burn Units are funded through an activity based funding (ABF) arrangement using 10 diagnosis related groups. ABF is based on an average rate of reimbursement, which may be acceptable if there are a large number of cases with a normal distribution of complexity, however where there are relatively few very expensive admissions, for instance with DRG Y01Z (*patient ventilated for ≥96hrs or a tracheostomy for severe full thickness burns*), there is considerable adverse financial risk to the hospital. In 2021/22 the estimated reimbursement for a 17 day inpatient admission for Y01Z is about \$188k, but only \$198k for a 164 day admission. Detailed case costing undertaken at an Australian Major Burn Unit estimated that a 36 day admission for a major burn injury incurred costs in excess of \$800k.
10. Individual Major Burn Units and their host hospitals are routinely exposed to considerable financial risk because of the in-built weaknesses of a small number of cases in high cost,

high complexity DRGs, where institutional cost accounting systems fail to identify all attributable costs.

### ***Major Burn Unit surgeons, model of care and leadership***

11. In Australia in adult Major Burn Units, with the exception of the Royal Brisbane & Women's Hospital (RBWH), surgery is almost entirely undertaken by plastic surgeons employed as sessional Visiting Medical Officers (VMOs), but with one Unit currently employing a full time plastic surgeon and another a full time general surgeon. RBWH has a general surgeon burn workforce. Major units may also have small fractional appointments for other subspecialist surgeons such as urologists.
12. Paediatric Major Burn Units have a mix of paediatric and plastic surgery VMOs, with three having a majority of paediatric surgeons and a paediatric director, with the other two having a predominantly plastic surgery workforce with a plastic surgeon head.
13. All Major Burn Units run a comprehensive multidisciplinary model of care with specialist nursing, allied health, anaesthetists, psychiatrists and psychologists, and subspecialist physician and surgeons, either directly employed or available on a consultative basis.
14. In Australia all Major Burn Units have a surgeon Director, whether a general, paediatric or plastic surgeon. These arrangements which are also preferred in North America and Europe have significant advantages in: participation by the Director in the burn surgery roster and on call; providing leadership and mentoring to the surgical workforce; sponsoring new surgeon recruitment; and influencing College and specialist society training policies.
15. Access to regular, planned elective surgery theatre lists ensures that care of patients with major burn injuries is organised, not rushed and optimised, and should be a minimum expectation in hospitals with Major Burn Units.
16. One adult Unit reported a relatively long-standing vacancy for a surgeon.
17. Pre-COVID no units reported particular problems in recruiting specialist nursing and allied health staff.

### ***Burn surgery training and trainees***

18. Exposure to burn surgery provided by enthusiastic burn surgeons at formative periods in medical school and during specialist surgery training can stimulate career interest in a clinical field which is often poorly understood by students and trainees.
19. Students in the final years of medical school and with an interest in surgery are particularly amenable to exposure to the management of patients with burns.
20. As noted, there are three surgical subspecialties who undertake burn injury surgery in the Major Burn Units, general (about 450 total trainees), paediatric (about 30 trainees) and plastic surgery (about 85 trainees). Minimum expectations for burn surgery training for:
  - general surgery is set out as part of the Trauma module, which is one of 17 training modules;
  - paediatric surgery is not specifically defined, but forms part of the broad training curriculum;
  - plastic surgery is set out in detail in the Burn and Cold Injury training module.

21. Paediatric and plastic surgery trainees are required to successfully complete the Emergency Management of Serious Burns (EMSB) course ideally before, or early in their training. General surgery trainees are not required to complete the course.
22. General surgery trainees, with the exception of rotations at RBWH are unlikely to undertake a formal term in burn surgery during their training. All paediatric surgery trainees can expect to have significant exposure to burn surgery training, as it represents a significant proportion of paediatric surgery caseload. Plastic surgery trainees must be able to demonstrate burn surgery competencies during the course of their training, which obviously requires exposure to this caseload.
23. Each of the Major Burn Units has a plastic surgery trainee assigned on either a shared or whole time basis. However in Australia plastic surgery trainees are not required to complete a substantive term at a Major Burn Unit, which stands in contrast to the mandatory requirements for New Zealand trainees to complete a rotation at the National Burn Service at Middlemore Hospital.
24. Worldwide there appear to be only a small number of Fellowship training posts, with few in Australia, however overseas-trained Burn Fellows are routinely employed in Australian Units.

### ***Career and future work expectations of Surgical Trainees and Burn Surgeons***

25. Current work conditions for surgeons and future career decisions for trainees appear to be closely tied to the structure of the burn surgery workplace. Recent research about plastic and burn surgeon burnout and factors influencing surgical trainee work expectations intersect around the employment model of surgeons.
26. Risk factors identified for burn out in plastic surgeons, include: a reconstructive rather than cosmetic practice; long work hours; on-call more than two nights a week; lack of professional autonomy; and a junior academic rank.
27. Plastic surgery trainee burnout was significantly associated with: a feeling of exclusion from involvement in Unit decisions; increasing hours worked; too much on call; being in the early years of training; working in units in which senior surgeons did not make weekly ward rounds and in which regular staff meetings were not scheduled.
28. A recent survey (2021) of RACS plastic surgery trainees found that the four most common impediments to a career in burn surgery were: the nature of burn operations; the nature of burn care; the expected level of on-call commitments; the adequacy of exposure and training in burn surgery.
29. The same survey found the current interest in a burn surgery at 49% compared favourably with a rate of 21% in a similar 2004 survey. 47% respondents were interested in a half time or sessional type appointment.

### ***Key issues for consideration***

- a. Hospitals with Major Burn Units are likely to be at considerable financial risk from the level of reimbursement provided through activity-based funding alone. The average cost method for small volume, high cost, high complexity patients, has been recognised elsewhere as being inadequate, for instance in the funding of National and Statewide programs. There needs to be ongoing and coordinated responses from Major Burn Units and their host hospitals to Commonwealth and State jurisdictions to remedy these funding shortfalls.
- b. Projected population increases will require about 20% more beds, both paediatric and adult by 2033, which will need to be addressed especially with respect to adult capacity in NSW and Victoria, given current bed numbers in those states.

- c. Up-to-date, high-cost equipment is required at each centre to ensure patients can access the most effective, best practice, contemporary treatments, especially in relation to evaluating burn injuries and treating burn scars.
- d. All Major Burn Units need an up-to-date workforce plan to ensure they have access to a specialist MD workforce now, and a succession plan for the future.
- e. A qualified, specialist surgeon, depending on the type and composition of the Unit's surgeon workforce, is best placed to develop and promote the interests of the Burn Unit.
- f. In most instances the flexibility afforded by a largely VMO burn surgeon cohort can help to reduce work pressures, the risk of surgeon burnout and present a model of care acceptable to prospective burn surgeons.
- g. There would appear to significant advantages in increasing medical student and surgical trainee exposure to burn surgery.
- h. Consistent with practice in New Zealand strong consideration should be given to ensure that all Australian plastic surgery trainees are required to be appointed to and complete a substantive rotation to a Major Burn Unit.
- i. International burn surgery Fellows play an important role in bolstering the workforce in Major Burn Units. In turn Australian surgeons go overseas to complete formal Burn Fellowship training. It would be progressive if Australian Units working could either:
  - i. work to establish a burn Fellowship training program for Australian surgeons in Australia; and / or
  - ii. more explicitly develop an organised pathway to support Australian surgeons to train overseas and to facilitate return here after completion of their studies.



## Model of Care

---

Modern burn care, informed by extensive research, has evolved substantially over the last few decades, with wide acceptance that best practice care of major burn injuries requires the coordination of sophisticated clinical services and potentially utilising resources across hospitals and health services. The physical, psychological and social needs of burn victims necessitate the close collaboration of a broad spectrum of health care professionals, with the ultimate aim of providing patient-centred care and returning the patient to the optimal level of physical and psychological health and social function (Butler 2013).

High quality clinical outcomes are achieved through the use of standardised, efficient and effective operational procedures, that incorporate the planned coordination of a wide range of resources from the initial presentation of an acute injury through the often, many steps in long term care and rehabilitation.

Prolonged hospitalisation and the need for extended nursing and therapy is quantitatively different from other surgical services. The late outcomes of major burn injuries can have significant psychological effects, leading to considerable patient morbidity and a significant impact on return- to-work rates (Kastenmeier 2010). However markedly better survival rates have allowed major burn units to develop programs to improve burn patient long-term functional outcomes and quality of life.

Treatment and management of major burn injuries is therefore very resource intensive in terms of access to:

- a workforce, with burn expertise and competencies, that include nurse and allied health specialists, social workers, anaesthetists, the breadth of specialty and subspecialty surgeons and physicians, psychologists, psychiatrists and rehabilitation specialists;
- major hospital infrastructure including operating theatres, critical and high dependency care, and complex rehabilitation;
- specialised equipment, including lasers to measure burn depth and to assist the management of burn scars;
- complex dressings and other therapeutics; and
- a skin lab to participate in research to develop and make available skin substitutes to cover burn injury wounds.

Burn specialists are also best placed to undertake all levels of research in the field and to provide expert public health guidance about reducing the risk and incidence of burn injuries and widely promote best practice acute burn management.

Major Burn Units in Australia and New Zealand undertake research and quality improvement activities including submission of patient data and outcomes to the bi-national Burns Registry of Australia and New Zealand (BRANZ).

## Burns Registry of Australia and New Zealand

---

The primary source of data about the management of burn injury patients in Australia is the Burns Registry of Australia and New Zealand (BRANZ), which is a clinical quality registry capturing epidemiological, quality of care, and outcome data for adult and paediatric burn patients across thirteen Australian and four New Zealand Burn Units (Tracy 2020, BRANZ 2021). It is expected that additional burn units will contribute data in due course.

The Registry was established to provide cohesive reporting across the two nations regarding burn epidemiology and treatment, with the aim of minimising the incidence and severity of injury and ensuring the best treatment for those who are injured.

The number of reporting institutions has increased from 12 in 2009/10 to 15 in 2015-16, then 17 in 2016/17 through to the 2019/20 financial year.

BRANZ captures data about all first admissions to an Australian or New Zealand Burns Unit within 28 days of injury where a burn is the principal reason for admission and one of the following criteria are met:

- the patient is admitted to hospital for a period of 24 hours or more; or
- the patient is admitted to hospital for less than 24 hours but requires a burn wound management procedure in theatre; or
- the patient dies within 24 hours of presentation to the BRANZ hospital.

The following referral criteria are endorsed by the Australian & New Zealand Burn Association (ANZBA) in assessing whether burns require treatment in a specialised Burns Unit:

- burns greater than 10% of total body surface area (TBSA);
- burns greater than 5% TBSA in children;
- full-thickness burns greater than 5% TBSA;
- burns to special areas (i.e., face, hands, feet, genitalia, perineum, and major joints);
- electrical burns;
- chemical burns;
- burns with an association inhalation injury;
- circumferential burns of the limbs or chest;
- burns in the very young, very old, or pregnant women;
- burns in people with pre-existing medical disorders that could complicate management, prolong recovery, or increase mortality;
- burns associated with major trauma; and
- non-accidental burns.

All Australian Major Burn Units have formal referral processes for assessing, and if required, accepting referrals from other hospitals. Telehealth arrangements allow staff at the Major Burn Units to provide support for other hospitals without the transfer of the patient.

Table 1 shows the annual number of first admissions by country over the last five years and the number of Units reporting data. The inclusion of an additional Unit in each country in 2016/17 had a substantial impact upon case numbers reported which increased by 17% in Australia and 9% in New Zealand, with the inter-year variation in case numbers in both countries occurring in a tighter band since then.

**Table 1: BRANZ cases, 2015/16 – 2019/20 (source relevant BRANZ annual report)**

| Year    | Australia (Units reporting) | NZ (Units reporting) | Total (Units reporting) |
|---------|-----------------------------|----------------------|-------------------------|
| 2015/16 | 2416 (12)                   | 401 (3)              | 2817 (15)               |
| 2016/17 | 2821 (13)                   | 437 (4)              | 3258 (17)               |
| 2017/18 | 2976 (13)                   | 483 (4)              | 3459 (17)               |
| 2018/19 | 2844 (13)                   | 437 (4)              | 3281 (17)               |
| 2019/20 | 2929 (13)                   | 438 (4)              | 3367 (17)               |

Data reported for Australia for geographical area using the Australian Standard Geographical Classification (ASGC) shows in 2019/20 that the rate of burn injury per 100,000 people is higher in regional and remote areas compared with capital cities for both Indigenous and non-indigenous people. The rate of burn injury for Indigenous people is higher than for non-indigenous people for all geographic regions except in very remote areas.

**Table 2: Rate of burn injury per 100,000 population, Indigenous status and Australian region, 2019/20**

| Region         | Indigenous |      | Non-indigenous |      | Combined |      |
|----------------|------------|------|----------------|------|----------|------|
|                | Number     | Rate | Number         | Rate | Number   | Rate |
| Major Cities   | 36         | 15   | 1,096          | 7    | 1,132    | 6    |
| Inner Regional | 46         | 30   | 471            | 12   | 517      | 12   |
| Outer Regional | 70         | 55   | 334            | 20   | 404      | 20   |
| Remote         | 21         | 52   | 61             | 29   | 82       | 28   |
| Very Remote    | 17         | 21   | 21             | 23   | 38       | 19   |
| Total          | 190        | 29   | 1,983          | 9    | 2,173    | 9    |

Table 3 shows the summary rates for the four years from 2016/17 to 2019/20. The rate of burn injury in non-indigenous people was very similar year to year with the Indigenous rate having greater inter-year variation, but it was consistently around three times higher than the non-indigenous rate.

**Table 3: Rate of burn injury per 100,000 pop, Indigenous status, Australian region, 2016/17-2019/20**

| Year    | Indigenous | Non-indigenous | Total | Highest rate Indigenous | Highest rate non-indigenous |
|---------|------------|----------------|-------|-------------------------|-----------------------------|
| 2016/17 | 33         | 9              | 10    | 67 (Remote)             | 35 (Remote)                 |
| 2017/18 | 35         | 10             | 11    | 73 (Remote)             | 30 (Very Remote)            |
| 2018/19 | 24         | 9              | 9     | 77 (Remote)             | 39 (Very Remote)            |
| 2019/20 | 29         | 9              | 9     | 55 (Outer Regional)     | 29 (Remote)                 |

The highest rates each year were in remote or outer regional areas for Indigenous people and remote or very remote areas for non-indigenous people.

In relation to caring for Indigenous patients with burn injuries, surveys (Fraser 2020) conducted of staff working in major Australian burn units identified that a Western biomedical health paradigm predominated, which used team experience, population data, evidence derived from a scientific understanding of care, expert information and direction from senior clinicians to determine model of care and allocation of resources. However, the authors concluded it would be beneficial if these methods were adaptable and modifiable to help formulate policy and practice in burns care

specifically for Indigenous children and families to encompass appropriate Indigenous constructs of health and wellbeing.

The extent of burn injury is measured in terms of percentage of total body surface area burned (TBSA). In 2019/20 the burn area for both paediatric and adult age groups was less than 5% in 65% of cases, with less than 3% of paediatric cases and 8% of adult cases having burn areas exceeding 20% (see Table 4).

**Table 4: Percentage Total Body Surface Area Burned by Age Group, 2019/20 (BRANZ AR Table 16)**

| TBSA     | Paediatric patients (0-15 years) |     | Adult patients (≥ 16 years) |    |
|----------|----------------------------------|-----|-----------------------------|----|
|          | Number                           | %   | Number                      | %  |
| 0-4.9%   | 544                              | 65  | 1,546                       | 65 |
| 5-9.9%   | 186                              | 22  | 404                         | 17 |
| 10-19.9% | 79                               | 10  | 251                         | 11 |
| 20-49.9% | 19                               | 2   | 148                         | 6  |
| ≥ 50%    | < 5                              | < 1 | 37                          | 2  |

The extent of patient burns appears to be consistent year to year for both paediatric (see Table 5) and adult patients (see Table 6), with almost 90% of paediatric patients having TBSA of less than 10%.

**Table 5: Percentage TBSA Burned - Paediatric patients (0-15 years), 2019/20 and four-year average**

| Paediatrics | 0-9.9% TBSA |     | 10-19.9% TBSA |    | ≥ 20% TBSA |      | Total No. |
|-------------|-------------|-----|---------------|----|------------|------|-----------|
|             | No.         | %   | No.           | %  | No.        | %    |           |
| 2016/17     | 875         | 88% | 80            | 8% | 38         | 4%   | 993       |
| 2017/18     | 884         | 89% | 94            | 9% | 20         | 2%   | 998       |
| 2018/19     | 829         | 92% | 64            | 7% | 13         | 1%   | 906       |
| 2019/20     | 730         | 88% | 79            | 9% | 20-23      | 2-3% | 832       |
| Average     | 830         | 89% | 79            | 8% | 23-24      | 2-3% | 932       |

For adults about 82% of patients have TBSA of less than 10% and 7% have burn areas greater or equal to 20%, figures which were also consistent across the review period.

**Table 6: Percentage TBSA Burned - Adult patients (≥ 16 years), 2019/20 and four-year average**

| Adults  | 0-9.9% TBSA |     | 10-19.9% TBSA |     | ≥ 20% TBSA |    | Total No. |
|---------|-------------|-----|---------------|-----|------------|----|-----------|
|         | No.         | %   | No.           | %   | No.        | %  |           |
| 2016/17 | 1900        | 82% | 256           | 11% | 171        | 7% | 2327      |
| 2017/18 | 2013        | 81% | 283           | 11% | 174        | 7% | 2470      |
| 2018/19 | 1952        | 82% | 270           | 11% | 152        | 6% | 2374      |
| 2019/20 | 1950        | 82% | 251           | 11% | 185        | 8% | 2386      |
| Average | 1954        | 82% | 265           | 11% | 171        | 7% | 2389      |

Table 7 provides details of the source of referral for BRANZ hospital patients. A substantial proportion of patients are appropriately referred from other hospitals, with all Australian BRANZ hospitals having a formal referral process which ensures and supports timely and appropriate patient referral. Survey respondents indicated that through extensive, and consistent statewide education programs, there was a clear understanding as to which burn injury patients should be referred to BRANZ hospitals.

**Table 7: Referral source for registered BRANZ patients, 2019/20 (BRANZ Annual Report Table 20)**

| Referral source      | Paediatric patients (0-15 years) |     | Adult patients (≥ 16 years) |     |
|----------------------|----------------------------------|-----|-----------------------------|-----|
|                      | No.                              | %   | No.                         | %   |
| Scene via ambulance  | 151                              | 16% | 457                         | 19% |
| Other hospital       | 463                              | 50% | 1,059                       | 43% |
| General practitioner | 52                               | 6%  | 151                         | 6%  |
| Self-presentation    | 96                               | 10% | 140                         | 6%  |
| Emergency department | 0                                | 0%  | 193                         | 8%  |
| Outpatients          | 107                              | 12% | 365                         | 15% |
| Other source         | 55                               | 6%  | 78                          | 3%  |

Patient referrals through Outpatient Clinics raise the possibility that it may have been more appropriate for a proportion of these patients to have been referred at the time of the burn injury. One survey respondent from an adult unit noted that a number of these patients should have preferentially been treated initially at the Major Burn Unit.

Survey respondents did not think late referral of paediatric patients was a particular concern, with only small burns (1-2% TBSA) referred late, with this delay arising when a secondary centre is initially happy to manage the minor burn, but later refers due to greater burn depth than expected, or difficulty with dressing changes, or because of a parental request.

Access to critical care is an important aspect of care for a proportion of burn injury patients, in particular for those who sustain a major burn injury. Table 8 shows the proportion of all burn injury and major burn injury patients (paediatric >15% TBSA, adult >20% TBSA) admitted to intensive care units from 2017/19 to 2019/20 and the ten-year average from 2009/10 until 2018/19.

**Table 8: ICU admissions, age group, burn severity, length of stay hours (median, IQR), 2017/18-2019/20**

|                    | Paediatrics (0-15 years)  |                         |                        | Adult (≥16 Years)         |                         |                        |
|--------------------|---------------------------|-------------------------|------------------------|---------------------------|-------------------------|------------------------|
|                    | % admitted – all patients | % admitted – major burn | LOS hours, median, IQR | % admitted – all patients | % admitted – major burn | LOS hours, median, IQR |
| 2017/18            | 3%                        | 48%                     | 56 (28-299)            | 11%                       | 77%                     | 67 (30-221)            |
| 2018/19            | 4%                        | 40%                     | 57 (27-211)            | 10%                       | 64%                     | 60 (24-215)            |
| 2019/20            | 6%                        | 44%                     | 63 (23-228)            | 11%                       | 76%                     | 72 (27-208)            |
| Av 2009/10-2018/19 | 4.4%                      | 47.0%                   | 64 (28-205)            | 12.8%                     | 68.3%                   | 64 (29-196)            |

The average median length of stay over the decade from 2009/10 of 2.7 days for both paediatric and adult patients, and the 75% interquartile average length of stay of 8-9 days confirms the key role critical care resources play in major burn injury care.

Table 9 provides a summary of key outcomes and indicators reported in the BRANZ annual reports for 2018/19 and 2019/20. BRANZ monitors and updates the data items collected (Gong 2021), utilising expert multidisciplinary clinical opinion and published literature. In 2016 the list of clinical quality indicators and data items was updated to 23 which cover structure, process, and outcome measures. At that stage four indicators were removed as not being useful, nine were revised, and eight new clinically useful indicators / data items were added.

In paediatric patients it shows improvements in 2019/20 compared with the previous year in rates of:

- gold standard first aid;
- enteral and parenteral feeding commenced within 24 hours;
- malnutrition screens; and
- planned and unplanned readmissions.

However there were deterioration in rates of:

- definitive assessment by a senior burn clinician;
- validated pain assessments;
- use of a burn diagram; and
- use of an accepted formula for fluid requirement estimation.

**Table 9: Summary BRANZ outcomes and indicators, 2018/19 and 2019/20**

| Key indicator  | Paediatric (0-15 years) |                  | Adults (≥16 Years) |                  |
|--|-------------------------|------------------|--------------------|------------------|
|  | 2018/19                 | 2019/20          | 2018/19            | 2019/20          |
| Gold standard first aid  | 71%                     | 77%              | 61%                | 58%              |
| Time to reach BRANZ hospital median and IQR  | 23 (4-173) hours        | 22 (4-142) hours | 37 (6-140) hours   | 32 (6-130) hours |
| Major burn injury, transfer from scene direct to BRANZ hospital within 2 hours     | nr                      | 59%              | nr                 | 38%              |
| Major burn injury, transfer from scene direct to BRANZ hospital                    | nr                      | 72% in 3 hours   | nr                 | 91% in 7 hours   |
| Definitive wound assessment by senior burn clinician within 72 hours of admit      | 98%                     | 92%              | 97%                | 97%              |
| Allied health physical assessment within 48 hours for patients with LOS > 48 hours | 63%                     | 63%              | 98%                | 95%              |
| Validated pain assessment within 24 hours of admission                             | 95%                     | 89%              | 91%                | 97%              |
| At risk of kidney injury or failure  | 4%                      | 5%               | 3%                 | 3%               |
| Enteral or parenteral feeding within 24 hours of admission                         | 63%                     | 85%              | 70%                | 75%              |
| Blood culture taken during admission   | 9%                      | 10%              | 14%                | 13%              |
| Percentage of blood cultures that are positive                                     | 7%                      | 13%              | 15%                | 17%              |
| Positive MRSA swab   | 2%                      | 5%               | 9%                 | 3%               |
| Diagram used to determine burn size  | 66%                     | 64%              | 74%                | 70%              |
| Malnutrition screen within 24 hours for patients with LOS > 24 hours               | 57%                     | 60%              | 80%                | 86%              |
| Use of accepted formula use in fluid requirement estimation                        | 91%                     | 89%              | 86%                | 98%              |
| Venous thromboembolism prophylaxis ≥16years  | na                      | na               | 67%                | 70%              |
| Readmissions with 28 days / proportion unplanned                                   | 15% / 24%               | 13% / 20%        | 5% / 54%           | 4% / 41%         |

In 2019/20 for adult patients there were improvements for the rate of:

- validated pain assessment;
- enteral or parenteral feeding started within 24 hours;
- malnutrition screens;
- use of accepted formula for fluid requirement estimation;
- use of VTE prophylaxis; and
- planned and unplanned readmissions.

There was a small reduction in the rate of physical assessments undertaken by allied health specialists and the rate of definitive wound assessments was maintained at very high levels of 97%.

In 2018/19, 79% of adults and 72% of paediatric patients underwent at least one burn management procedure in the operating theatres, this proportion fell to 68% for both patient cohorts in 2019/20 (see Table 10).

In adults more than 95% of these procedures involved debridement, with or without skin grafting. In the paediatric age group, 17% of operating theatre procedures were for dressing changes only, whereas in adults this represented less than 1% of procedures.

Only 1% of adult patients and less than 1% of paediatric patients required an escharotomy, fasciotomy or amputation in 2019/20.

**Table 10: Operating theatre procedures, by age cohort 2019/20**

| Procedure type  | Paediatrics | Adult |
|---|-------------|-------|
| <i>Procedures related to debridement</i>  |             |       |
| Debridement only  | 21%         | 22%   |
| Debridement and temporary skin closure product eg Biobrane™   | 13%         | 20%   |
| Debridement and dermal reconstructive product eg Integra™ or other biodegradable temporising matrix | <1%         | 1%    |
| Debridement and skin cell product   | 17%         | 10%   |
| Debridement and skin grafting   | 48%         | 70%   |
| Debridement and temporary skin closure with cadaver skin  | <1%         | 4%    |
| <i>Other procedures</i>   |             |       |
| Dressing change in theatre only   | 17%         | 1%    |
| Escharotomy, fasciotomy, amputation   | 0%          | 1%    |
| Other procedure   | 2%          | 2%    |

## Burn Surgery Activity in Australia

In addition to the BRANZ registry data reported by the Major Burn Units other sources of national data provide context as to the level of burn injury in Australia. Referenced here are the National Hospital Cost Data Collection (NHCCDC) and Australian Institute of Health and Welfare (AIHW) specialist reports, principal diagnosis and procedure data cubes.

In 2016 the AIHW and Flinders University released *Hospitalised Burn Injuries Australia 2013-14*. It found that there had been 5430 burn injury cases in Australia that year, of which 2319 were reported by the then twelve Australian BRANZ hospitals. The 5,430 cases led to 8,055 separations (1.49 / case) and 23,880 procedures (4.4 / case; 2.9 / separation). The AIHW report categorised cases as high threat to life (HTTL) using predicted mortality risk of 6% or higher and low threat to life (LTTL) (Stephenson 2003). HTTL injuries if not fatal are likely to have a large impact on the patient, often with persisting problems and ongoing need for health-care services.

The AIHW report estimated that in 2013/14 in Australia:

- there were 850 HTTL cases representing 15.7% of total 5,430 cases;
- the mean length of stay (LoS) for HTTL cases was 17.3 days and 4.5 days for LTTL cases;
- the mean LoS per case for people aged 0-15 years was 5.5 days and 7.2 days for adults;
- there were 246 ICU admissions with an average stay of 141 hours.

Mapping these findings to BRANZ hospitals, if it is assumed that all the HTTL cases were admitted to a Major Burns Unit then for the 2,319 Australian cases in 2013/14 recorded by BRANZ:

- the 850 HTTL cases would represent 14,705 bed days;
- the remaining 1,469 Australian cases, would represent a further 6,610 bed days, for a total of 21,315 days.

If this mix of patient severity and average length of stay was applied to the 2019/20 BRANZ caseload of 2929 admissions, it would represent a total of 26,939 bed days equivalent to 87 beds at 85% occupancy. It is estimated that while paediatric patients represent about 27% of total number of cases occupy approximately 20% of bed days given the average shorter length of stay.

Table 11 provides additional information about the number of burn related episodes of care in public hospitals from the NHCCDC data sets, for 2013/14 and from 2015/16 to 2018/19, the most recent year for which data is available. The annual number of admissions to private hospitals for these diagnosis related groups (DRGs) is in the order of 200-300 separations of less complex burn injury.

**Table 11: National Hospital Cost Data Collection, Public Hospital separations, 2015/16 – 2018/19**

| DRG    | DRG Description                          | 2013/14 | 2015/16 | 2016/17 | 2017/18 | 2018/19 |
|--------|--|---------|---------|---------|---------|---------|
| Y01Z   | Vent ≥96hrs / Trach for Severe FT Burns  | 103     | 137     | 134     | 113     | 125     |
| Y02ABC | Skin Grafts for Other Burns              | 2429    | 2791    | 2693    | 2642    | 2604    |
| Y03AB  | Other OR Procedures for Other Burns      | 1088    | 1254    | 1239    | 1658    | 1684    |
| Y60Z   | Burns, Transferred to Acute Facility <5d | 484     | 489     | 476     | 489     | 489     |
| Y61Z   | Severe Burns                             | 389     | 482     | 435     | 436     | 457     |
| Y62AB  | Other Burns                              | 2912    | 3047    | 3058    | 3032    | 3120    |
| All    | -  | 7405    | 8200    | 8035    | 8360    | 8479    |



The progressive increase in the count of separations in the NHCDC is consistent with changes reported to BRANZ. The NHCDC data shows an annual 2.7% increase in the number of separations.

Table 12 shows the site of the burn injury by case numbers and bed occupancy from the AIHW Principal Diagnosis data cube for 2018/19 from the National Hospital Morbidity Database (METeOR ID: 641349). Overall these data identify more than 40,000 occupied bed days for almost 8,000 burn injury cases.

**Table 12: Separations and occupied bed days, ICD sub-chapter T20–T25, 2018/19**

| ICD sub chapter   | Paed Septs  | Paed bed days | Adult Septs | Adult bed days |
|---|-------------|---------------|-------------|----------------|
| T20 Burn of head and neck                               | 303         | 1115          | 856         | 4325           |
| T21 Burn of trunk                                       | 380         | 1510          | 752         | 7020           |
| T22 Burn of shoulder and upper limb, except wrist, hand | 270         | 708           | 882         | 4838           |
| T23 Burn of wrist and hand                              | 484         | 911           | 1030        | 3494           |
| T24 Burn of hip and lower limb, except ankle and foot   | 360         | 1081          | 1376        | 9177           |
| T25 Burn of ankle and foot                              | 338         | 1093          | 885         | 5184           |
| T26 Burn of eye and adnexa                              | 16          | 20            | 146         | 213            |
| T27 Burn of respiratory tract                           | 2           | 5             | 41          | 287            |
| T28 Burn of other internal organs                       | 23          | 151           | 75          | 292            |
| T29–T31 Burns of multiple and unspecified body regions  | 0           | 0             | 25          | 105            |
| <b>Total</b>  | <b>2176</b> | <b>6418</b>   | <b>5781</b> | <b>34038</b>   |

Table 13 shows data from the AIHW Procedure ACHI for 2018-19 from the National Hospital Morbidity database (METeOR ID: 676382) on burn injury procedures by age group, with 39% of paediatric patients and 19% of adult patients admitted as day cases for procedures.

**Table 13: Burn injury procedures, same day and overnight, by age cohort, 2018/19**

| Sub-chapter procedure codes                        | Same day 0-15 Years | O/N 0-15 Years | Total ≥16 Years | Same day ≥16 Years | O/N ≥16 Years | Total ≥16 Years |
|--|---------------------|----------------|-----------------|--------------------|---------------|-----------------|
| 30010 Dressing of burn < 10% of TBSA dressed       | 415                 | 303            | 719             | 57                 | 420           | 477             |
| 30014 Dressing of burn ≥10% of TBSA dressed        | 25                  | 146            | 171             | 9                  | 211           | 220             |
| 45054-00 Escharotomy                               | 0                   | 10             | 10              | 3                  | 50            | 53              |
| 1627 Debridement of burn                           | 244                 | 656            | 900             | 332                | 1887          | 2219            |
| 1640 Allograft, xenograft, or synthetic skin graft | 9                   | 50             | 59              | 306                | 1373          | 1679            |
| 1641 Split skin graft to granulating burn site     | 30                  | 16             | 46              | 17                 | 63            | 80              |
| 1643 Split skin graft to burn of specific sites    | 94                  | 147            | 241             | 199                | 775           | 974             |
| 1644 Split skin graft to burn of other sites       | 155                 | 282            | 437             | 287                | 1496          | 1783            |
| 1648 Full thickness skin graft to burn             | 25                  | 40             | 65              | 86                 | 94            | 180             |
| 1656 Revision of burn scar or contracture          | 114                 | 99             | 213             | 232                | 255           | 487             |
| <b>Total number of procedures</b>                  | <b>1112</b>         | <b>1748</b>    | <b>2860</b>     | <b>1527</b>        | <b>6625</b>   | <b>8152</b>     |

## Funding of burn injury care

Australian public hospitals are funded using activity-based funding (ABF) where an average cost has been determined for each of about 800 DRGs. In 2021/2022 the ABF payment for each unit of activity (NWAU) is \$5597. The payments are adjusted annually but three years in arrears. There are 10 DRGs that are specifically assigned to burn injury related admissions, Table 14 shows the

expected average length of stay, the low and high boundary length of stay for inlier payments and the average high outlier per diem.

**Table 14: Burn DRG metrics, inlier and outlier payments, 2021/22**

| DRG  | Average length of stay | Low boundary days | High boundary days | Maximum payment low outlier | Inlier payment | High outlier payment per day |
|------|------------------------|-------------------|--------------------|-----------------------------|----------------|------------------------------|
| Y01Z | 29.7                   | 18                | 164                | \$188,567                   | \$198,963      | \$3,725                      |
| Y02A | 19.1                   | 5                 | 53                 | \$42,682                    | \$52,366       | \$2,588                      |
| Y02B | 7.6                    | 2                 | 23                 | \$12,706                    | \$22,855       | \$1,989                      |
| Y02C | 3.0                    | 1                 | 9                  | \$0                         | \$8,208        | \$2,500                      |
| Y03A | 4.5                    | 1                 | 13                 | \$0                         | \$10,033       | \$1,987                      |
| Y03B | 1.6                    | 1                 | 5                  | \$0                         | \$4,418        | \$2,334                      |
| Y60Z | 1.3                    | 1                 | 4                  | \$0                         | \$3,419        | \$1,790                      |
| Y61Z | 4.1                    | 1                 | 10                 | \$0                         | \$4,927        | \$1,288                      |
| Y62A | 5.2                    | 1                 | 14                 | \$0                         | \$8,885        | \$1,619                      |
| Y62B | 2.4                    | 1                 | 7                  | \$0                         | \$3,817        | \$1,686                      |

The use of average costs has proven problematic for hospitals which have a relatively small number of high cost and high complexity cases, whether for major burn injuries or other conditions. By way of example, DRG Y01Z (*patient ventilated for ≥96hrs or a tracheostomy for severe full thickness burns*) the consequences are set out in Table 15. There are on average only about 125 cases assigned in Australia each year. The inlier payment is based on average length of stay, however there is an extreme span between the low and high boundary points of 146 days. The highest average daily payments accrue for shorter stay admissions up to the low boundary point of 18 days, with total payments on day 17 of \$188,567 at an average daily rate of \$11,092. The ABF payment from day 18 to 164 is fixed at \$198,963, which at the high boundary point represents an average of just \$1,213 per day which clearly is an improbably low amount to meet the daily care costs of major burn injury patients.

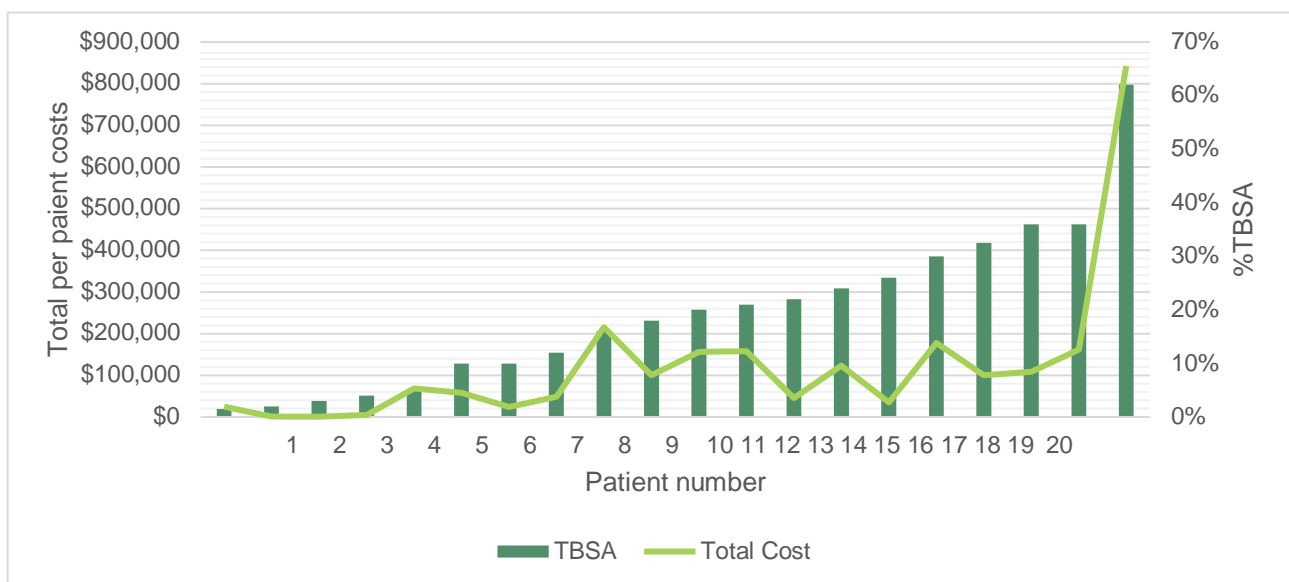
**Table 15: Activity based funding payment schedule, DRG Y01Z, 2021/22**

| Day of admission | Total ABF payment | Average daily payment | Day of admission | Total ABF payment | Average daily payment |
|------------------|-------------------|-----------------------|------------------|-------------------|-----------------------|
| 1                | \$22,234          | \$22,234              | 12               | \$136,588         | \$11,382              |
| 2                | \$32,629          | \$16,315              | 13               | \$146,984         | \$11,306              |
| 3                | \$43,025          | \$14,342              | 14               | \$157,380         | \$11,241              |
| 4                | \$53,421          | \$13,355              | 15               | \$167,776         | \$11,185              |
| 5                | \$63,817          | \$12,763              | 16               | \$178,172         | \$11,136              |
| 6                | \$74,213          | \$12,369              | 17               | \$188,567         | \$11,092              |
| 7                | \$84,609          | \$12,087              | 18               | \$198,963         | \$11,053              |
| 8                | \$95,005          | \$11,876              | 29               | \$198,963         | \$6,861               |
| 9                | \$105,400         | \$11,711              | 164              | \$198,963         | \$1,213               |
| 10               | \$115,796         | \$11,580              | 165              | \$202,688         | \$1,228               |
| 11               | \$126,192         | \$11,472              | 166              | \$206,413         | \$1,243               |

A study (Ahn 2012) at a Major Burn Unit set out to achieve an accurate calculation of the cost of acute burns care in an Australian context. It involved a retrospective review of 20 adult burn

patients treated at the hospital. An itemized price list was prepared based on items, services and equipment actually used in the care of burns patients. Case records were reviewed for a count of quantities to calculate costs for each item. Regression analysis was performed to produce a cost vs %TBSA curve for cost prediction. Using a direct cost attribution method established a daily bed cost in 2012 of \$13,110. The cost calculated for an average adult burns patient was \$71,056. The %TBSA was confirmed as the primary determinant of cost. Hospital length of stay, operative costs, dressings and staffing were found to be the most significant components of cost and increased in line with increases of %TBSA. Figure 1 shows the costs per patient. In this study patients 2 to 4 did not have an overnight inpatient stay. Patient 20 had an inpatient length of stay of 36 days, while accruing total costs in 2012 of more than \$800,000, which is more than four times the payment in 2021/22, potentially for patient with much longer admissions.

**Figure 1: Estimated patient cost, %TBSA (derived from Ahn 2012)**



The risk of funding shortfall under ABF is further exemplified in that the next five cases with highest costs (9, 12, 14, 16, 19) had an average estimated cost of \$166,000 and average length of stay of 8 days. In DRG terms these cases would likely code as Y02A, which in 2021/22 has an inlier payment of \$52,366, a difference of \$114,000 per case.

### Current bed capacity and projections

In the mainland Australian states the adult Major Burn Units have dedicated ward facilities, which are not shared with other specialties, with the exception of The Alfred Hospital Melbourne, which shares a 34 bed ward with other surgical specialties. The Burn Service at Royal Hobart Hospital has two designated single rooms on a shared adult surgical ward and access to two paediatric beds.

Table 16 shows the number of Major Burn Unit beds for estimated resident population aged over 15 years. The population of New South Wales and ACT are combined to recognise patient flows and service availability.

**Table 16: Major adult burn unit bed count, rate per 100,000 population, 2020**

| Jurisdiction            | Population aged over 15 years, 2020 | Number unit beds | Number of beds / million population | Projected increase in adult population 2020-2033 |
|-------------------------|-------------------------------------|------------------|-------------------------------------|--|
| NSW + ACT               | 7098880                             | 22               | 3.1                                 | 11%  |
| Victoria                | 5547030                             | 9                | 1.6                                 | 22%  |
| Queensland              | 4183762                             | 18               | 4.3                                 | 20%  |
| Western Australia       | 2128218                             | 10               | 4.7                                 | 22%  |
| South Australia         | 1438470                             | 8                | 5.6                                 | 10%  |
| Tasmania                | 437974                              | 2                | 4.6                                 | 6%   |
| Northern Territory      | 197391                              | nr               | nr                                  | 18%  |
| Australia               | 21031725                            | 69               | 3.3                                 | 17%  |
| Australia excl Victoria | 15484695                            | 60               | 3.9                                 | 15%  |

On a population basis the number of adult beds in Victoria in the Major Burn Unit appears to be substantially lower compared with other jurisdictions noting that it is readily able to increase bed numbers because of the flexible shared ward configuration. However the number of formally assigned ward beds appears to be about half of New South Wales and only 40% of the rest of Australia.

Population projections out to 2033 (ABS 2019, no. 3222.0, medium projections) estimate an increase in the adult Australian population of about 17%. For the purpose of these projections if the Major Burn Unit beds in Victoria were increased to 18, to bring the national total to 78, then on a population only basis, there would need to be a minimum of 91 adult beds in 2033 to manage increase demand. This assumes that there is already capacity redundancy factored into the bed numbers in at least some of the jurisdictions to allow occupancy of 85-90%.

Using an alternative method to estimate future resource need, Table 17 shows the current rate of admissions to BRANZ major Burns Units from 2015/16 through to 2019/20. As noted above an additional Unit in both Australia and New Zealand started contributing data in 2016/17. The rate of admissions per 100,000 population has been calculated for these years. From 2016/17 the Australian rate ranged from 11.4 to 12.1, with an average of 11.7. In New Zealand the range was from 8.8 to 10.0, with an average of 9.3

**Table 17: Admissions to Major Burn Units, per 100,000 population, Australia and New Zealand**

| Year    | Estimated population Australia | Australian patients | Rate / 100,000 population | Estimated population NZ | NZ patients      | Rate / 100,000 population |
|---------|--------------------------------|---------------------|---------------------------|-------------------------|------------------|---------------------------|
| 2015/16 | 23815995                       | 2416                | 10.1                      | 4609400                 | 401              | 8.7                       |
| 2016/17 | 24190907                       | 2821                | 11.7                      | 4714100                 | 437              | 9.3                       |
| 2017/18 | 24601860                       | 2976                | 12.1                      | 4813600                 | 483              | 10.0                      |
| 2018/19 | 24982688                       | 2844                | 11.4                      | 4900600                 | 437              | 8.9                       |
| 2019/20 | 25688676                       | 2929                | 11.5                      | 4979200                 | 438              | 8.8                       |
| Year    | Projected population           | Projected number    | Rate                      | Projected population    | Projected number | Rate                      |
| 2023    | 27047951                       | 3165                | 11.7                      | 5022400                 | 467              | 9.3                       |
| 2028    | 29051673                       | 3399                | 11.7                      | 5460500                 | 508              | 9.3                       |
| 2033    | 30512645                       | 3570                | 11.7                      | 5679000                 | 528              | 9.3                       |

Using this average rate and the same projected population increases (ABS 2019, no. 3222.0, medium projections) and Stats NZ shows an estimated increase in the number of patients receiving treatment at Major Burn Units in Australia in 2033 compared with 2020 of 641 (increase of 22%) patients and in New Zealand 90 patients (increase of 21%).

Ideally inpatient wards with multi-day stay patients with immunocompromised and high risk patients, should not be expected to operate at occupancies beyond 85%, as time must be taken to ensure safe patient transfers, clean beds and equipment and allow sufficient redundancy for staff to undertake required quality and safety protocols.

If the previously calculated mix of patient severity and average length of stay was applied to the projected caseload of 3,570 admissions in Australia in 2033, it would represent a total of 32,822 bed days an increase of 5,583, which at 85% occupancy represents 18 beds. The total estimated minimum requirement in Australia in 2033 would therefore be under this method 106 beds, of which about 80% would be adult (85 beds), with 21 paediatric beds. These estimates are broadly consistent with the simple, population-based projections.

These methods project the number of beds in Australian Major Burn Units at 85-91 in 2033, an increase of 23-32% on current numbers, noting the relatively low number of beds in Victoria. Paediatric beds are estimated at about 20% of the total and therefore would be in the range 21-23.

## Burn surgery training

### International experience

In North America Shih (2019) and colleagues undertook a retrospective review of 55 graduating plastic surgery residents in Canada over a ten-year period. Case logs showed an average of 73 burn and burn-related care procedures for each resident, accounting for 6.8% of an average of 1080 total procedures logged. Ninety-nine percent of the logged burn procedures were core procedural competencies (CPCs). The most frequently performed procedure was harvest and application of autograft, allograft, or xenograft, while emergent procedures such as escharotomy and compartment release were performed on average less than one time per resident. Personal competence scores as well as role of the resident increased with progression through the residency.

A US study of applicants for the final surgery qualifying exam found that they had an average and median 10 months of experience in surgical critical care, trauma and burn rotations, representing about one sixth of their five years of training. Of this the burn rotation duration was a mean of 0.8 and median of 1.0 months (Napolitano 2016).

A review of UK plastic surgery trainee experience (Highton 2017) for 336 specialty registrars found that over the six-year training program, trainees participated in an average of 2117 procedures, performing an average of 1571 procedures with / without supervision. The average weighted mean number for burns resuscitation cases performed was 39, compared with an expected number in 2012 of 18 and an ongoing projected number in 2016 of 18. The number of excisional burn or emergency burn operations performed was an average 85, compared with an expected 63 and revised number of 60 cases. The new indicative numbers were set at approximately one standard deviation below national mean number of procedures performed during training using the eLogbook data. Statistically, 84% of trainees would be expected to achieve this target. The target of 78 burn surgery cases represents 4.1% of total expected plastic surgery procedures.

In the US the Accreditation Council for Graduate Medical Education (ACGME 2014) specifies that plastic surgery trainees must perform a total of 24 integument burn procedures, of which 16 are burn reconstructions. Review of the ACGME requirements for general surgery and paediatric surgery did not specify any target number of burn surgery procedures.

Drawing on a comparison of plastic surgery training in the United States and Europe (Kamali 2016) Highton (2017) drew up the following table, which provides information on the new annual intake, the extant number of plastic surgeons and the expected total number of trainee operations. Additional information has been added for Australia and Canada.

**Table 18: Comparison of plastic surgery trainee intakes and log book requirements**

|                                       | USA         | Ger  | Neth       | UK                     | Fra                    | Spa        | Ita        | Pol        | Aust                         | Can                              |
|---------------------------------------|-------------|------|------------|------------------------|------------------------|------------|------------|------------|------------------------------|----------------------------------|
| New annual Intake Trainee (pmp)       | 148<br>0.45 | nr   | 16<br>0.94 | 10–20<br>up to<br>0.30 | 25–30<br>up to<br>0.44 | 37<br>0.79 | 39<br>0.66 | 32<br>0.84 | 17<br>(ASPS<br>2021)<br>0.65 | 30<br>(Morzycki<br>2018)<br>0.77 |
| Plastic surgeons / 100,000 population | 1.98        | 1.94 | 1.71       | 0.79                   | 1.11                   | 2.09       | 1.30       | 0.50       | 1.81<br>(RACS<br>2016)       | 1.55<br>(Morzycki<br>2018)       |

|                          | USA  | Ger | Neth | UK   | Fra | Spa | Ita | Pol | Aust | Can              |
|--------------------------|------|-----|------|------|-----|-----|-----|-----|------|------------------|
| Total trainee operations | 1150 | 640 | 600  | 2100 | nr  | 560 | nr  | 450 | nr   | 1050 (Shih 2019) |
| Burn surgery operations  | 24   | nr  | nr   | 78   | nr  | nr  | nr  | nr  | nr   | 73               |

Source: Highton 2017

The number of plastic surgeons per capita in Australia is mid-way between Canada and USA, but more than twice the number in the UK. The annual intake of new plastic surgery trainees in Australia at 0.65 per million population is substantially higher than USA, UK and France, but less than Canada, Poland, Spain and the Netherlands.

## Burn surgery training in Australia

The Royal Australasian College of Surgeons (RACS) has adopted competency-based, rather than time-based only surgical training programs, which in turn have been applied by the designated professional societies to the specific specialty. RACS has established ten domains of competence - technical domains (Medical expertise, Judgement and clinical decision-making, and Technical expertise), and non-technical domains (Leadership and Management Professionalism, Communication, Health Advocacy, Scholarship and teaching, Collaboration and Teamwork, Cultural competence and safety). The specialty surgery curricula guides assessment of trainees in all of these domains, as well as providing direction as to what level of competence should be attained both during, and by the completion of, the training program.

In Australia major burn surgery is performed by members of three surgical specialties:

- Paediatric Surgery – 28 trainees;
- General Surgery - 455 trainees; and
- Plastic and Reconstructive Surgery – 82 posts, 87 trainees.

### Paediatric Surgery

Paediatric Surgery is numerically the smallest of these three specialties, with currently 29 trainee posts, spread over the various years of training.

**Table 19: Paediatric surgery training program posts, 2021**

| Hospital / Health Service              | Number of trainees | Major Burn Unit | Major Paediatric Trauma Service |
|--|--------------------|-----------------|---------------------------------|
| The Canberra Hospital                  | 1                  | No              | No                              |
| John Hunter Children's Hospital        | 1                  | No              | Yes                             |
| Sydney Children's Hospital Randwick    | 3                  | No              | Yes                             |
| The Children's Hospital Westmead       | 4                  | Yes             | Yes                             |
| Gold Coast University Hospital         | 2                  | No              | No                              |
| Queensland Children's Hospital         | 4                  | Yes             | Yes                             |
| Townsville Hospital                    | 2                  | No              | No                              |
| Adelaide Women's & Children's Hospital | 2                  | Yes             | Yes                             |
| Monash Health Melbourne                | 2                  | No              | No                              |
| Royal Children's Hospital Melbourne    | 5                  | Yes             | Yes                             |
| Perth Children's Hospital              | 2                  | Yes             | Yes                             |

Twenty-one of the twenty-nine posts are located at hospitals with Major Paediatric Burn Units. Trainees are required to undertake training in at least two geographic regions.

The publicly available curriculum for paediatric surgery (RACS 2021) provides no explicit description of the expected competencies for paediatric surgery trainees. It does however specify that experience and competence should be gained in examples of common conditions (including but not exclusive to) each of the following:

- neonatal surgical conditions;
- trauma and burns, including prevention and management;
- the abdomen;
- abdominal wall, hernia and inguino-scrotal conditions;
- head and neck;
- skin, subcutaneous tissue and extremities;
- tumours occurring in childhood; and
- thoracic (non-cardiac).

Paediatric surgery trainees are required to successfully complete the following courses:

- Advanced Paediatric Life Support (APLS) Courses
- Early Management of Severe Trauma (EMST) Course
- Care of the Critically Ill Surgical Patient (CCrISP) Course
- Training in Professional Skills (TIPS) Course
- Emergency Management of Severe Burns (EMSB) Course prior to their training starting or by the end of early SET.

Information provided by two major Paediatric Burn Units demonstrate different approaches according to the senior surgical staff profile. Where paediatric surgeons lead the Unit the paediatric surgery trainees are significantly involved in the management of burn injury patients, with between one third and two thirds of the trainee complement formally linked to the paediatric burn surgery service. One paediatric surgery trainee attends every elective burn surgery list and multidisciplinary team meeting. All trainees participate on the emergency on-call roster.

At the other hospital the clinical workload is split between plastic surgeons who have predominant responsibility for hand and face burn injury and scar reconstruction, with other burn injuries managed by the paediatric surgeons. The paediatric surgery trainees spend part of their time in the Burn Unit.

### **General Surgery**

The management of burn injury in the General Surgery curriculum is set out in the Trauma Module, which is one of seventeen modules. It is expected that the graduating general surgery trainee will be able to, amongst others:

- describe the pathophysiology of shock, acute brain injury, respiratory failure, sepsis, renal failure, multi-organ failure and burns;
- identify appropriate treatment options, and their indications and contraindications;
- participate in a trauma team including in the team leader role;
- safely and effectively assess and resuscitate the injured patient;
- implement the principles of:
  - Early Management of Severe Trauma (EMST) / Advanced Trauma Life Support (ATLS);
  - Care of Critically Ill Surgical Patients (CCrISP); and



- Definitive Surgical Trauma Care (DSTC);
- have a clear understanding of the potential disaster, humanitarian and military responsibilities of general surgeons;
- disaster planning;
- epidemiology and prevention; and
- trauma quality improvement, benchmarking and audit trauma systems and resources allocation.

The expected competencies at the various SET levels in the General Surgery Trauma Module are set out in Appendix 1. The technical operative expertise in early SET includes compartment pressure measurement, wound exploration and debridement, wound closure or open management, split skin grafting and VACC therapy. In mid SET the competencies include escharotomy and local flap coverage.

### **Plastic & Reconstructive Surgery**

In 2021 there were 82 Plastic & Reconstructive Surgery training posts. Table 20 lists where they are distributed, clearly not all work in Burn Units. Each of the mainland Adult Burn Units led by a plastic surgeon have a plastic surgery trainee who is appointed as an 0.8 to 1.0 FTE. In Tasmania burn surgery management is an integral part of the overall plastics workload, but the trainee is not appointed wholly to the Burn Unit, with its caseload and emergency on-call also shared with a number of non-accredited registrars.

**Table 20: Plastic surgery trainee rotations 2021**

|                 | Major Burn Unit<br>Adult | Major Burn Unit<br>Paediatrics | Other<br>hospitals | Total     |
|-----------------|--------------------------|--------------------------------|--------------------|-----------|
| NSW             | Concord -1<br>RNSH - 3   | TCHW - 1                       | 17                 | 22        |
| Victoria        | Alfred - 3               | RCHM - 2                       | 20                 | 25        |
| Queensland      | RBWH - 3                 | QCH - 2                        | 8                  | 13        |
| WA              | FCH – 2                  | PCH - 2                        | 7                  | 11        |
| South Australia | RAH - 3                  | AW&CH - 1                      | 5                  | 9         |
| Tasmania        | RHH - 1                  | 0                              | 1                  | 2         |
| <b>Total</b>    | <b>16</b>                | <b>8</b>                       | <b>58</b>          | <b>82</b> |

Both the plastic surgery trainees at Perth Children’s Hospital work in the Burn Unit and there also are supported by a number of non-accredited service registrars.

Trainees are expected to manage burn patients from first presentation and initial resuscitation, through acute management to meeting their long-term reconstructive needs, for both minor and major burn injuries, and both functional and cosmetic aspects.

Trainees are also expected to manage more complex scenarios such as inhalation injuries and burns in the setting of polytrauma and to be able to perform emergency treatment such as escharotomies and tracheostomies.

Burn surgery competencies are set out in the Burn and Cold Injury module ( see Appendix 1) of the curriculum. Early SET trainees are expected to be able to:

- perform an accurate assessment of burn wounds (extent and depth);
- debride minor burns; and
- perform skin grafts for minor burns.

Mid SET trainees are expected to be competent in:

- escharotomy and fasciotomy;
- debride and dress major burns, including the use of temporary skin cover;
- perform skin grafts to specialised areas (eg hands and face);
- perform a tracheostomy;
- design flaps for burn contracture release.

Late SET trainees are required to perform:

- use skin substitutes for burns and reconstruction;
- perform distant and free flaps for acute burns and burn reconstruction.

Importantly while all Major Burn Units in Australia have dedicated plastic surgery trainees, not all trainees undertake a substantive appointment at one of these Units during the course of their training. This stands in comparison with New Zealand requirements that all plastic surgery trainees must complete a term at the National Burn Unit at Middlemore Hospital.

## Major Burn Unit facilities, organisation, leadership and workforce

---

The information in this section has been sourced from:

- the survey undertaken for this report, which had a moderate response rate, but with detailed information provided. Responses were received from three of the six major adult burn units, two of the five paediatric units and one of the two combined units;
- the comprehensive paediatric hospital and burn unit websites; and
- other web searches including peer reviewed and grey literature and reports.

All the major burn units are integrated in major trauma networks, however Concord Hospital and Fiona Stanley Hospital are not major trauma hospitals but have organisational arrangements to manage this situation.

For the twelve major burn units where detailed information was available, all have adopted a multidisciplinary team approach which of specialized burn surgery, specialist burn nursing staff, the breadth of allied health disciplines, rehabilitation and other medical specialties usually on a consultative basis.

### Facilities and infrastructure

There have been new hospital builds relatively recently (last ten years) at the following sites:

- Perth Children's Hospital;
- Fiona Stanley Hospital;
- Royal Adelaide Hospital;
- Royal Children's Hospital Melbourne;
- Royal Hobart Hospital;
- Royal North Shore Hospital; and
- Queensland Children's Hospital;

which has ensured that these sites have modern, purpose-built facilities, with single rooms with pressure and temperature controls needed for the management of major burn injury patients.

The larger adult units have routinely scheduled operating lists, but smaller units require access emergency surgery lists or scheduled plastic surgery lists to treat burn injury patients. All units have access to critical care and intensive care facilities.

Improvements in acute burn care have enabled patients to survive major burn injuries that would have once been fatal (Finnerty 2016). Now up to 70% of patients develop hypertrophic scars after burns which often have long-term consequences for quality of life and return to work.

Compression garments, massage, laser therapy, intense pulsed light, steroids, exercise, and injection of fat into the scar have been used to reduce hypertrophic scar (Friedstadt 2014), with a combination of these usually needed. The incorporation of laser and light therapy can reduce hypertrophic scar by decreasing erythema, reducing height, and increasing pliability of scar (Hultmann 2015). Additional benefits included reduced pain, pruritus, colour, and abnormal texture. Non-ablative or ablative fractional lasers have become a standard therapy reduce stiffness in hypertrophic scar by inducing collagen remodelling. The pulsed dye laser, the ablative fractional CO<sub>2</sub> laser, and intense pulse light reduce particular aspects of the hypertrophic scar. Pulsed dye laser decreases vascularity by inducing necrosis in the targeted

capillaries leading to reducing scar volume, erythema, pliability, hyperaemia, itch, and pruritus (Finnerty 2016).

Major Burn Units therefore also require access to up-to-date equipment to manage post-burn scarring to optimise the benefits of other life-saving advances in management of major burn injuries.

### Burn unit surgical workforce

Paediatric Burn Units have the following staff configurations:

- The Children’s Hospital Westmead - paediatric surgery lead, 5 VMO paediatric surgeons; 2 VMO plastic surgeons;
- Royal Children’s Hospital Melbourne – paediatric surgery lead, 2 VMO paediatric surgeons; 1 VMO paediatric plastic surgeon;
- Queensland Children’s Hospital – paediatric surgery lead, 7 VMO paediatric surgeons, 1 VMO paediatric urologist;
- Perth Children’s Hospital – plastic surgery lead, 3 VMO plastic surgery, 2 VMO paediatric surgeons;
- Adelaide Women’s & Children’s Hospital – plastic surgery lead, 4 VMO plastic surgeons, 1 VMO paediatric surgeon.

All the Adult Burn Units, with the exception of Royal Brisbane & Women’s Hospital (RBWH) have a plastic surgeon lead and all, or a significant majority of plastic surgery VMOs. RBWH has a general lead and additional VMO general/ trauma surgeons. It is also noted Major Trauma Services, which are not also Major Burns Units may receive patients with burn injuries, which are usually managed by general or trauma surgeons.

Detailed staffing was provided from six burns units, which is presented in Table 21. Some Burn Units have been successful in building up a significant surgical workforce whether of full time or VMO staff. The larger units are also significantly advantaged in having overseas Fellows who contribute substantially to managing the Unit caseload. The current pandemic border restrictions are however causing difficulties in enabling efficient recruitment and retention of international staff.

**Table 21: Senior surgical staffing profile**

| Unit type   | Annual admissions | FTE                           | Admits / FTE |
|-------------|-------------------|-------------------------------|--------------|
| Adult       | 300               | 2 FTE<br>1 Fellow, other VMOs | ~75 / FTE    |
| Adult       | 300               | 3.1 FTE VMOs<br>Fellow        | ~75 / FTE    |
| Adult       | 275               | 1.2 FTE<br>1 Fellow           | ~ 125 / FTE  |
| Combined    | 100               | 0.5 FTE, other VMOs           | ~100 / FTE   |
| Paediatrics | Not specified     | 1.9 FTE                       | ~100 / FTE   |
| Paediatrics | Not specified     | 1.0 FTE, 0.5 Fellow           | ~125 / FTE   |

## Burn Unit head

The International Society of Burn Injury guidelines (2017) recognise that the specialty of the burn unit Director can vary depending on local conditions, however burn surgeons must maintain active decision-making responsibility and control of care for major burn injury patients. Surgical specialisation of the Director may be general or plastic with additional training in burn care, wound management, skin grafting and amputations, and depending on available resources advanced knowledge in critical care. The guidelines identify a failed model as one where intensivists have primary responsibility for the patient, with a consultative role for the burn surgeon when surgery is deemed necessary.

The 2017 European Burns Association guidelines provide more explicit recommendations, in that the Director should be a medical specialist dedicated to and experienced in burn treatment, familiar with all aspects of complex and continuous burn care, with at least 10 years of clinical practice, taking responsibility for all activities at the burn unit. Formal education could be as a plastic surgeon, general surgeon, anaesthetist or intensivist. Surgical background though is preferred, as the causal treatment of severe burns is done with surgery.

In the United States, a 2017 survey of burn surgery units (Egro 2019) found that 69% of unit directors were general surgeons, a third of whom had completed additional burn surgery fellowships. Burn surgery and wound care was undertaken by general surgeons in 51% of units and plastic surgeons in 42%. With respect to future recruitment desirable qualifications were identified as general surgery (67%) and / or plastic surgery (41%) with additional fellowships in burn surgery (55%), trauma surgery (15%) or critical care (44%). The survey found that the Director's primary surgery qualification had a substantial influence on their recruitment preferences.

Currently in Australia the heads of the major Burn Unit are surgeons, of the subspecialty they provides the predominant proportion of the surgical workforce. For the adults units the Burn Unit lead is a specialist plastic surgeon, except at RBWH which has a general surgery lead. In the major paediatric units, there are plastic surgery leads in Adelaide and Perth, with paediatric surgery leads in Melbourne, Sydney and Brisbane.

The clear advantages of having a specialist burn surgeon as the Director of the Unit are:

- able to model to other staff the primary responsibilities of a burn surgeon;
- availability to participate in all clinical aspects of burn surgery, including roster, on-call, outpatients and multidisciplinary care;
- able to provide leadership, mentorship and collegiate support to other burn surgeons;
- able to effectively promote the Unit to prospective surgeons;
- able to contribute to key research and development strategies;
- better placed to work with RACS and professional societies to influence trainee curriculum.

Overall its very likely that the advantages of having the most appropriately qualified surgical Director of the Burns Unit, whether plastics, paediatrics or general, depending on local circumstances, would outweigh any other considerations.

## Burn Unit workforce planning, recruitment and retention

As identified Major Burn Units are structured and staffed to provide complex multidisciplinary care, with ongoing monitoring needed to ensure that the current composition meets the needs of the Unit and that there is a broad understanding of the future work intention of each health

professional and the workforce as a whole. The model in place whilst important in its own right for the current workforce in terms of retention, will also likely have a significant impact upon the attitudes of prospective staff and the success of future recruitment.

With respect to the burn surgeon workforce there are broadly three main models: all sessional visiting medical officers (VMOs), mixed VMO and full time surgeons, or an all full time workforce. The workforce in all three forms can be substantially buttressed by International Burn Fellows, who may be available either on a part time or fulltime basis, but who do not impose a long term obligation on the Unit. All the models have advantages and disadvantages, which may change over time, which will in turn influence the risk profile for staffing the Burn Unit.

All Burn Units have a finite amount of total remuneration available to employ staff in general and burn surgeon staff in particular. In Australia larger units have about 3 FTE surgeons and a full time or half time Fellow. Total head count is important in spreading the on-call load, with a minimum of 5 or 6 surgeons needed to fully cover the roster, especially when surgeons are on leave. The availability of Fellows on time limited contracts is an important lever in managing the on-call roster. Table 22 presents possible staffing mix, with 3 FTE surgeon.

**Table 22: Surgeon and workforce appointment and staffing mix models**

| Number full time FTE       | Number of VMO FTE   | Total Head count |
|----------------------------|---|------------------|
| 3 FTE, one of whom is Head | 0 VMO   | 3                |
| 2 FTE, one of whom is Head | 2 VMOs each at 0.3 FTE; 1 VMO at 0.4 FTE  | 5                |
| 1 FTE                      | 1 VMO 0.6 head of unit, 2 VMOs each at 0.4 FTE, 2 VMOs each at 0.3 FTE                                    | 6                |
| 0 FTE                      | 1 VMO 0.6 head of unit, 2 VMOs each at 0.4 FTE, 3 VMOs each at 0.3 FTE, 2 each at 0.2 FTE, 0.3 FTE ad hoc | 8+               |

Full time surgeons are currently employed in major Australian Burn Units, but according to their mode of employment, as a joint University / hospital appointee or only through the hospital, they are most likely to have an actual clinical appointment of 7 to 8 sessions each week, with the remainder of 2 to 3 sessions, explicitly designated for administration, teaching, research, private practice and other activities. The advantages of full-time appointments include:

- that one surgeon is available to cover a substantial block of the Unit’s workload;
- the surgeon is usually on-site in-hours if emergency treatment of a patient is required;
- there is good continuity of care and clarity about clinical responsibility; and
- a presence within the hospital and university hierarchy, which can help in the promotion of the work and objectives of the Unit.

An appointment of a full time surgeon is particularly appealing if a Unit has had a period of some workforce and roster instability. A hospital’s short-term interest in an employing a well-qualified surgeon who maybe a recently recognised, overseas qualified surgeon or an older local surgeon, with no current or future interest in private practice is fairly clear cut.

The main disadvantage relates directly to the key advantage, key-person dependence, in that undertaking a substantial block of work presumably with a significant on-call requirement can become a problem if the surgeon becomes unavailable because of sickness, holidays,

resignation or retirement, which will lead to a significant gap in the roster. A significant proportion of the burn surgeon budget is therefore locked into one or two key personnel, which reduces other employment flexibility.

Visiting Medical Officers are usually contracted for an agreed, remunerated number of sessions (usually of about 3.5 hours each), with principal responsibilities related to theatre, ward, outpatients and the on call roster. A VMO, if the Director of the Unit, may also be paid for an administrative session. However other VMOs are unlikely to have paid sessions not directly related to clinical care, notwithstanding likely participation in teaching, research and administration, which does allow for some free-riding by the hospital. Ideally VMOs should have a substantial appointment of three to four sessions each week, which demonstrates commitment to the service, provides for a robust service model including reasonable on-call, and helps with continuity of care. Other advantages therefore largely relate to the availability of a larger qualified surgical cohort:

- public workload is shared;
- less onerous on call demands;
- ensures leave entitlements are used;
- allows for diversification of interest and the development of a non-burn surgery private practice;
- increases breadth of surgical experience and expertise in the Unit;
- more easily allows internal re-allocation of sessions with changing surgeon interest, which also facilitates future leadership development;
- supports initial surgeon appointments to Burn Unit, with the reallocation of one session from a couple surgeons less impactful in them if they already have established private practices.

The issue of a having a substantially full-time appointment in smaller Burns Units, will further heighten the key worker loss.

The extant workforce model will have a significant influence on the perceived and actual attractiveness of the Unit to prospective surgeons.

### ***Surgeon and trainee burnout***

There has been a lot of recent international research about factors influencing retention of surgeons, with particular reference to surgeon burnout, which is characterised as a state of mental and physical exhaustion (Khansa 2015). In the research literature the dependent variable for professional burnout is measured by three subscales from the Maslach Burnout Inventory Human Services Survey. These are:

- emotional exhaustion;
- depersonalization; and
- feelings of reduced personal accomplishment (Prendergast 2017).

Studies (Streu 2014, Qureshi 2015, Santos 2020) have found more than a quarter of plastic surgeons and 40% of general surgeons, suffer from burnout, which can have negative repercussions for the surgeon, their family, patients and colleagues. Risk factors identified for plastic surgeons, include:

- a reconstructive rather than cosmetic practice;
- long work hours;
- on-call more than two nights a week;

- lack of professional autonomy; and
- a junior academic rank;
- being middle-aged; and
- having poor health.

Plastic surgeons with burn out also reported a nearly two-fold increased risk of self-reported medical errors and self-reported impairment (Qureshi 2015). There is also a significant overlap of burnout, depression, and substance abuse (Khansa 2015).

A 2020 survey of American burn surgeons (Sutherland 2021) found that 85-90% of respondents experienced burn-out, with women surgeons five times more likely to report burnout compared to male colleagues. The highest rates were in the 40-44 age group compared with older surgeons.

Professional burnout has also been investigated with respect to plastic surgery trainees (Grome 2021). Almost 150 P&RS trainees who responded to a survey (Coombs 2020) in the US found an overall burnout rate of 57.5%, and on average, all residents experienced work exhaustion and interpersonal disengagement. Burnout was significantly associated with respondents who:

- did not feel involved in Unit decisions;
- reported increasing hours worked;
- felt that they had too much on call; or
- reported making a major medical error that could have harmed a patient.

Consistent with these findings Hart (2020) found that 65.5% of plastic surgery residents met the definition of burnout by their scores from at least one of the Maslach Burnout subscales. The number of hours worked each week significantly correlated with increased scores in the emotional exhaustion and depersonalisation subscales. Burnout risk was increased in trainees in the early years of training, who were feeling dissatisfied with career plans or worked in units in which senior surgeons did not make weekly ward rounds and in which regular staff meetings were not scheduled (Chaput 2015). The occurrence of a weekly ward round by a senior surgeon appears to be protective against burnout ( $P = 0.007$ ); regular staff meetings also appeared have a similar effect as they offered an opportunity to ask questions, and to receive follow-up, feedback and mentoring. Notwithstanding these findings almost 70% reported satisfaction with their careers (Chaput 2015).

### **Addressing burnout**

The literature indicates that a two pronged approach is needed to addressing surgeon and trainee burnout, an individual one and an organisational response which can make the work environment more appealing to clinical staff.

At an individual surgeon level, interventions such as stress management, self-care, communication skills training, facilitated small group discussion, gratitude interventions, and professional coaching (Drybe 2019) have been shown to build resiliency, mindfulness and reflection. For surgical trainees, peer mentoring, professional development coaching, physical exercise, discussion of imposter syndrome, and having a general practitioner to support their well-being can help, though alone these will not necessarily reduce burnout (Sharpe 2017).

Organisational leadership qualities, attributes, and management styles have a direct impact on surgeon satisfaction and burnout. Transformational qualities and skills such as mentorship, coaching, instilling pride, discussing values and purpose, praising accomplishments, and



identifying individual needs and talents result in the highest rates of satisfaction (Menaker 2008, Shanafelt 2015).

Effective organisational interventions to reduce the risk of staff burnout include:

- strengthen individual professional autonomy;
- attention to workload and job demands, with the prospect of increased roster flexibility and shorter shifts;
- broader responsibility for on call;
- modifications to work processes and flows;
- optimisation of electronic health records;
- availability of support staff to undertake administrative tasks;
- optimisation of shared work spaces;
- certainty about allowable leave (holiday, sick, family, maternity, paternity);
- support staff access to self-care resources;
- team building exercises; and
- open and consistent dialogue between clinicians, Unit management and hospital administration.

### ***Plastic surgery trainee work intentions***

In the context of their current state of well-being and options for surgical careers, consideration of future work intentions feed into the overall equation for trainees and Burn Units as to how organisational and professional structures can positively influence these decisions.

Recent surveys of North American plastic surgery training programs (Vrouwe 2020) found that burn care was considered an important component in training by program directors (USA 88%; Canada 100%) and trainees (USA 87%; Canada 99%). Rotations for trainees averaged 2.5 months and most commonly occurred during the second year of training. Three-quarters of American residents were interested in a career that involved burn care in some capacity, primarily burn reconstruction (40%). Factors that discouraged North American trainees were:

- the nature of burn care (60%);
- the nature of burn operations (45%);
- the on-call commitment (39%); and
- a narrow scope of practice (38%).

A study of plastic surgery trainees in Canada (Morzycki 2018) asked them about their experience of the training program, specifically as to whether they would like to see more of a particular training domain and whether they intended to seek additional qualifications (see Table 23). Ninety-six percent of trainees had had a term in burn surgery during their training, with 7% interested in having further training exposure and 3% of trainees intending to seek further qualifications and Fellowship in burn surgery.

**Table 23: P&RS Training domains, exposure and future training intention**

| Domains                             | Domain exposure during residency (%) | Domain would like to see more of during residency (%) | Domain intending to seek additional qualifications (%) |
|-------------------------------------|--------------------------------------|---|--|
| Hand/ Upper extremity               | 100                                  | 9   | 23   |
| General principles                  | 99                                   | 10  | 2  |
| Breast surgery                      | 97                                   | 3   | 11   |
| Craniofacial                        | 97                                   | 32  | 11   |
| Pre-operative assessments           | 97                                   | nr  | nr   |
| Post-operative assessments          | 97                                   | nr  | nr   |
| General cutaneous disorders / burns | 96                                   | 7   | 3  |
| Research                            | 88                                   | 10  | 0  |
| Lower extremity reconstruction      | 86                                   | 32  | 2  |
| Head and neck reconstruction        | 80                                   | 41  | 5  |
| Aesthetic surgery/ body contouring  | 77                                   | 52  | 13   |
| Medical education                   | 74                                   | 17  | 3  |
| Trunk reconstruction                | 74                                   | 32  | 2  |
| Pelvic/ genital surgery             | 62                                   | 36  | 2  |
| Microsurgery                        | nr                                   | nr  | 8  |
| Paediatric plastic surgery          | nr                                   | nr  | 5  |
| Peripheral nerve surgery            | nr                                   | nr  | 2  |
| Brachial plexus surgery             | nr                                   | nr  | 1%   |

A study of UK plastic surgery trainees (Fell 2020) found that in relation to first choice subspecialty, that 7% were interested in a burn surgery career (see Table 24)

**Table 24: Plastic surgery trainees, first choice subspecialty intent**

| First choice subspecialty  | Percentage |
|----------------------------|------------|
| Hand and upper limb        | 20%        |
| Cleft lip and palate       | 12%        |
| Lower limb trauma          | 12%        |
| Oncoplastic breast surgery | 12%        |
| Skin and sarcoma           | 10%        |
| Burns                      | 7%         |
| Academic plastic surgery   | 6%         |
| Head and neck oncology     | 5%         |
| Craniofacial surgery       | 4%         |
| Aesthetic plastic surgery  | 2%         |
| Complex wounds             | 2%         |
| Ear reconstruction         | 1%         |
| Genito-urinary             | 1%         |
| Pelvic reconstruction      | 1%         |
| Vascular anomalies         | 0%         |

Surgical trainee intention remains a key determinant in building and maintaining the burn surgeon workforce. A recent survey (Sreedharan 2021) of 121 plastic surgery trainees (response rate 59%) in Australia and New Zealand, replicating the study of Brown (2004), found an increased interest in having a career in burn surgery. Thirty-three of seventy

respondents were interested in a half time or sessional type involvement, with one wishing to pursue a fulltime career. The current interest in a burn surgery of 49% compared favourably with a rate of 21% in the 2004 survey.

Sreedharan (2021) found that the three most common impediments to a career in burn surgery were the nature of burn operations and burn care, and the level of on-call commitments which were the same as the previous survey. A fourth factor identified related to the adequacy of exposure and training in burn surgery.

Exposure to a specialty in medical school has been shown to influence students' career choices. Medical students and early year medical post-graduates (Davis 2016, Johnson 2018) were found to have a greater interest in a career in plastic surgery with greater exposure to the discipline, in particular operating theatre time, and specialist surgeon interest and interaction with the student or junior doctor. A survey (Kahn 2011) of medical students found that significant predictors of interest in burn surgery were an interest in surgery ( $P < .001$ , odds ratio [OR] = 56.3), prior exposure to burn surgery ( $P = .02$ , OR = 5.7), which became a stronger predictor for fourth-year medical students ( $P < .001$ , OR = 24.5). The majority of students reported that exposure to burn surgery (76%) and a strong mentor (87%) would make them more likely to consider burn surgery as a career. The majority of students reported ignorance of the field of burns with three quarters not knowing enough about the field to consider it as a career. Exposure during medical school and strong mentorship may influence more students to become burn surgeons, with mentorship and recruiting efforts focused on students with a general interest in surgery. Brady (2018) also proposes mentoring to encourage plastic surgery trainees to develop skills and an interest in burn surgery.

Sreedharan (2021) identified that more comprehensive training exposure would provide additional confidence about developing a burn surgery career. It was noted that all New Zealand trainees are required to undertake a formal placement at the National Burn Unit at Middlemore Hospital, a requirement not in place in Australia. Survey respondents indicated that strong, early mentorship as a burn surgeon, supported by sufficient resources and funding would increase the attractiveness of a career in the field. The authors identified that the employment of more burn surgeons on a part time or sessional basis, rather than a full-time basis would address a major concern about on-call responsibility and increase the number of burn surgeons to spread the workload, which in turn would help mitigate the risk of surgeon burn out. An increase in the size of the workforce, coupled with additional training exposure provides a strong basis to provide the surge capacity needed during mass burn events.

Sreedharan estimated based on the number of P&RS trainees and an interest in a burn surgery career that over the next five years there would potentially be two P&R surgeons available to work for each of the 17 major burn units in Australia and New Zealand, which would represent about 13 FTE based on expressed work preferences.

### ***Other members of the Multidisciplinary Burn Unit team***

Surveys of North American and UK burn units have clarified future intentions about the burn surgeon workforce in the next ten years, with a substantial cohort of older surgeons considering retirement. These surveys also found that three quarters of Canadian burn units (Vrouwe 2018) were currently in need of additional specialist burn nurses, with the availability of nursing expertise cited as the most common barrier to delivering burn care. Similarly in the United States, 62% of major units had experienced a nursing shortage, with an average of almost five vacant positions. A French study (Ravat 2014) found excess time spent on administration de-incentivised nurses. In the review a third of nurse time in a large burn unit was occupied with

administrative tasks, a third of which was not clinically related and could be performed by administrative staff.

There needs to be a clear understanding of what factors support and hinder all members of the multidisciplinary team including specialist nurses, physiotherapists, occupational therapists, psychologists and social workers with a view to effective workforce planning that covers future intentions and recruitment strategies.

## Appendix 1 – surgical training curricula

### General Surgery Trauma Module Competencies

| SET level  | Medical expertise  | Judgement and clinical decision - making  | Technical expertise - operative management knows | Technical expertise – operative management does  |
|--|--|---|--|--|
| <b>Ongoing ICU management: definitive care phase</b> |  |   |  |  |
| Early SET  | Definition and pathophysiology of traumatic shock, ischaemia reperfusion injury, post injury SIRS, sepsis and MOF, nutrition, compartment syndromes, burn care | Ability to perform focused assessment of the organ systems based on clinical examination, vital parameters, laboratory data and the required level of organ support. Ability to indicate and interpret focused imaging required based on clinical assessment.<br>Interpret compartment pressure measurements and know the indications for treatment.<br>Attention to prevention of common postinjury complications. |  | Compartment pressure measurement   |
| <b>Soft tissue and skin</b>                          |  |   |  |  |
| Early SET  | Wound healing<br>Pathophysiology of necrosis and ischaemia<br>Pathophysiology of burns   | Distal neuro-vascular assessment; Viability assessment of soft tissues;<br>Burn assessment;<br>Fluid resuscitation in severe burn patients; Inhalation injuries;<br>Management priorities of acute traumatic wounds depending on mechanism, location and contamination;<br>Initial management principles of severe burns;<br>Anticipation and recognition of wound complications.                                   | Surgical airway                                  | Wound exploration;<br>Wound debridement;<br>Wound closure or open management;<br>Split skin grafting;<br>VACC therapy. |
| Mid SET  |  | Advanced soft tissue management decisions: identifying the need for specialist involvement.<br>Wound management in specific areas.  | Wound management in specific areas               | Escharotomy;<br>Local flap coverage.   |
| <b>Blast injuries</b>                                |  |   |  |  |
| Early SET  | Understanding the unique patterns of blast trauma<br>Pathophysiology of blast injury   | Assessment and description of wounds<br>Identify life threatening injuries;<br>Initiate initial resuscitation;  |  | Lavage and debride contaminated wounds;<br>Intercostal catheters.  |
|  |  | Assess tetanus immunisation status;<br>Identify possible exposures to toxins, chemicals or radiological;<br>Relevant investigations for barotrauma, penetrating, blunt and burn injuries.   |  |  |

|         |  |  |   |   |
|---------|--|--|---|---|
| Mid SET |  | <p>Mass casualty triaging;<br/> Resource allocations;<br/> Co-ordinate multidisciplinary team efforts; As per initial resuscitation phase and identify life threatening injuries; Management of contaminated wounds;<br/> Management of severe burns;<br/> Air embolism.</p> | <p>As per initial resuscitation phase and identify life threatening injuries.</p> | <p>Surgical airway;<br/> Thoracotomy;<br/> Emergency laparotomy;<br/> Haemorrhage control;<br/> Escharotomy in burns.</p> |
|---------|--|--|---|---|

## Plastic and Reconstructive Surgery - burn and cold injury module competencies

| SET level       | Applied Medical expertise   | Clinical Assessment   | Management   | Technical expertise   |
|-----------------|---|---|--|---|
| Early (SET 1-2) | <p>Able to discuss:</p> <p>Burn depth</p> <ul style="list-style-type: none"> <li>• pathophysiology of burn injuries</li> <li>• thermal (hot and cold)</li> <li>• electrical</li> <li>• chemical</li> </ul> <p>Timing and rationale for antibiotic use<br/>Timing of initial surgery<br/>Resuscitation options<br/>Fluid regimes</p> <p>The benefits and disadvantages of both early excision and conservative management.</p> <p>Nutritional support<br/>Microbiology of burn wounds<br/>Extravasation injuries.</p> <p>Outline the features and management of toxic epidermolysis syndrome.</p> <p>Outline the criteria for transfer of a patient to a burns unit.</p> | <p>Elicit a targeted history from a patient presenting with burns.</p> <p>Conduct a focused physical examination to assess the severity of the injury.</p> <p>Recognise life-threatening injuries and septic shock.</p> <p>Assess the vascular status of a limb.</p> <p>Assess the presence of compartment syndrome.</p> <p>Select and interpret appropriate preoperative investigations.</p> <p>Determine whether transfer to burn unit is required.</p> <p>Assess the psychological impact of burns trauma for the patient and refer appropriately.</p> | <p>Apply a range of burn dressings.</p> <p>Manage acute minor burns.</p> <p>Resuscitate a burns patient. Apply knowledge of fluid resuscitation in the management of paediatric burn patients and implement paediatric fluid regimes.</p> <p>Plan burns excision and grafting.</p> <p>Plan release of burn scars using grafting and local flaps.</p> <p>Use simple scar management techniques including splints and pressure garments.</p> | <p>Perform an accurate assessment of burn wounds (extent and depth).</p> <p>Debride minor burns.</p> <p>Perform skin grafts for minor burns.</p>  |
| Mid (SET 3-4)   | <p>Explain the pathophysiology of inhalation and burn injury.</p> <p>Describe the management of patients with specific burn injuries (e.g., inhalation, chemical and electrical burns).</p> <p>Discuss:</p> <ul style="list-style-type: none"> <li>• principles of early burn debridement</li> <li>• principles and management of burn and relevance to subsequent soft-tissue reconstruction</li> <li>• management of inhalation injury including bronchoscopy</li> </ul>  | <p>Recognise non-accidental burn injuries and refer to appropriate services.</p> <p>Clinically assess burn scars and contractures, demonstrating recognition of injury patterns.</p>  | <p>Prescribe appropriate antibiotics.</p> <p>Formulate management plans for patients with common patterns of burn injuries.</p> <p>Plan total and staged burn excision and grafting.</p> <p>Facilitate end-of-life decisionmaking with patients and families.</p> <p>Effectively lead initial resuscitation of a major burn.</p>   | <p>Perform escharotomy and fasciotomy.</p> <p>Debride and dress major burns, including use of temporary skin cover.</p> <p>Perform skin grafts to specialized areas (e.g., hands, face).</p> <p>Perform a tracheostomy.</p> <p>Design flaps for burn contracture release.</p> |

| SET level           | Applied Medical expertise  | Clinical Assessment | Management   | Technical expertise   |
|---------------------|--|---------------------|--|---|
|                     | <ul style="list-style-type: none"> <li>• metabolic response to burn injury.</li> </ul> <p>Demonstrate knowledge of:</p> <ul style="list-style-type: none"> <li>• options available for early surgery</li> <li>• requirements of special sites</li> <li>• principles of management of more complex injuries including polytrauma planning and prioritising treatment in a multidisciplinary setting.</li> </ul> <p>Demonstrate knowledge of the differences in aetiology and pathophysiology between adult and paediatric burns patients.</p> <p>Demonstrate knowledge of the differing role of burn facilities, units and centres and integration with major trauma.</p> |                     |  |   |
| <b>Late (SET 5)</b> | <p>Demonstrate knowledge of principles and use of dermal and epidermal substitutes, including stem cells, cultured epithelial autografts, and other emerging technologies.</p>   |                     | <p>Formulate a reconstructive plan for patients with a major burn injury, considering a range of reconstructive techniques and priorities.</p> | <p>Use skin substitutes for burns and reconstruction. Perform distant and free flaps for acute burns and burn reconstruction.</p> |



## Appendix 2 - Major Burn Unit survey

The survey was developed based primarily on Australian and international guidelines, and the terms of reference for the project,

|  | <b>Example Reference</b>   | <b>Rationale</b>   | <b>Expected data source</b>              |
|--|--|--|--|
| 1. Respondent  | N /A   | Allows follow-up   | Survey respondent                        |
| 2. Service Lead  | British Burn Association, European Burns Association   | Influences structure of service, new appointments, development of future workforce   | Survey respondent                        |
| 2. Type of appointment   | British Burn Association, project terms of reference   | Provides indication of workforce structure, options for service development  | Survey respondent                        |
| 3. Hospital division   | Project terms of reference   | Demonstrates key organizational relationships  | Survey respondent                        |
| <b>Activity and Caseload</b>   |  |  |  |
| 4. Admissions, LOS, proportion major burns                                     | BRANZ data   | Provides an estimate of usual demand   | Survey respondent                        |
| 5. Proportion referred from another hospital                                   | BRANZ data   | Provides an estimate of usual demand   | Survey respondent                        |
| 6. Proportion referred meet ANZBA guidelines                                   | Estimate based on BRANZ data, professional estimate  | Provides an estimate of usual demand   | Professional estimate made by respondent |
| 7. Proportion of referring hospitals comply with referral guidelines           | Estimate based on BRANZ data, professional estimate  | Provides an estimate of usual demand   | Professional estimate made by respondent |
| 8. Estimate of proportion of patients not referred                             | Carmichael 2019; professional estimate, based on late referrals post-discharge from another hospital to ED, OP | Provides an estimate of non-referral, to help identify opportunities to improve patient care, to help project additional Burn Service demand | Professional estimate made by respondent |
| 9. Proportion of burn patients admitted to critical care, LOS                  | BRANZ data   | Provides an estimate of usual demand   | Survey respondent                        |
| 10. Proportion of admissions with at least one major burn management procedure | BRANZ data   | Provides an estimate of usual demand   | Survey respondent                        |
| 11. Number of OP attendances   | British Burn Association   | Provides an estimate of usual demand and an estimate of possible post discharge referrals from other sources                                 | Burn service estimate                    |
| 12. OP clinic names  | British Burn Association, NSW ACI  | Provides an estimate of usual demand   | Burn service estimate                    |

|   | <b>Example Reference</b>                             | <b>Rationale</b>   | <b>Expected data source</b> |
|---|--|--|-----------------------------|
| 13. Telehealth OP follow up                   | NSW ACI, British Burn Association                    | Provides an estimate of usual demand; measures uptake of new technology and patient focused care   | Burn service estimate       |
| <b>Ward and hospital infrastructure</b>       |  |  |                             |
| 14. Integrated with major trauma network      | British Burn Association                             | Identifies key organizational supports and inter-dependencies                                      | Survey respondent           |
| 15. Ward co-located with critical care        | British Burn Association                             | Describes key burn service clinical infrastructure   | Survey respondent           |
| 16. Designated critical care beds             | British Burn Association                             | Describes key burn service clinical infrastructure, organizational supports and inter-dependencies | Survey respondent           |
| 17. Formal joint care in critical care        | NSW ACI, British Burn Association                    | Demonstrates key clinical & organizational relationships   | Survey respondent           |
| 18. Dedicated ward – usual number of beds     | Project terms of reference                           | Describes key burn service clinical infrastructure   | Survey respondent           |
| 19. Dedicated ward – flex number of beds      | Project terms of reference                           | Describes key clinical infrastructure; may demonstrate mass incident planning                      | Survey respondent           |
| 20. Ward shared with other specialties        | British Burn Association                             | Describes key clinical infrastructure  | Survey respondent           |
| 21. Differential air pressure control - ward  | British Burn Association, European Burns Association | Describes key burn service clinical infrastructure and infection control systems                   | Survey respondent           |
| 22. Ward bed configuration                    | British Burn Association, European Burns Association | Describes key burn service clinical infrastructure   | Survey respondent           |
| 23. Differential air pressure control - rooms | British Burn Association, European Burns Association | Describes key burn service clinical infrastructure and infection control systems                   | Survey respondent           |
| 24. Thermally controlled rooms                | British Burn Association, European Burns Association | Describes key burn service clinical infrastructure   | Survey respondent           |
| 25. Hydrotherapy facilities                   | Baier 2018   | Describes key burn service clinical infrastructure   | Survey respondent           |
| 26. Ward water supply                         | Baier 2018   | Describes burn service infection control systems   | Survey respondent           |
| 27. Own procedure rooms                       | European Burns Association                           | Describes key burn service clinical infrastructure   | Survey respondent           |
| 28. Own operating theatre                     | British Burn Association, European Burns Association | Describes key burn service clinical infrastructure   | Survey respondent           |
| 29. Own therapy rooms                         | British Burn Association, European Burns Association | Describes key burn service clinical infrastructure   | Survey respondent           |

|   | <b>Example Reference</b>                                      | <b>Rationale</b>   | <b>Expected data source</b> |
|---|---|--|-----------------------------|
| 30. Telehealth – accept referrals, advice to referrers, stores images | NSW ACI, British Burn Association                             | Describes key clinical infrastructure, system and network support                                  | Survey respondent           |
| 31. Rehabilitation facilities   | NSW ACI, British Burn Association                             | Describes key burn service clinical infrastructure   | Survey respondent           |
| 32. Well located for medical imaging                                  | British Burn Association                                      | Describes key burn service clinical infrastructure, organizational supports and inter-dependencies | Survey respondent           |
| 33. Well located for main Operating Theatres                          | NSW ACI, British Burn Association                             | Describes key burn service clinical infrastructure, organizational supports and inter-dependencies | Survey respondent           |
| 34. Surge demand management   | NSW ACI,  | Demonstrates mass incident planning  | Survey respondent           |
| <b>Operating theatre availability</b>                                 |   |  |                             |
| 35. Scheduled in hours operating sessions                             | NSW ACI, ASPS feedback  | Describes key burn service clinical services and organizational supports                           | Survey respondent           |
| 36. Other access for major burn injuries                              | NSW ACI, ASPS feedback  | Describes key burn service clinical services and organizational supports                           | Survey respondent           |
| 37. Access for minor burns surgery                                    | NSW ACI, ASPS feedback  | Describes key burn service clinical services and organizational supports                           | Survey respondent           |
| 38. Emergency theatre for major burns                                 | NSW ACI, ASPS feedback  | Describes key burn service clinical services and organizational supports                           | Survey respondent           |
| <b>Model of care</b>  |   |  |                             |
| 39. Model of care   | NSW ACI, British Burn Association, project terms of reference | Describes key burn service clinical services and organizational supports                           | Survey respondent           |
| <b>Inter-related services</b>   |   |  |                             |
| <i>Scar management services</i>                                       |   |  |                             |
| 40. education and advice  | NSW ACI, British Burn Association                             | Describes access to key clinical service   | Survey respondent           |
| 40. pressure therapy  | NSW ACI, British Burn Association                             | Describes access to key clinical service   | Survey respondent           |
| 40. splinting   | NSW ACI, British Burn Association                             | Describes access to key clinical service   | Survey respondent           |
| 40. intra-lesional steroid inject                                     | NSW ACI, British Burn Association                             | Describes access to key clinical service   | Survey respondent           |
| 40. cosmetic camouflage   | British Burn Association                                      | Describes access to key clinical service   | Survey respondent           |
| 40. medical tattooing   | British Burn Association                                      | Describes access to key clinical service   | Survey respondent           |
| 40. laser therapy   | British Burn Association                                      | Describes access to key clinical service   | Survey respondent           |
| 40. hair restoration  | British Burn Association                                      | Describes access to key clinical service   | Survey respondent           |
| 41. Integrated MD outreach, off-site                                  | NSW ACI, British Burn Association                             | Describes access to key clinical service   | Survey respondent           |

|   | <b>Example Reference</b>                              | <b>Rationale</b>   | <b>Expected data source</b> |
|---|---|--|-----------------------------|
| 41. Burn research, development                            | NSW ACI, British Burn Association                     | Describes burn service activity and staff resource                       | Survey respondent           |
| 41. Education and prof develop                            | NSW ACI, British Burn Association                     | Describes burn service activity and staff resource                       | Survey respondent           |
| 41. Fund EMSB courses                                     | NSW ACI, British Burn Association                     | Describes burn service activity and staff resource                       | Survey respondent           |
| 41. Psychological support for staff                       | NSW ACI, British Burn Association                     | Describes burn service activity and staff resource                       | Survey respondent           |
| 41. Admin & support                                       | British BurnAssociation                               | Describes burn service activity and staff resource                       | Survey respondent           |
| 41. Data Management                                       | NSW ACI, British Burn Association                     | Describes burn service activity and staff resource                       | Survey respondent           |
| 41. Mx SJS, TEN patients                                  | British BurnAssociation                               | Describes access to key clinical service                                 | Survey respondent           |
| 42. Integrated A & P pain service                         | NSW ACI, British Burn Association                     | Describes access to key clinical service                                 | Survey respondent           |
| 42. Acute pain service                                    | NSW ACI, British Burn Association                     | Describes access to key clinical service                                 | Survey respondent           |
| 42. Persistent pain service                               | NSW ACI, British Burn Association                     | Describes access to key clinical service                                 | Survey respondent           |
| 42. Liaison psychiatry                                    | NSW ACI, British Burn Association                     | Describes access to key clinical service                                 | Survey respondent           |
| 42. Medical illustration / photo                          | British BurnAssociation                               | Describes access to key clinical service                                 | Survey respondent           |
| 42. Prosthetic service                                    | NSW ACI, British Burn Association                     | Describes access to key clinical service                                 | Survey respondent           |
| 43. Surgical specialties FTE, HC                          | Project terms of reference                            | Describes key burn service clinical services and organizational supports | Survey respondent           |
| 44. Surgical trainees, FTE, HC                            | Project terms of reference                            | Describes key burn service clinical services and organizational supports | Survey respondent           |
| 45. Junior medical staff FTE, HC                          | Project terms of reference                            | Describes key burn service clinical services and organizational supports | Survey respondent           |
| 46. Formal burn surgery training                          | Project terms of reference                            | Describes key burn service clinical services and organizational supports | Survey respondent           |
| 47. Surgical experience consistent with level of training | P&RS trainee curriculum                               | Describes burn service training capability                               | Survey respondent           |
| 47. graft minor burns                                     | P&RS trainee curriculum                               | Describes burn service training capability                               | Survey respondent           |
| 47. debride and graft major burns                         | P&RS trainee curriculum                               | Describes burn service training capability                               | Survey respondent           |
| 47. resuscitate major burns                               | P&RS trainee curriculum                               | Describes burn service training capability                               | Survey respondent           |
| 47. escharotomy   | P&RS trainee curriculum                               | Describes burn service training capability                               | Survey respondent           |
| 47. reconstruct major burn                                | P&RS trainee curriculum                               | Describes burn service training capability                               | Survey respondent           |
| 48. Other medical appointments to Burn Service            | British Burns Association, project terms of reference | Describes key burn service clinical services and organizational supports | Survey respondent           |

|   | <b>Example Reference</b>                                       | <b>Rationale</b>   | <b>Expected data source</b> |
|---|--|--|-----------------------------|
| 49. Burn nurse qualifications, experience   | NSW ACI, British Burns Association, project terms of reference | Describes key burn service clinical services and organizational supports | Survey respondent           |
| 50. ICU nurses, burn experience   | NSW ACI, British Burns Association, project terms of reference | Describes key burn service clinical services and organizational supports | Survey respondent           |
| 51. Theatre nurses, burn experience, scheduled surgery  | NSW ACI, British Burns Association, project terms of reference | Describes key burn service clinical services and organizational supports | Survey respondent           |
| 52. Theatre nurses, burn experience, emergency surgery  | NSW ACI, British Burns Association, project terms of reference | Describes key burn service clinical services and organizational supports | Survey respondent           |
| 53. Nurse patient ratios  | NSW ACI, British Burns Association, project terms of reference | Describes key burn service clinical services and organizational supports | Survey respondent           |
| 54. Burn service allied health FTE, HC – resp physio, physio, OT, dietetics, psychology, play, SW, speech | NSW ACI, British Burns Association, project terms of reference | Describes key burn service clinical services and organizational supports | Survey respondent           |
| 55. Other allied health FTE, HC – resp physio, physio, OT, dietetics, psychology, play, SW, speech        | NSW ACI, British Burns Association, project terms of reference | Describes key burn service clinical services and organizational supports | Survey respondent           |
| 56. Workforce – surgeon vacancy   | Project terms of reference                                     | Provides indication of current and future workforce availability         | Survey respondent           |
| 57. Workforce intention -burn surgeon   | Project terms of reference                                     | Provides indication of current and future workforce availability         | Survey respondent           |
| 58. Workforce – nurse vacancy   | Project terms of reference                                     | Provides indication of current and future workforce availability         | Survey respondent           |
| 59. Workforce – allied health vacancy   | Project terms of reference                                     | Provides indication of current and future workforce availability         | Survey respondent           |
| <b>Policy and procedures</b>  |  |  |                             |
| 60. admission policy  | NSW ACI, British Burn Association                              | Describes standardised approach to care                                  | Survey respondent           |
| 60. referring service guidelines  | NSW ACI, British Burn Association, European Burns Association  | Describes standardised approach to care                                  | Survey respondent           |
| 60. transfer of patients between services   | NSW ACI, British Burn Association                              | Describes standardised approach to care                                  | Survey respondent           |
| 60. inpatient rehabilitation  | NSW ACI, British Burn Association                              | Describes standardised approach to care                                  | Survey respondent           |
| 60. discharge guidelines  | NSW ACI, British Burn Association                              | Describes standardised approach to care                                  | Survey respondent           |
| 60. end of life guidelines  | British Burn Association                                       | Describes standardised approach to care                                  | Survey respondent           |

|                                  | <b>Example Reference</b>                                | <b>Rationale</b>                        | <b>Expected data source</b> |
|----------------------------------|---|---|-----------------------------|
| 60. infection control            | NSW ACI, British Burn Association                       | Describes standardised approach to care | Survey respondent           |
| 60. major incident               | National planning requirement, British Burn Association | Describes standardised approach to care | Survey respondent           |
| 60. clinical practice guidelines | NSW ACI, British Burn Association                       | Describes standardised approach to care | Survey respondent           |

## References

---

- Ahn CS, Maitz PK. The true cost of burn. *Burns*. 2012 Nov;38(7):967-74. doi: 10.1016/j.burns.2012.05.016. Epub 2012 Jul 13. PMID: 22795515.
- AIHW. Pointer S & Tovell A 2016. Hospitalised burn injuries Australia 2013–14. Cat. no. INJCAT 178. Canberra: AIHW.
- Australian Institute of Health and Welfare 2020. Procedure data cubes. Cat. no. WEB 216 Canberra: AIHW. Viewed 16 June 2021, <https://www.aihw.gov.au/reports/hospitals/procedures-data-cubes>.
- Australian Institute of Health and Welfare 2020. Principal Diagnosis data cubes. Cat. no. WEB 216. Canberra: AIHW. Viewed 16 June 2021, <https://www.aihw.gov.au/reports/hospitals/procedures-data-cubes>.
- Brady C, Edmondson SJ, Murray A. Ensuring Sustainability for UK Burns Services: Workforce Planning for Burns Consultants. *Ann Plast Surg*. 2019 Mar;82(3):274 -276. doi: 10.1097/SAP.0000000000001847. PMID: 30730348.
- British Burns Association, National Standards for Provision and Outcomes in Adult and Paediatric Burn Care, November 2018
- Brown TLH, Mills S. Where are all the burn surgeons? A survey of plastic surgical trainees in Australasia. *Burns* 2004; 30:577–580.
- Burns Registry of Australia and New Zealand (May 2021). Annual Report 2019/20. Department of Epidemiology and Preventive Medicine, Monash University. Melbourne, Australia.
- Carmichael H, Wiktor AJ, McIntyre RC, Lambert Wagner A, Velopoulos CG. Regional disparities in access to verified burn center care in the United States. *J Trauma Acute Care Surg*. 2019 Jul;87(1):111-116. doi: 10.1097/TA.0000000000002259. PMID: 30865160.
- Carrau D, Janis JE. Physician Burnout: Solutions for Individuals and Organizations. *Plast Reconstr Surg Glob Open*. 2021 Feb 16;9(2):e3418. doi: 10.1097/GOX.0000000000003418. PMID: 33680666; PMCID: PMC7929696.
- Chaput B, Bertheuil N, Jacques J, Smilevitch D, Bekara F, Soler P, Garrido I, Herlin C, Grolleau JL. Professional Burnout Among Plastic Surgery Residents: Can it be Prevented? Outcomes of a National Survey. *Ann Plast Surg*. 2015 Jul;75(1):2-8. doi: 10.1097/SAP.0000000000000530.
- Cleland HJ, Proud D, Spinks A and Wasiak J. Multidisciplinary team response to a mass burn casualty event: outcomes and implications. *Med J Aust* 2011; 194 (11): 589 -593.
- Cochran A, Greenhalgh DG. Building the Burn Physician Workforce for the 21st Century: Report from February 2014 Burns Workforce Conference. *J Burn Care Res*. 2018 Oct 23;39(6):853-857. doi: 10.1093/jbcr/iry020. PMID: 29771369.
- Coombs DM, Lanni MA, Fosnot J, Patel A, Korentager R, Lin IC, Djohan R. Professional Burnout in United States Plastic Surgery Residents: Is It a Legitimate Concern? *Aesthet Surg J*. 2020 Jun 15;40(7):802-810. doi: 10.1093/asj/sjz281. PMID: 31621825
- Davis CR, Trevatt AE, McGoldrick RB, Parrott FE, Mohanna PN. How to train plastic surgeons of the future. *J Plast Reconstr Aesthet Surg*. 2016 Aug;69(8):1134-40. doi: 10.1016/j.bjps.2016.05.001. Epub 2016 May 13. PMID: 27268948.

- Dyrbye LN, Shanafelt TD, Gill PR, et al. Effect of a professional coaching intervention on the well-being and distress of physicians: a pilot randomized clinical trial. *JAMA Intern Med.* 2019;179:1406–1414.
- Egro FM, Johnson ED, Kenny EM, Foglio AM, Smith BT, Corcos AC, Ziembicki JA. A Qualitative Survey Study of United States Burn Units: Pathways to a Career in Burn Surgery. *J Burn Care Res.* 2019 Aug 14;40(5):595-600. doi: 10.1093/jbcr/irz071. PMID: 31032517.
- Fell M, Staruch R, Baker BG, Nicholas R, Howes R; Collaborating Authors. Plastic surgery training in the UK: Results from a national survey of trainee experiences. *JPRAS Open.* 2020 Jun 27;25:72-82. doi: 10.1016/j.jptra.2020.06.003. PMID: 32775592.
- Finnerty CC, Jeschke MG, Branski LK, Barret JP, Dziewulski P, Herndon DN. Hypertrophic scarring: the greatest unmet challenge after burn injury. *Lancet.* 2016 Oct 1;388(10052):1427-1436. doi: 10.1016/S0140-6736(16)31406-4. PMID: 27707499; PMCID: PMC5380137.
- Fraser S, Grant J, Mackean T, et al. What informs care? Descriptions by multidisciplinary teams about burns care for Aboriginal and Torres Strait Islander children *Burns* 2020; 46 (2): 430-440
- Fraser S, Grant J, Mackean T, et al. Burn injury models of care: A review of quality and cultural safety for care of Indigenous children. *Burns* 2018; 44 (3): 665-677
- Friedstat JS, Hultman CS. Hypertrophic burn scar management: what does the evidence show? A systematic review of randomized controlled trials. *Annals of plastic surgery.* 2014;72:S198–201.
- General Surgery Australia, Training Curriculum, 2021
- Gong J, Singer Y, Cleland H, Wood F, Cameron P, Tracy L, Gabbe B. Driving improved burns care and patient outcomes through clinical registry data: A review of quality indicators in the Burns Registry of Australia and New Zealand. *Burns;* 2021; 47(1):14-24. <https://doi.org/10.1016/j.burns.2020.01.005>.
- Grome LJ, Reul RM, Agrawal N, Abu-Ghname A, Winocour S, Buchanan EP, Maricevich RS, Reece EM. A Systematic Review of Wellness in Plastic Surgery Training. *Aesthet Surg J.* 2021 Jul 14;41(8):969-977. doi: 10.1093/asj/sjaa185. PMID: 32596712
- Hart AM, Crowley C, Janis JE, Losken A. Survey Based Assessment of Burnout Rates Among US Plastic Surgery Residents. *Ann Plast Surg.* 2020 Sep;85(3):215-220. doi: 10.1097/SAP.0000000000002353. PMID: 32349078.
- Highton L, Lamb A, Fitzgerald A, Wood S, Lees V, Winterton R. An analysis of the operative experience of plastic surgery trainees in the United Kingdom using eLogbook. *J Plast Reconstr Aesthet Surg.* 2017 Oct;70(10):1464-1471. doi: 10.1016/j.bjps.2017.05.020. Epub 2017 May 22. PMID: 28572042.
- Hultman CS, Edkins RE, Lee CN, Calvert CT, Cairns BA. Shine on: Review of Laser- and Light-Based Therapies for the Treatment of Burn Scars. *Dermatology research and practice.* 2012:243651.
- Independent Hospital Pricing Authority 2021, National Efficient Price Determination 2021-2022, Canberra
- Jeschke M, McCallum C, Baron Det al. Best practice recommendations for the prevention and management of burns. In: Foundations of Best Practice for Skin and Wound Management. A supplement of Wound Care Canada; 2018. Available from: [www.woundscanada.ca/ index](http://www.woundscanada.ca/index).



- Johnson LS, Jordan MH, Shupp JW. Contemplating a Career in Burn Surgery: Data From the 2016 Burn Physician Survey. *J Burn Care Res*. 2018 Oct 23;39(6):863-868. doi: 10.1093/jbcr/iry047. Erratum in: *J Burn Care Res*. 2019 Oct 16;40(6):1019-1020. PMID: 30202971.
- Kahn SA, Goldman M, Daul M, Lentz C. The burn surgeon: an endangered species. Can exposure in medical school increase interest in burn surgery? *J Burn Care Res*. Jan-Feb 2011;32(1):39-45. doi: 10.1097/BCR.0b013e318204b318.
- Kamali P, Paridon MW, Ibrahim AM, et al. Plastic surgery training worldwide: Part 1. The United States and Europe. *Plast Reconstr Surg Glob Open* 2016 Mar 17;4(3):e641. <http://dx.doi.org/10.1097/GOX.0000000000000627>
- Kastenmeier A, Faraklas I, Cochran A, Pham TN, Young SR, Gibran NS, et al. The evolution of resource utilization in regional burn centers. *J Burn Care Res* 2010;31:130–6.
- Khansa I, Janis JE. A Growing Epidemic: Plastic Surgeons and Burnout-A Literature Review. *Plast Reconstr Surg*. 2019 Aug;144(2):298e-305e. doi: 10.1097/PRS.0000000000005875. PMID: 31348370.
- Menaker R, Bahn RS. How perceived physician leadership behavior affects physician satisfaction. *Mayo Clin Proc*. 2008;83: 983–988.
- Morzycki A, Retrouvey H, Alhalabi B, et al. The Canadian Plastic Surgery Workforce Analysis: Forecasting Future Need. *Plastic Surgery*. 2018;26(4):269-279. doi:10.1177/2292550318800328
- Napolitano LM, Biester TW, Jurkovich GJ, Buyske J, Malangoni MA, Lewis FR Jr; Members of the Trauma, Burns and Critical Care Board of the American Board of Surgery. General surgery resident rotations in surgical critical care, trauma, and burns: what is optimal for residency training? *Am J Surg*. 2016 Oct;212(4):629-637. doi: 10.1016/j.amjsurg.2016.07.016. Epub 2016 Aug 13. PMID: 27634425.
- NSW Health, Agency for Clinical Improvement, <https://www.aci.health.nsw.gov.au/networks/eci/clinical/clinical-resources/clinical-tools/burns-guidelines>
- Prendergast C, Ketteler E, Evans G. Burnout in the Plastic Surgeon: Implications and Interventions. *Aesthet Surg J* 2017 Mar 1;37(3):363-368. doi: 10.1093/asj/sjw158.
- Ravat F, Percier L, Akkal R et al. Working time and workload of nurses: the experience of a burn center in a high income country. *Burns* 2014 Sep;40(6):113-40 DOI: 10.1016/j.burns.2014.01.002
- Qureshi HA, Rawlani R, Mioton LM, Dumanian GA, Kim JYS, Rawlani V. Burnout phenomenon in U.S. plastic surgeons: risk factors and impact on quality of life. *Plast Reconstr Surg*. 2015 Feb;135(2):619- 626. doi: 10.1097/PRS.0000000000000855. PMID: 25357156.
- Royal Australasian College of Surgeons (RACS), Training Regulations Board of Paediatric Surgery, May 2020
- Royal Australasian College of Surgeons (RACS), Surgical Competence and Performance, a guide to aid the development and assessment of surgeons, Melbourne 2020.
- Royal Australasian College of Surgeons (RACS), Surgery Oversight Committee, Plastic and Reconstructive Surgery Curriculum 2019, Australia and New Zealand, St Leonard's NSW 2019

Santos PJF, Evans GRD. Practical Strategies for Identifying and Managing Burnout in Plastic Surgeons. *Plast Reconstr Surg*. 2020 Oct;146(4):464e-473e. doi: 10.1097/PRS.00000000000007186. PMID: 32970014.

Shanafelt TD, Gorringer G, Menaker R, et al. Impact of organizational leadership on physician burnout and satisfaction. *Mayo Clin Proc*. 2015;90:432–440.

Sharp M, Burkart KM. Trainee wellness: why it matters, and how to promote it. *Ann Am Thorac Soc*. 2017;14:505–512.

Shih J, Quong W, Knox A, Zhygan N et al Burn Care and Surgical Exposure amongst Canadian Plastic Surgery Residents: Recommendations for Transitioning to a Competency-Based Medical Education Model. *J Burn Care Res* 2019; 40(6):796-804.

Stephenson S, Henley G, Harrison J & Langley J 2003. Diagnosis-based injury severity scaling. Cat. no. INJCAT 59. Canberra: AIHW.

Streu R, Hansen J, Abrahamse P, Alderman A. Professional burnout amongst US plastic surgeons: results of a national survey. *Ann Plast Surg* 2014 Mar;72(3):346-50. doi: 10.1097/SAP.0000000000000056.

Sutherland M, Kinslow K, Boneva D, McKenney M, Elkbuli A. Perceived Burnout Among Burn Surgeons: Results from a survey of American Burn Association members. *J Burn Care & Research* 2021; 42:2 p186-192. doi.org/10.1093/jbcr/iraa146

Tracy LM, Rosenblum S, & Gabbe BJ. (2020). Burns Registry of Australia and New Zealand (BRANZ) 2018/19 Annual Report. Department of Epidemiology and Preventive Medicine, Monash University. Melbourne Australia

USA AGCME Operative Minimums 2014.  
[http://www.acgme.org/Portals/0/PFAssets/ProgramResources/Operative\\_Minimums\\_effective\\_0701214.pdf](http://www.acgme.org/Portals/0/PFAssets/ProgramResources/Operative_Minimums_effective_0701214.pdf) (Accessed June 2021)

Vrouwe SQ, Jeschke MG, Fish JS. Are we headed for a shortage of burn care providers in Canada? *Burns*. 2018 Jun;44(4):1000-1004. doi: 10.1016/j.burns.2017.11.009. Epub 2018 Feb 1. PMID: 29395411.

Vrouwe SQ, Pham CH, Minasian RA, Yenikomshian HA, Garner WL, Gillenwater TJ. The State of Burn Care Training During Plastic Surgery Residency. *Ann Plast Surg*. 2020 Aug;85(2):122-126. doi: 10.1097/SAP.0000000000002267. PMID: 32039995.

**Comissioned by ASPS**

5 May 2022

By



**Australian Society of Plastic Surgeons**

Suite G01 Ground Floor  
69 Christie Street  
St Leonards NSW 2065

Phone: 02 9437 9200  
Email: [info@plasticsurgery.org.au](mailto:info@plasticsurgery.org.au)  
[www.plasticsurgery.org.au](http://www.plasticsurgery.org.au)