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Survey of national and local practice of compression therapy timing for burn patients in the United States

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ABSTRACT

Objective: Compression therapy (CT) has been an important, but debated, treatment for burn scars. To better understand one source of variation in observed outcomes after CT, an evaluation of CT timing of application is needed.

Materials and Methods: Following IRB approval, 126 burn centers were contacted to complete a 17-question survey regarding the center's practice pattern for compression garment therapy. Locally, study subjects were identified between March 1, 2014 and December 31, 2015 and medical records examined for timing of garment ordering, delivery and fitting.

Results: The majority believed that compression therapy is beneficial. Most centers reported using custom-fit and pre-fabricated garments, and a goal time of application between 2–4 weeks (42%) and 4–6 weeks (36%). After the garments are ordered, 61% of centers estimate that it takes 2–4 weeks for them to arrive. No significant differences in practices were found among centers treating pediatric patients only, adults only or both. Locally, the mean number of weeks between the date of original injury and garment order placement was 9.1 weeks with an additional 8.7 weeks between the date of order and date of delivery.

Conclusions: The current study identified that although the national reporting of time to garment application is estimated to be between 2–6 weeks at the majority of burn centers including our own, we found our center to be well in excess of 17 weeks. The findings offer an opportunity for local improvement, and raise the possibility of similar incongruity between goals and practice at other centers.

1. Introduction

Patients with severe burns can suffer tremendous physical and psycho-social disability from scars [1,2], with a significant economic impact [3]. Scar formation often leads to a myriad of consequences including restricted movement (from joint and scar contractures), chronic pain, chronic itching, inability to sweat, and psychological problems that result from social

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discrimination and stigmatization. Multiple modalities, surgical releases, light-based therapies, orthotics, topical silicone, and medical treatment of symptoms, have been employed to lessen the impact of scars [4–7]. However, the most widely utilized method, with the longest history of clinical use, is compression therapy [8–13].

Unfortunately, the evidence supporting the use of compression therapy is far from complete. Compression therapy has been reported to reduce height, increase pliability, and improve the clinical appearance of burn scars [14–18]. However, a meta-analysis of 6 randomized clinical trials found only a small decrease in scar height with no significant change in scar vascularity, pliability or color [14]. Another study conducted on more than 50 patients over 12 years concluded that pressure therapy results in observable improvement but only for moderate to severe scars [15]. However, this study did not specifically examine the timing of application of compression garments and its relationship to outcomes. This issue of timing of application may be critical, as the exact mechanism of action is uncertain [15,16]. In vitro studies looking at fibroblast contraction activity indicate that the cytokine expression patterns, which could influence the healing tissue, is different between animals that scar and those that do not [17]. These differences begin within the first four weeks of healing, which suggests there may be time-sensitivity to any therapy intended to modulate scar formation.

The generally accepted clinical practice is to apply compression early; however, the definition of "early" is not standardized. Different physicians may apply the compression at different points in the continuum of recovery — dictated by perceived frailty of the wound, grafts, and patient tolerance or estimated patient compliance. A range of application times was previously noted in pediatric patients, from immediately after the burn wound had healed to 7–14 days after the wound had healed. The same study noted others waited until hypertrophic scars had appeared [18]. In addition to differences in goals of timing, custom-made garments take time to order, fabricate, and fit. This production time could contribute to delays between the intended application and the actual application.

In addition to timing, there are other variables that might contribute to the observed variability in clinical outcomes. The magnitude of garment pressure is not routinely measured in the clinical setting. This is despite evidence that it can easily vary with time and garment material [19]. Garments fabricated using Laplace's Law method utilize the fabric's tension profile when constructing custom garments leading to more accurate delivery of the desired pressure magnitude [20,21]. Unfortunately, the exact magnitudes of pressure required for effective scar treatment have never been scientifically established. Some studies suggest that lower pressures (15–24 mm Hg) can be effective [22–25] while others propose that applied pressure must exceed capillary pressure (~25 mm Hg) [26,27] Others suggest that high pressures (>30–40 mm Hg) can be harmful and extremely uncomfortable for the patient [28–33]. It is currently unclear if there is a standardized expectation or general consensus of the goal pressure to be applied (especially outside of formally fabricated garments) [7,34–36].

To date, no study has examined the practice patterns in the United States. With this in mind, the aims of this study were to describe the use and timing of the application of compression therapy for burn patients at our verified burn center and conduct a survey of goals of practice in burn centers throughout the United States. We hypothesized that our local practice would have greater than 14–28 days between times of wound closure and application of compression. We further hypothesized that there is a great degree of variability in goals of compression therapy between burn units. Documenting a variance in clinical practice would serve the burn community, as it would highlight practice differences and allow for examination of the variability in order to standardize care. Furthermore, any variances in practice may help to explain the wide range of outcomes reported in the literature.

2. Materials and methods

Burn centers within the United States were identified through the American Burn Association burn care resource directory (www.ameriburn.org/verification_verifiedcenters). Centers were sent two emails, two weeks apart, to invite them to respond to an online survey (SurveyMonkey®) regarding their local burn garment practices. If centers did not respond to the initial and follow-up email, a phone call was made asking for participation following a predetermined script. Consent was obtained when they agreed to participate in the survey (either as part of the online or phone survey). For each center that responded, the survey was presumed to have been answered by a knowledgeable expert from the center as the initial contact was part of each unit's leadership team (e.g. director, nursing manager). The survey contained 17 questions, developed by the authors, which included open-ended and multiple-choice responses (Appendix A). Response rates were analyzed with all data pooled (All centers) or by the type of patient treated: pediatric only, adult only, and pediatric and adult.

Institutional Review Board approval was obtained for both portions of this study. For the local practice review, all patients in our outpatient burn registry treated between March 1, 2014 and December 31, 2015 who had garments mentioned as part of their care plan were eligible for this retrospective study. Data recorded included a description of patient demographics and burn injury, any surgical procedures, the date garments were ordered, the date patient measurements were collected, the date garments were delivered to our outpatient clinic, and when they were fitted (donned by patient).

3. Results

3.1. *National practices*

The survey response rate was 47% (59 of 126) of centers contacted. Of the 59 responding centers, 32 were American Burn Association verified. Of the respondents, 21% identified as adult only, 10% identified as pediatric only, and 69% self-identified as caring for all age groups. Measurement of garments for burn scar management was most often performed by an occupational therapist or a physical therapist (85%).

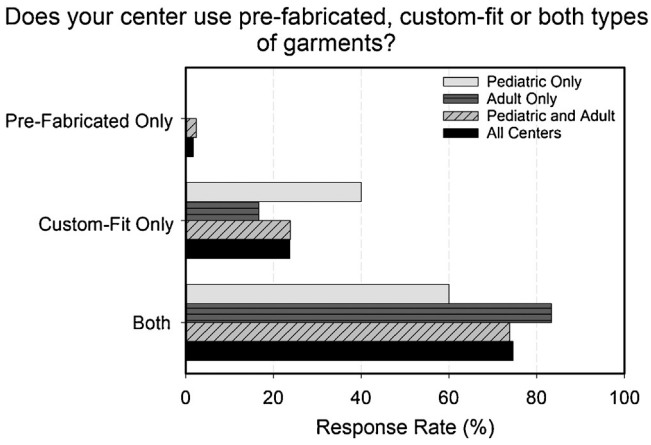

Fig. 1 – Garment type used as a function of patient population.

All of the respondents stated that their center prescribes pressure garments for patients who have suffered acute burn injury, and the majority of centers use both pre-fabricated and custom-fit garments (Fig. 1). Pediatric centers were more likely to use custom-fit garments only (40%) with one center utilizing pre-fabricated garments only (1.7%). The majority of respondents believed that pressure therapy is beneficial in prevention of hypertrophic scarring, decreasing edema, and/or treatment of established hypertrophic scars. Notably, 11% answered stating that they believed the garment use was probably of uncertain benefit but used because no other options exist.

The majority of respondents indicated that patients were measured for custom garments after all wounds have healed (100% in pediatric only serving centers) while ~20% of adult only and adult/pediatric centers measuring at the first post-operative visit (Fig. 2A). More than 50% of centers report a goal of initiating compression therapy by 2–6 weeks after grafting (Fig. 2B) with the goal timing of custom-fit garment application following the same 2–6 week after surgery/healing trend (Fig. 2C). Greater than 60% of adult/pediatric serving centers reported that 2–4 weeks are required to receive garments after they have been ordered while the majority of pediatric only hospitals reported between 2–6 weeks and adult only hospitals reported between 1–4 weeks (Fig. 2D).

For all centers that utilize custom-fit garments, most centers reported the pressure exerted by the compression garments to be between 15–25 mm Hg (37%) or >25 mm Hg (40%) and the pressure exerted or reduction in circumference were not measured or known (Fig. 3A). Centers also reported compression therapy duration to be between 6–12 months (52.5%) or greater than 12 months (45.8) with 60% of participating pediatric only centers prescribing compression therapy for greater than 12 months (Fig. 3B). For all centers,

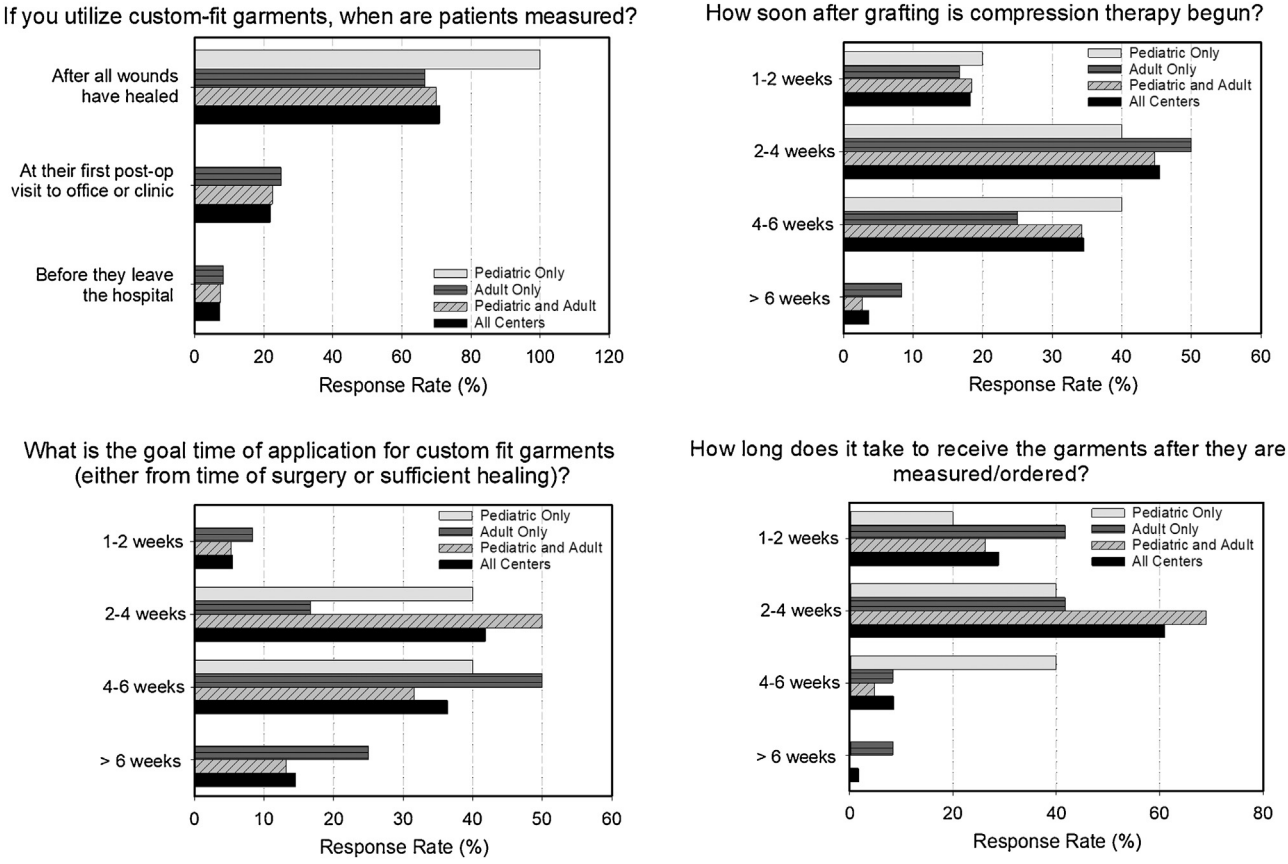

Fig. 2 – Response rates for timing of garment measurement, time of compression therapy initiation after injury, goal timing of custom garment application, and average garment delivery time after measurement/ordering.

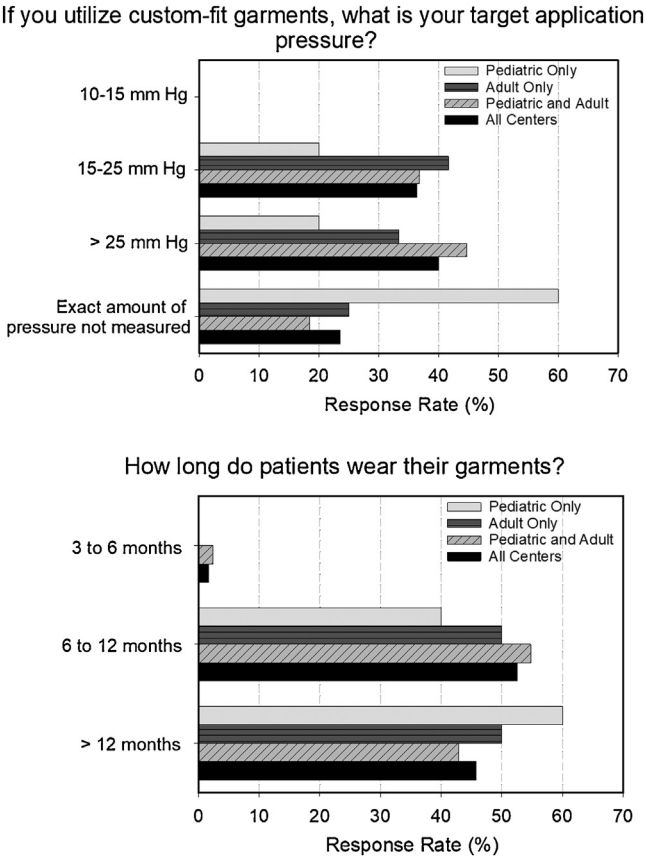

Fig. 3 – Response rates for magnitude of pressure delivered and duration of compression therapy as a function of patient population.

patient satisfaction was the most common method for assessing outcomes following compression therapy (43%). To a lesser extent, Patient and Observer Scar Scale (POSAS), the Visual Analog Scale (VAS) and an assessment of function were utilized to evaluate efficacy (Fig. 4). Challenges associated with obtaining compression garments for burn patients included non-compliance (62%), cost (55%), and lack of insurance coverage (67%).

3.2. *Local practice*

Our center completed the survey prior to reviewing the data reflecting our actual practice. Our responses were the same as the majority of adult burn centers responding to the survey. The study population of our local review of practice included 112 patients identified as having full-thickness burns, hypertrophic burn scars, or new skin grafts that were considered for compression therapy. Four patients did not have a garment order placed. Of the 108 patients who had garment orders placed, 15 patients did not get measured for custom garments. Of the 93 patients successfully measured, only 75 patients had garments delivered to our burn center and an additional 4 patients refused to pay the required co-pay amount, leaving 71 patients for analysis.

The mean number of weeks between the date of original burn injury and garment order placement was 9.1+8.1 weeks. There was a mean of 8.7+4.1 weeks between the date of order and date of delivery. All patients who received garments were then segregated by their payer source to examine for potential impact on the time to garment delivery to the patient. There were no significant differences in burn size or total number of weeks between injury and garment delivery (Table 1). A charity-supported burn fund was used to provide garments for patients without other financial means. The patients requiring burn fund support were on average older with greater TBSA than the group with reimbursement provided by a third party payer; however, method of payment did not influence time of order or time to delivery of garments (Table 1).

4. Discussion

Compression therapy has long been used for hypertrophic scars, with the first mention of the modality in the medical literature as early as 1678 [13]. It has remained a persistent tool of uncertain efficacy and remains in common use. The challenge of supporting the practice with rigorous evidence has been addressed by multiple authors noting that there is a lack of clarity in treatment variables [37–39].

Given the evidence that the timing of the application of compression therapy was important in prospective, controlled trials in both humans and animals, it would seem prudent to

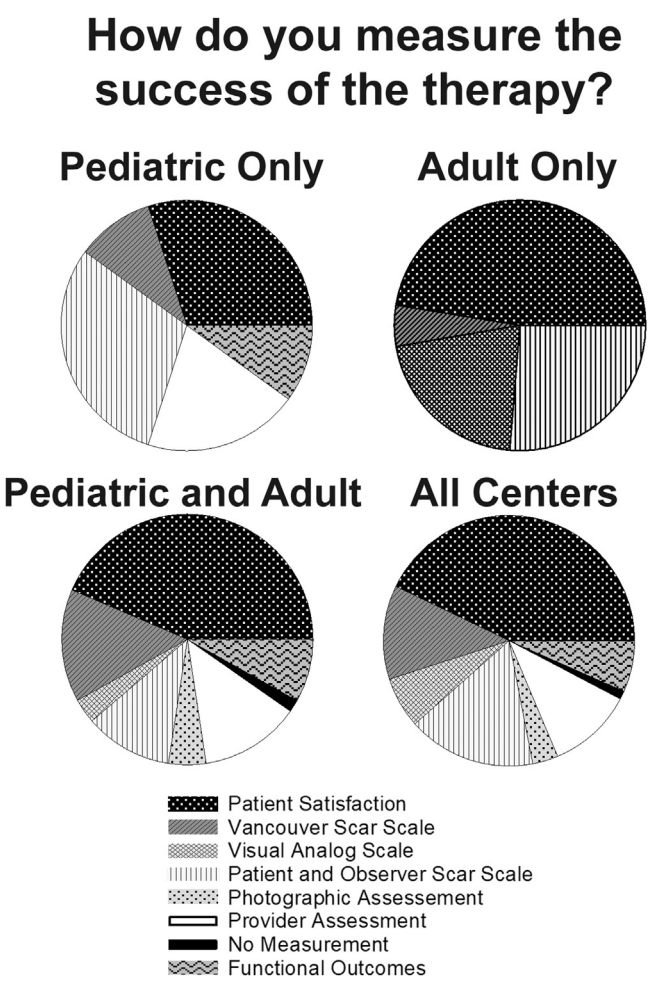

Fig. 4 – Methodologies utilized to assess success of compression therapy in hospitals serving pediatric patients only, adult patients only or both patient populations. Among all hospital types, patient satisfaction was the most utilized method for assessing success.

Table 1 – Comparisons in patient demographics and injury between burn fund paying and covered by insurance.

Variable	Mean+stdev		p-value
	Insurance	Burn fund	
Age	37.4+13.6	45.0+19.9	0.152
% TBSA	9.0+12.0	12.3+13.5	0.189
% Partial thickness wound	5.4+9.4	6.7+8.5	0.293
% Full	3.5+5.8	5.3+6.7	0.100
Weeks between date of injury and date garment ordered	10.5+9.7	7.6+5.4	0.089
Weeks between garment ordering and delivery	8.4+4.0	8.7+4.2	0.771
Total number of weeks between injury and garment application	18.5+11.1	16.3+6.3	0.815

assess current practice with regards to the timing of pressure application. The process of fabricating the garments requires multiple steps from ordering the garment, successful measurement to complete the order, securing payment, fabrication, delivery, and final fitting. Each of these steps takes a variable length of time, and our unit was noticing increasing delays that seemed coincident with delays we attributed to denials of payment from insurers. This inspired our efforts to examine our local process while beginning to explore the attitudes and goals at burn centers nationally.

The majority of respondents indicated that they would ideally see application of compression therapy somewhere between 2 and 6 weeks after healing. Our local practice goal would be application of therapeutic compression within 2–4 weeks of re-epithelization of the wound. This goal time allows for wound closure (so that extensive dressings will not distort

measurements for purchased garments) and diminishment of edema (again to allow for more accurate fitting). Clearly, the reality of application of therapeutic pressure timing is quite disparate from our unit's expressed goal. Given the results of the reported audit, it may be that the processes at other units might result in a similar degree of delay with a discrepancy between stated goal and practice. Secondly, even the variability in the goal time of application reflects heterogeneity of treatment that might partly explain the heterogeneity of reported efficacy from previous studies. This potential for additional variation in treatment standards is also reflected by the more technical questions regarding the goal for "application pressure" and "percent reduction". And finally, there appears to be somewhat of a consensus with regards to concerns of reimbursement as a barrier to providing garments. There is a clear need for continued investigation of this tool for burn scar management. Within the community there is concern that reimbursement is uncertain. The uncertainty of reimbursement may be the result of uncertainty in consistent therapeutic efficacy. Interestingly, this uncertainty of efficacy might be the result of heterogeneous application (in terms of timing of application and intensity of pressure).

It took our institution an average of 120 days from the date of injury until garments were available to be donned by the patient. It might seem reasonable that a portion of this delay is caused by giving patients 2 weeks to demarcate their wound, a week to get to excision and grafting, and then another week until follow-up and ordering the garment. This would account for about 30 days of time passing before the order for garments was placed, but this accounts for only about half of the mean time to order placement at our institution. There is clearly prolonged time period between ordering the garment and its delivery (over 7 weeks). As in many institutions, diagnosis of the need for garments, determining appropriate timing, placing orders, measuring, ensuring payment, fitting, and then re-ordering garments is a complex process. Efforts to improve the local timeline are ongoing. Two potential areas for improvement under exploration are potential administrative delays within the burn center and the potential for acceleration of our current vendor's workflow (particularly in addressing payment concerns). The authors have taken these findings a challenge for process improvement and look forward to a future manuscript detailing the solution.

With regards to the pattern of payers for compression garments, we found that patients who required burn center funding to purchase garment were on average older than insurance paid patients. Of note, there is no difference in the number of days between ordering and delivery of the garment as regards to insurance status and may reflect a general appreciation for which insurers will and will not pay for garments so that the additional time caused by denials is minimized. It may be that this portion of delay is inherent to the fabrication process and/or the vendor's ability to secure precertification from insurers.

There are several limitations to the current study. We did not attempt to collect data regarding washing schedules or replacement timing of fatigued or worn garments. These are additional important variables of pressure delivery [19]. The focus of this study was specifically initial variables – as the authors were impressed by the disparity between the results of our local Process Improvement findings contrasted with our own expectations. The time from injury until custom compression garments were delivered is noteworthy. Ideally, the authors would have liked to include data regarding the time until the wounds were sufficiently healed to allow for garment application. The use of the date an order was place for a garment is a surrogate marker that could introduce error — e.g. burn wounds could have been healed for a long period before compression was ever considered. In that case, the error would be in the provider's timing of prescribing therapy.

There is an opportunity for internal process improvement; however, there may also be a room for improvement outside of the burn unit. In addition, the survey provides continued evidence of variability in goals for compression therapy, and this variability may have clinical relevance. It would seem that in an environment of increasing fiscal pressure and evidence-based practice, the burn community needs to provide the evidence for use of scar treatment modalities such as compression therapy.

5. Conclusions

The current study identified that although the national reporting of time to garment application is estimated to be between 2–6 weeks at the majority of burn centers including our own, we found our center to be well in excess of 17 weeks, offering an opportunity for process improvement. It also raises the possibility of an incongruity between goals and practice at other centers.

Conflicts of interest

None.

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Appendix A. Survey questions

1. What is your job role?
2. What is the name of your burn unit?
3. Type
   Adults only
   Pediatric only
   Both adults and pediatric
4. Does your center prescribe pressure garments for patients who have suffered acute burn injury?
   Yes
   No
5. Does your center use pre-fabricated, custom-fit, or both types of garments?
   Pre-fabricated
   Custom-fit

Both
Neither

6. In selecting areas for pressure treatment, what are the indications for treatment used by your center? (select all that apply)
Prevent hypertrophic scar
Decrease edema
Treat hypertrophic scar
Probably of uncertain benefit, but we have few other options

7. If you utilize custom-fit garments, when are patients measured?
Before they leave the hospital
At their first post-op visit to office or clinic
After all wounds have healed (2-4 weeks after surgery)

8. If you utilize custom-fit garments, what is your target application pressure?
10–15 mmHg
15–25 mmHg
>25 mmHg
Exact amount of pressure is not measured

9. Based on garment measurements, what is the percent reduction the garments are manufactured to?
7–10%
10–15%
>15%
Exact reduction not known/measured for our garments

10. How soon after grafting is compression therapy begun?
1–2 weeks
2–4 weeks
4–6 weeks
>6 weeks

11. What is the goal time for application of custom garments (either from time of surgery or sufficient amount of healing)?
1–2 weeks
2–4 weeks
4–6 weeks
>6 weeks

12. What are your barriers to getting burn garments for patients that might benefit?
Non-compliance
Cost
No insurance coverage
Other (please specify)

13. How long does it take to receive the garments after they are measured/ordered?
1–2 weeks
2–4 weeks
4–6 weeks
>6 weeks

14. Who on your team measures?
Provider (MD, PA, NP)
Nursing
PT
OT
Other

15. How do you justify the need for garments?
Total body surface area burn
Skin grafts
Anatomic location
Hypertrophic scar/scar therapy
Other (please specify)

16. How do you measure the success of the therapy?
Vancouver scar scale
Patient satisfaction
Patient and observer scar assessment scale (POSAS)
Visual analogue scale (VAS)
Other (please specify)

17. How long do patients wear their garments?
3–6 months
6–12 months
>12 months

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