

Practice Guidelines for Early Ambulation of Burn Survivors after Lower Extremity Grafts

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The objective of this review was to systematically evaluate the available clinical evidence for early ambulation of burn survivors after lower extremity skin grafting procedures so that practice guidelines could be proposed. It provides evidence-based recommendations, specifically for the rehabilitation interventions required for early ambulation of burn survivors. These guidelines are designed to assist all healthcare providers who are responsible for initiating and supporting the ambulation and rehabilitation of burn survivors after lower extremity grafting. Summary recommendations were made after the literature, retrieved by systematic review, was critically appraised and the level of evidence determined according to Oxford Centre for Evidence-Based Medicine criteria. A formal consensus exercise was performed to address some of the identified gaps in the literature which were believed to be critical building blocks of clinical practice. (J Burn Care Res 2012;33:319–329)

RECOMMENDATIONS

Standards

The data are insufficient to support standardized treatment of all burn survivors with lower extremity grafts. The following guidelines, however, should be applied to burn survivors with isolated lower extremity burns who have undergone skin grafting or when medical needs associated with larger burns do not contraindicate the guidelines below.

Guidelines

- An early postoperative ambulation protocol should be initiated immediately, or as soon as possible, after lower extremity grafting unless any exclusion criteria are encountered.

- External compression must be applied before ambulation.
- If the graft crosses a joint, the joint should be immobilized continuously until the first dressing change.

Options

- Gradual ambulation and weight bearing can be introduced if full weight bearing is not immediately tolerated.

OVERVIEW

Purpose

The purpose of these guidelines was to review the evidence supporting early ambulation after lower extremity grafts and to determine when burn survivors should begin ambulating after lower extremity skin grafting.¹ In areas within the existing literature, where rehabilitation-specific information and evidence were lacking, an international consensus exercise was performed to provide further guidance to clinicians.

Users

These guidelines are designed to aid burn care team members (nurses, occupational therapists, physical therapists, physicians, etc.) who are responsible for initiating and supporting the ambulation and

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rehabilitation of burn survivors. In addition, the recommended guidelines can be implemented by medical professionals who do not routinely treat burn patients at their facilities such as ambulatory care centers.

Clinical Problem

Immobilization and elevation of lower extremity grafts after debridement and grafting of deep partial-thickness or full-thickness burn injuries continue to be a common practice. In addition to the fact that evidence-based, broadly accepted practice guidelines do not exist,² the reasons for the continued immobilization of these grafts seems to be fear of graft failure or loss due to hematoma formation, shearing or lack of graft adherence, and tissue necrosis.³⁻⁹ However, immobilization can lead to associated morbidity, such as decreased range of motion, reduced endurance, lack of independence in activities of daily living, deep vein thrombosis, pulmonary embolism, prolonged hospital stay, increased costs associated with length of stay, and in-hospital complications as well as inferior quality of life.^{4,6-22} The objective of this review is to systematically evaluate the available evidence for early ambulation of burn survivors after lower extremity skin grafting procedures so that practice guidelines can be proposed that specifically outline required rehabilitation interventions.

PROCESS

The steps taken to develop the practice guidelines reported here are those outlined by Bowker et al.²³ These steps included the creation of a guideline development group, forging links with stakeholder groups, agreeing on the scope of the guidelines, formulating clinically relevant questions, searching the literature for evidence, appraising the evidence found, conducting a formal consensus study where evidence is lacking, and making practice recommendations. The guideline development group consisted of an international assembly of occupational and physical therapists from Australia, Canada, Ireland, and the United States with existing links to national and international stakeholder organizations. Communication in the group was conducted via a virtual classroom. The scope of the guidelines is limited to the PICO (population, intervention, condition, outcome) question: "When is it safe to ambulate burn survivors who have had lower extremity skin grafting performed?"

Search Strategy

A broad computerized search was conducted, with assistance from an academic librarian, in the following databases: MEDLINE, the Cumulative Index of Nursing and Allied Health Literature (CINAHL), and EMBASE from the earliest available date until August 2009. The specific search strategy for the MEDLINE database is described in Appendix A,

Table 1. Evidentiary table: evaluation of the quality of intervention studies in early ambulation of lower extremity grafts

Citation	Study Purpose	Literature Review	Sample		Outcomes	
			Details	Justified	Reliable	Valid
Bodenham and Watson (1971)	1	0	0	0	0	0
Budny et al (1993)	1	1	1	0	0	1
Burnsworth et al (1992)	0	1	1	1	0	0
Chilvers and Freeman (1969)	0	1	0	0	0	0
Cox and Griswold (1993)	1	1	1	0	0	0
Dean and Press (1990)	0	0	0	0	0	0
Gaze et al (1979)	0	0	0	0	0	0
Golden et al (1977)	0	1	0	0	0	0
Grube et al (1992)	1	1	1	0	1	1
Harnar et al (1982)	1	0	0	0	0	0
Shankar and Khoo (1987)	0	0	0	0	0	0
Sharpe et al (1983)	0	0	0	0	0	0
Tallon et al (2009)	1	0	0	0	0	1
Wallenberg (1999)	1	1	1	0	0	0
Wells et al (1995)	1	0	1	0	0	0
Wood and Lees (1994)	1	1	1	1	0	1

Level 1b or 1c was assigned to RCTs based on the critique rating received. Rather than limiting the review to studies of only burn survivors, all patient populations were included. Seven of the citations' study samples contained burn survivors with five of them exclusively involving burn survivors. None of the studies that investigated burn survivors was a RCT.

All studies in this review entailed some sort of elastic compression before ambulating the patients. The majority (56%) applied split-thickness meshed grafts or both split-thickness meshed grafts and split-thickness sheet grafts (25%). Three studies (19%) did not specify whether sheet or meshed grafts were used, but as they did not indicate whether the grafts were meshed, it must be assumed that the method in all of them was sheet grafting because of the year in which they were published.

Scientific Foundation

One of the first studies available in the literature questioning the value of bed rest after lower extremity skin grafting was by Bodenham and Watson in 1971.³ The 25 study participants in that prospective case series ambulated within 24 to 48 hours of a grafting procedure performed after the excision of malignant melanomas. The authors' conclusion after evaluation of their wound healing times and length of stay was that early ambulation did not jeopardize skin graft take.

A study by Budny et al²⁶ focused specifically on elderly patients (average age 74.2 years). This prospective RCT comprised 56 participants. The authors' evaluation of graft take, length of stay, complications, and ease of activity demonstrated that there was no significant difference between those who were discharged the same day or the day after surgery and between those who ambulated immediately in comparison to participants who were confined to strict bed rest for 7 days.

A retrospective review by Burnsworth et al¹¹ examined 58 burn survivors who only had lower extremity burns and were encouraged to ambulate as soon as they recovered from the anesthetic. The average TBSA burned was 15.2% (range, 1–28%), and the TBSA grafted was 4.1% (range, 1–13%). Average skin graft take was judged to be 96% (range, 50–100%). The authors compared their retrospective data to survey data that they collected by questionnaires mailed out to North American burn centers. This comparison showed that the early ambulation group was able to ambulate more than 30 feet sooner (1.7 vs 7.2 days; $P < .001$), were discharged from hospital sooner postoperatively (6.9 vs 9.4 days; $P < .01$), and required a reduced overall length of stay (10.2 vs 12.6 days; $P < .012$). Although these findings were interesting, data comparison with their survey results was

problematic as details of the survey were not included, patient characteristics were not provided, and it was not clear whether comparison was made only with those centers that delayed ambulation or all centers.

The study by Chilvers and Freeman²⁷ was the first to be cited in the literature advocating early ambulation after skin grafting. Although minimal details were provided, they reported that they followed 25 patients with skin grafts for the treatment of venous ulcers who were encouraged to ambulate immediately after surgery. Average healing time was 19 days (range, 11–33 days) with two immediate graft failures and two late graft failures.

In 1993, Cox and Griswold¹² studied a prospective case series of 39 burn survivors who had Unna's boot applied after split-thickness skin grafting procedures. Average patient age was 30 years, and average wound size was 284 cm². Of their 39 patients, 25 had lower extremity burns and 6 had upper extremity burns with all but 3 procedures being performed on an outpatient basis. The patients with lower extremity burns were allowed to ambulate immediately. If the grafts crossed a joint, an orthosis was applied and the patients were restricted to partial weight bearing. Twenty-six patients had 100% graft take and five had minor graft loss, but as the authors did not present the results for lower and upper extremity grafts separately, it was impossible to determine whether graft loss was equally distributed between lower and upper extremity grafts.

Dean and Press¹³ investigated a retrospective case series of 9 burn survivors with injuries distal to the knee. Their patients ranged in age from 3 to 68 years with wounds measuring from 100 to 300 cm² and length of hospital stay averaging 0.9 days (range, 0–3 days). Unna's boot was applied and patients were encouraged to ambulate after it set. The authors reported an average graft take of 97%, but assessment spanned a 6-month time period.

In 1979, Gaze¹⁴ studied a series of 30 patients with shin injuries, 14 of whom were prescribed bed rest and 16 of whom were allowed to walk to the washroom on the first postoperative day. Although there was very little substance to this report, the author did state that there was no difference in healing between the two groups.

Golden et al¹⁵ were the first to investigate the early ambulation of burn survivors. Of the 10 patients whom they treated, 3 had sustained lower extremity burns. Their patients were encouraged to ambulate immediately after surgery, progressing to full weight bearing ambulation with a walking aid within 24 hours. Nine patients had 100% graft take, and one had 30 to 40% graft take. This patient was one of the burn survivors.

Table 2. Characteristics of included studies

Authors	Design	Sample	Outcome Measures	Intervention	Results	Level of Evidence
Bodenham and Watson (1971)	Prospective case series	<ul style="list-style-type: none"> n = 25 20 malignant melanomas 5 other Wound size range = 2 cm diameter to 25 × 12 cm 	<ul style="list-style-type: none"> LOS 	Dressing—foam pad and firm crepe bandage Graft—STG Rehabilitation—graduated, supervised ambulation 48 hr after surgery	<ul style="list-style-type: none"> 12 patients d/c by 2/52 9 patients d/c by 3/52 4 patients d/c ≥4/52 Three “failures” attributed to inadequate joint immobilization when graft crossed the joint 	Level 4
Budny et al (1993)	RCT	<ul style="list-style-type: none"> n = 56 patients with 61 wounds Pretibial laceration and flap wounds Wound size = <100 cm² Early mobilization (n = 21) Bed rest after surgical treatment (n = 40) 	<ul style="list-style-type: none"> Graft take LOS Complication Ease of activity 	Dressing—chlorhexidine-impregnated paraffin gauze, saline gauze, crepe bandage Graft—STG Rehabilitation—early ambulation group allowed to mobilize immediately, for bed rest group B/K plaster back slab applied with ankle in neutral, double Tubigrip when mobilized	<ul style="list-style-type: none"> No significant difference in graft take at 1 and 3/52 (% graft take: bed rest—1/52 = 93.7 ± 11%, 3/52 = 92.8 ± 18.1%; early mobilization 1/52 = 88.7 ± 26.4%, 3/52 = 89.7 ± 21.0%) Average LOS bed rest = 12.1 d, early mobilization = 2.3 d Complication—no significant difference “Diminished ease of activity”: bed rest = 10/31 (32%), early mobilization 1/16 (0%) 	Level 1c
Burnsworth et al (1992)	Retrospective case series	<ul style="list-style-type: none"> n = 58 Burns Average TBSA grafted 4.1% 	<ul style="list-style-type: none"> Ambulation day (>30 feet) Postop day of d/c LOS Compared with survey results of other burn centers 	Dressings—aquaphor, impregnated N-Terface, fine mesh gauze, multiple Kerlix rolls, elastic bandages Graft—STMG Rehabilitation—began walking immediately, orthosis if graft crossed a joint	<ul style="list-style-type: none"> Ambulation day (>30 feet): early ambulation = 1.7 d; survey results = 7.2 d (P < .001) Postop day of d/c: early ambulation = 6.9 d; survey results = 9.4 d (P < .01) LOS: early ambulation = 10.2 d; survey results = 12.6 d (P < .012) 	Level 4
Chilvers and Freeman (1969)	Prospective case series	<ul style="list-style-type: none"> n = 25 Venous ulcers Average wound size = 12 cm² Wound size range = 20 mm² to 48 cm² 	<ul style="list-style-type: none"> Time to wound healing 	Dressing—gauze and elastic wrap (Bisgaard compression bandages) Graft—STG (“pinch grafts”) Rehabilitation—encouraged to walk normally	<ul style="list-style-type: none"> Healing time: average 19 d, range 11–33 d Two immediate failures Two late failures 	Level 4
Cox and Griswold (1993)	Prospective case series	<ul style="list-style-type: none"> n = 31 (n = 25 L/E injuries; n = 6 U/E injuries) Burns average TBSA 3.5% Average wound size = 284 cm² 	<ul style="list-style-type: none"> % graft take 	Dressing—nonstick fine mesh gauze, Unna’s boot and elastic wrap Graft—STMG or STSG Rehabilitation—orthosis if graft crossed a joint and PWB, elevate extremity when nonambulatory, full AROM and FWB when graft not crossing joint	<ul style="list-style-type: none"> Graft take: 26 = 100%, 5 = minor graft loss (<5%) 	Level 4
Dean and Press (1990)	Retrospective case series	<ul style="list-style-type: none"> n = 9 Burns Wound size range = 100–300 cm² 	<ul style="list-style-type: none"> % graft take LOS 	Dressing—N-terface, Unna’s boot, dry gauze, elastic wrap Graft—STMG Rehabilitation—ambulation initiated after 24 hr elevation	<ul style="list-style-type: none"> Graft take = 97% Average LOS = 0.9 d 	Level 4
Gaze (1979)	Case series	<ul style="list-style-type: none"> n = 30 Wound size range = 3 × 4 cm to 10 × 16 cm Age range = 55–89 yr Bed rest (n = 14) Early ambulation (n = 16) 	<ul style="list-style-type: none"> Graft take 	Dressing—petrolatum gauze, 1-inch thick sponge, cotton bandage, elastic wrap Graft—STSG Rehabilitation—ambulate same day as surgery	<ul style="list-style-type: none"> No difference between groups 	Level 4

(Continued)

Table 2. (Continued)

Authors	Design	Sample	Outcome Measures	Intervention	Results	Level of Evidence
Golden et al (1977)	Case series	<ul style="list-style-type: none"> n = 10 n = 3 burns, n = 2 diabetic, or n = 5 stasis ulcers Wound size range = 3–20 cm diameter Age >50 yr 	<ul style="list-style-type: none"> Graft take 	Dressing—petroleum gauze, 0.25-inch thick foam rubber, gelatin-impregnated gauze, elastic wrap Graft—STMG Rehabilitation—immediate ambulation with crutches or walker, FWB after 48 hr	<ul style="list-style-type: none"> Graft take: 9 = 100%; 1 = 30–40% 	Level 4
Grube et al (1992)	Retrospective case series	<ul style="list-style-type: none"> n = 100 Burns average TBSA 3.7% Average age = 28.8 yr Age range = 1–72 yr 	<ul style="list-style-type: none"> Graft take Excellent $\geq 95\%$ graft take; satisfactory between 85 and 94%; poor requiring regrafting Complications listed 	Dressing—petrolatum gauze, Unna's boot, elastic wrap Graft—STSG or STMG Rehabilitation—ambulation 4 hr postop, FWB	<ul style="list-style-type: none"> Graft take: STMG = 97%, STSG = 96% Excellent results = 84%; satisfactory results = 10%; poor results = 4% 	Level 4
Harnar et al (1982)	Case series	<ul style="list-style-type: none"> n = 20 n = 14 burns, n = 4 ulcers, n = 1 trauma, n = 1 cancer Average wound size = 46.5 cm² Wound size range = 8 to 155 cm² Age range = 11–21 yr 	<ul style="list-style-type: none"> Graft take LOS Complications listed 	Dressing—petrolatum-impregnated fine-mesh gauze, Unna's boot, elastic wrap Graft—STMG Rehabilitation—crutch walking first day postop, then progressed to FWB, elevated extremity when resting	<ul style="list-style-type: none"> Graft take; 90–100% in 16/20 patients; >80% in 18/20; 1 required regrafting LOS = 3.75 d for clean uncomplicated wounds 	Level 4
Shankar and Khoo (1987)	Case series	<ul style="list-style-type: none"> n = 25 Pretibial wounds Average age = 75 yr Age range = 48–92 yr 	<ul style="list-style-type: none"> Graft take 	Dressing—tulle gas, firm pressure dressing, two layers of tubigrip Graft—STMG Rehabilitation—FWB immediately, elevation when resting	<ul style="list-style-type: none"> Graft take: 23/25 = 100% at 3/52; all healed at 1/12 	Level 4
Sharpe et al (1983)	Case series	<ul style="list-style-type: none"> n = 60 Pretibial wounds 	<ul style="list-style-type: none"> Graft take LOS 	Dressing—double layer of paraffin tulle, flavine wool or plastic foam sponge, crepe bandage, elastic wrap Graft—STMG or STSG Rehabilitation—FWB immediately	<ul style="list-style-type: none"> STMG take: 100% at 1/52; 10% showed some loss at 2/52; complete healing at 3/52 STSG take: 27% with seroma or hematoma at 1/52; complete healing at 3/52 	Level 4
Tallon et al (2009)	RCT	<ul style="list-style-type: none"> n = 44 Skin cancer Early ambulation: 2 d (n = 18) Late ambulation: 7 d (n = 24) Average age = 78.3 (early); 78.0 (late) Average wound size = 915 mm² (early); 716 mm² (late) Wound range = 210–2023 mm² (early); 180–2250 mm² (late) 	<ul style="list-style-type: none"> Graft take Infection Bleeding 	Dressing—nonadherent Melonlin, three layers of gauze, adherent Fixomull, Tubifast, crepe, Coban Graft—STG Rehabilitation—mobilization to the toilet only for 2 or 7 d, then FWB	<ul style="list-style-type: none"> Graft loss: n = 1 (early); n = 2 (late) Infections: n = 8 (early); n = 7 (late) No significant difference between early and late ambulation groups 	Level 1c

(Continued)

Table 2. (Continued)

Authors	Design	Sample	Outcome Measures	Intervention	Results	Level of Evidence
Wallenberg (1999)	RCT	<ul style="list-style-type: none"> n = 50 Early ambulation: day 1 (n = 25) Late ambulation: day 4 (n = 25) Cancer, trauma, ulcers Age range = 20–85 yr 	<ul style="list-style-type: none"> Graft take (rated 1 = primary healing of the whole graft; 2 = healed but with some minor defects; 3 = partial take ≈50%; 4 = essentially no take) 	Dressing—several layers of paraffin gauze, thick moist compresses, several layers of spongy roller (Acryl), elastic wrap Graft—STMG Rehabilitation—graduated ambulation beginning with 2 min 3×/day at day 1 to unrestricted ambulation on day 4	<ul style="list-style-type: none"> Graft take: early = 80% rated 1 or 2; late = 88% rated 1 or 2 Unsuccessful graft take = 3 patients in each group No significant difference between groups 	Level 1c
Wells et al (1995)	Case-controlled study	<ul style="list-style-type: none"> n = 26 Burn injuries Early mobilization (n = 13) Historical controls (n = 13) Average wound size = 131 cm² Wound range = 25–300 cm² Average age = 32 yr 	<ul style="list-style-type: none"> Graft take LOS Cost 	Dressing—paraffin gauze, sterile gauze, Unna's boot, elastic wrap Graft—STMG Rehabilitation—FWB immediately postop	<ul style="list-style-type: none"> Graft take: >95% in both early mobilization group and historical controls LOS: early mobilization = 1.4 d, historical controls = 12.9 d (P < .001) Treatment costs: early mobilization group = \$1260/patient, historical controls = \$11,610/patient 	Level 3b
Wood and Lees (1994)	RCT	<ul style="list-style-type: none"> n = 75 Pretibial wounds Early ambulation: day 1 (n = 36) Late ambulation: day 10 (n = 39) Average age = 75 yr Average wound size = 48.3 cm² (early); 51.7 cm² (late) 	<ul style="list-style-type: none"> Time to complete healing % graft take on days 7, 10, 14 LOS 	Dressing—2 layers of jelonet, 2.5 cm foam, gauze dressing, cotton bandage, Tubigrip Graft—STMG Rehabilitation—ambulate 1 d after surgery or 10 d after, elevate when resting, avoid long periods of still-standing	<ul style="list-style-type: none"> Healing time: early = 26.5 d, late = 26.1 d % graft take (early vs late) day 7 = 87.3 vs 88.0%, day 10 82.8 vs 88.1%, day 14 82.4 vs 90.0% 	Level 1b

AROM, active range of motion; B/K, below knee; d/c, discharged; FWB, full weight bearing; L/E, lower extremity; LOS, length of stay; PWB, partial weight bearing; RCT, randomized control trial; STG, split-thickness graft; STMG, split-thickness meshed graft; STSG, split thickness sheet graft; U/E, upper extremity; ×/12, months; ×/52, weeks.

Grube et al¹⁶ studied the largest case series, all of whom were burn survivors. They retrospectively reviewed 100 patients treated with split-thickness skin grafts to the lower extremities who were encouraged to ambulate as early as 4 hours postoperatively. Mean patient age was 28.8 ± 16.9 years (range, 1–72 years) with mean burn size of 3.6 ± 4.4% TBSA (range, 1–20% TBSA). Mean time to ambulation was 1.0 ± 1.0 days. Graft take was described as excellent (>95% graft take) in 86% of patients, satisfactory (85–94% graft take) in 10%, and 4% required regrafting. By postoperative day 3, 64% of the patients were discharged, and of the 43 patients for whom time to work resumption could be determined, the average time taken was 4.7 ± 3 weeks.

In 1982, Harnar et al⁶ described a series of 20 patients (14 burn survivors) and reported the results of a burn center early ambulation practice survey. In their patient series, 80% had graft take >90%, and 10% had graft take between 80 and 89%. One patient required regrafting. Their survey results indicated that

8% of units promoted early ambulation, 23% allowed ambulation at day 3, and 69% at day 5 after surgery.

Shankar and Khoo⁶ reported a case series of 25 patients with pretibial wounds whose average age was 75 years (range, 48–95 years). Twenty-three of these 25 patients had 100% initial graft take with the remaining 2 patients healing within 3 weeks.

Sharpe et al⁷ studied a series of 60 patients with pretibial lacerations, of whom 11 had sheet grafts and the remainder meshed grafts. All patients were allowed to ambulate immediately. Of the patients with meshed grafts, 10% had some graft loss compared with 27% of those with sheet grafts.

Tallon et al²⁰ conducted a RCT where patients after skin cancer excisions were randomized to either ambulation 2 or 7 days after grafting. No difference in graft loss, infection, bleeding, or number of follow-up visits (a surrogate measure of time to healing) was apparent. As there was no difference in outcomes between the two groups, the authors concluded that early ambulation did not impede graft take.

Wallenberg⁸ performed a RCT in which 50 participants were allocated to either ambulation the day after surgery with a graduated increase over 3 days in time spent standing or bed rest for 4 days. Wound healing was assessed at 2 weeks with no significant difference between the early vs late ambulation groups (80 vs 88% of patients had primarily healed wounds at 2 weeks). Graft take was unsuccessful in three participants from each group.

Wells et al²² conducted a retrospective, case-controlled evaluation of length of hospital stay and graft viability among 13 burn survivors who ambulated immediately postoperatively compared with historical controls. Average wound size was 131 cm² (range, 25–300 cm²). Unna's boot was applied in the early ambulation group as opposed to application of occlusive burn gauze in the historical group. The historical controls were matched with respect to age (mean age 32 years) and burn size, with burn injury being restricted to the foot and ankle in both groups. There was no significant difference in graft take, but length of hospital stay was significantly reduced (1.4 vs 12.9 days; $P < .001$) between groups. It was estimated that early ambulation and discharge saved approximately \$10,350 (1995 CAD\$)/per patient.

Wood and Lees⁹ undertook a prospective RCT of patients with pretibial wounds who were ambulated from the 1st and 10th postoperative days. Average age of the participants was 74.3 years in the early ambulation group and 73.2 years in the late ambulation group. Mean time to complete healing of the grafts (26.5 days for early ambulation and 26.1 days for late ambulation) and donor sites (14.8 days for early ambulation and 15.3 days for late ambulation) was similar. Wound healing was significantly delayed ($P < .02$) in participants who were taking or who had previously taken oral steroids.

An interesting study not included in the final list of articles that were formally critiqued was a systematic review that asked the question whether there was "evidence of benefit or harm for bed rest for any indication."¹⁰ This article was excluded because of the fact that it did not contain original data, and many of the studies cited in it were not related to skin grafting procedures. Interestingly, however, the authors concluded that there was little support for bed rest as a form of management under virtually any condition, which was consistent with the literature specifically investigating bed rest after skin grafting.

Consensus Exercise

The rehabilitation-specific information within citations was considered inadequate, although it stated that elastic compression was required before ambulation

postoperatively and that an orthosis should be applied if the graft crossed the ankle and/or knee joint. A consensus process was undertaken to elaborate the information contained in the literature. To provide occupational and physical therapists with adequate expert opinion-supported details—who had not been practicing early ambulation (defined as mobility immediately after recovery from anesthesia within 48 hours postoperatively)—a protocol was specifically devised to facilitate initiation of this treatment approach. Details were kept general in nature to allow for regional or institutional differences that will occur naturally, without interfering with the ultimate goal of initiating safe and successful early ambulation.

The consensus process included the following steps: 1) data extraction from the literature, 2) elaboration of a rehabilitation protocol and the development of an algorithm by the international practice guideline development group, 3) the rehabilitation protocol and algorithm were forwarded to international rehabilitation burn summit members² for review and their feedback ($n = 6$) was incorporated, and 4) the revised rehabilitation protocol and algorithm were sent to rehabilitation committee members of the International Society for Burn Injuries and their feedback ($n = 7$) was included. The final version of the rehabilitation protocol is presented in Table 3 with the corresponding algorithm appearing in Figure 1.

DISCUSSION

The objective of this review was to systematically evaluate the available evidence for early ambulation of burn survivors after lower extremity skin grafting procedures so that practice guidelines could be proposed. Unfortunately, the number and quality of such evidence are lacking; thus, the decision was made to include all patient populations to strengthen the conclusions and recommendations. In addition, a consensus exercise was performed to produce expert opinion-based rehabilitation-specific recommendations.

The consistent finding in the literature is that early ambulation can be safely initiated after lower extremity skin grafting without compromising graft take if external compression is applied. If only the evidence in burn survivors is considered, the quality of these studies substantially limits the strength of the conclusion as no RCTs have been conducted. However, as no studies of any patient population have concluded that early ambulation compromises graft take, it seems reasonable to infer that the observations in higher level RCTs in nonburn survivor populations can be generalized to burn survivors.

Table 3. Expert opinion–based rehabilitation-specific algorithm for early ambulation of lower extremity grafts

Postoperative Early Ambulation Protocol

Patients to be excluded from early ambulation protocol:

- Patients with associated fractures precluding early ambulation.
- Patients with preinjury inability to walk.
- Wounds >300 cm²
- Overriding social or psychiatric conditions.
- Medical status prohibiting mobilization.
- Plantar surface of the foot grafted.

Prior to initiating ambulation:

- Must apply external compression. Examples include support boot (eg, Unna's boot), two layers of tubular elastic bandage (eg, Tubigrip™), self-adhesive elastic wrap (eg, Coban™), two layers of figure of 8-wrapped, elastic bandage (eg, Ace™).
- If the graft crosses a joint (ankle or knee), a low-temperature thermoplastic or plaster orthosis should be applied to immobilize the joint and worn continuously. When treating children, the application of a plaster/fiberglass cast should be considered. The orthosis or cast should be discontinued at the first dressing change if the graft take is considered acceptable. Continuation of the positioning plan may be required to maintain range of motion (ROM), although the wearing schedule may be intermittent.

Ambulation:

- Should be encouraged immediately postoperatively, after recovery from anesthetic and after external support has been applied.
- Have patient begin by sitting at the edge of the bed and dangle feet for approximately 10 min. While sitting, assess for orthostatic hypotension (light-headedness). Also assess active ROM (if body surface not immobilized), pain, etc. of the extremity to ensure it is safe for ambulation. This determination must be based on the therapist's clinical judgment.
- If orthostatic hypotension occurs, use tilt table to increase tolerance for upright position.
- Proceed to standing if dangling is well tolerated. Assess for adequate standing balance.
- If unstable when standing, have the patient try walking with an appropriate walking aid, reducing to a less supportive aid or no assistive devices as soon as stability improves.
- Perform weight bearing as tolerated. Full weight bearing allowed (unless otherwise specified by surgeon for other reasons).
- If stable when standing, have patient try walking (therapist to determine if standby one-person assist or two-person assist or walking aid is most appropriate).
- If graft crosses the ankle, a rocker bottom boot may be worn. The orthosis or cast should be worn under the rocker boot if the rocker boot does not immobilize the ankle.
- If graft crosses the knee, patient may need a walking aid to ambulate with the orthosis. If graft take is considered acceptable when evaluated at days 5–7 postoperatively, walking aid may be discontinued at that time.
- Follow-up at 3–7 d for dressing change and wound evaluation.
- Patient instructed to elevate the affected extremity when not mobilizing. This should occur on a regular basis.

Activities of daily living:

- Gradually increase static standing time as tolerated.
- Return to normal activities as tolerated.
- Return to normal shower/bath as wound healing permits.
- Return to work or school recommendations should be based on individual patient work/school demands and circumstances.

Scar management:

- At first dressing change, replace initial compression with:
 - New support boot/cast or
 - Compression
 - Double tubular elastic bandage, eg, Tubigrip™ or
 - Self-adhesive elastic wrap, eg Coban™ or
 - Double-layer elastic bandage, eg, Ace™ or
 - Interim garment

However, many limitations in the literature should be addressed in future studies. The largest graft size investigated was 300 cm²; thus, larger grafts need to be considered before recommendations beyond that graft size can be made. Details on plantar grafts are insufficient to determine whether they can also be safely included in an early ambulation protocol; thus, they have been excluded (Table 3). Although there is a consensus that elastic compression is required, compression type and amount have not been examined; thus, two layers of elastic bandage are currently

recommended until further research is conducted to clarify this issue. The entire literature discussed the application of compression immediately postoperatively but some authors advocated removing it at night. The timing of compression and the possibility of removing it at night need further investigation. One study⁸ recommended graduated ambulation over a 3-day period. Further work is required to determine whether this is necessary or advantageous. Details contained in the rehabilitation protocol and algorithm are, for the most part, based on expert opinion only and

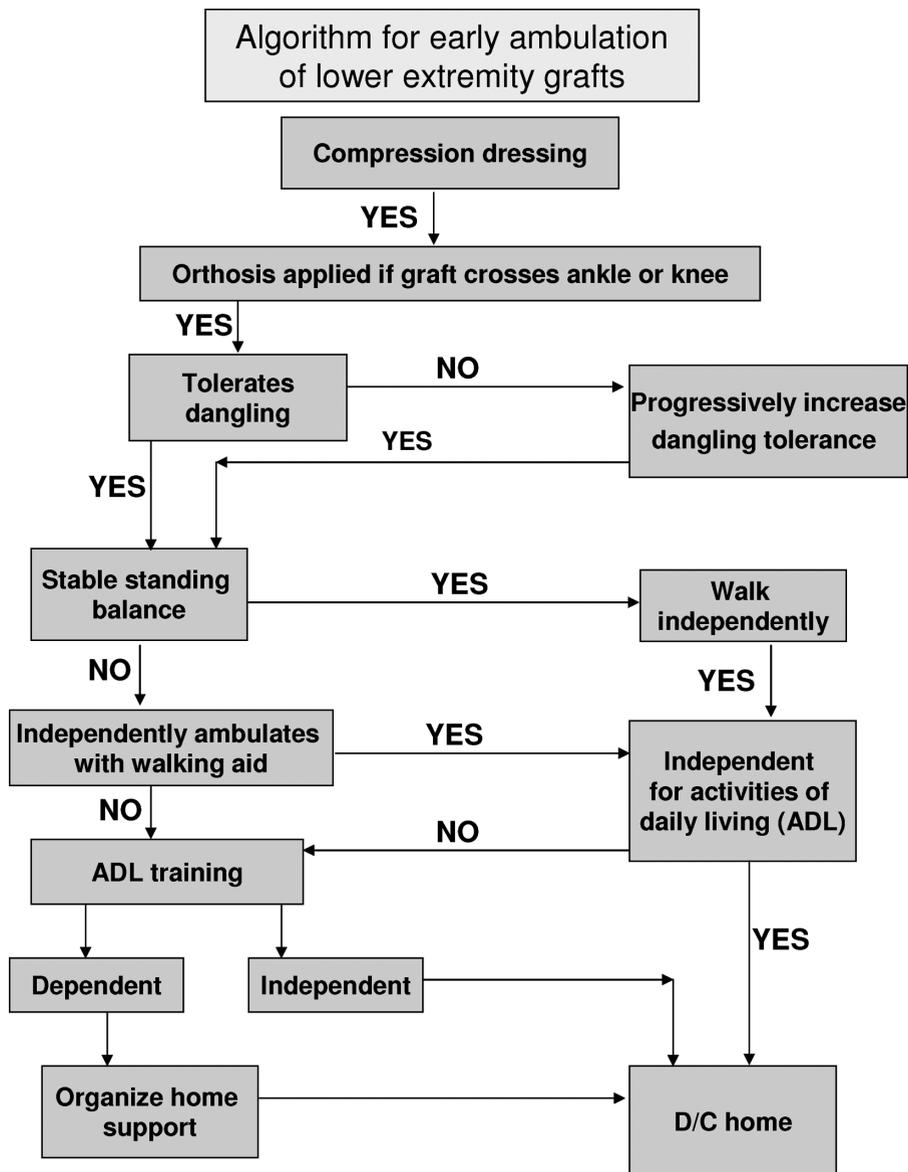


Figure 1. Algorithm for early ambulation of lower extremity grafts.

require further assessment. Outcome measures in this body of the literature have been limited to graft take and length of stay, except for one study that reported time to work resumption. Outcome evaluation at the International Classification of Functioning level²⁸ of activity and participation should be included in future investigations. Given the fact that an informal survey of therapists who participated in the Occupational Therapy and Physical Therapy special interest group meeting at the 2009 American Burn Association Annual Meeting indicated that approximately 50% of the burn centers represented by these participants still do not routinely ambulate burn survivors with uncomplicated lower extremity grafts early, it seems

that RCTs on this population need to be performed to convince burn survivor care providers that a change in practice is warranted. Finally, the burn survivor population-specific literature only includes small, uncomplicated burn injuries. There are occasions when burn survivors with large injuries could ambulate within 24 to 48 hours of skin grafting, but at the moment no literature has documented whether early ambulation is equally as safe for this population.

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APPENDIX

Table A1. Specific search strategy for the MEDLINE database

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- 1 Skin Graft/
 - 2 skin graft*.mp.
 - 3 skin transplantation.mp. or Skin Transplantation/
 - 4 skin defect*.mp. or Skin Abnormalities/
 - 5 skin abnormalit*.mp.
 - 6 leg.mp. or Leg/ or Lower Leg/
 - 7 lower extremity.mp.
 - 8 lower limb.mp.
 - 9 pretibial.mp.
 - 10 varicose ulcer/or venous ulcer*.mp.
 - 11 mobilization/ or mobilization.mp.
 - 12 mobilisation.mp.
 - 13 ambulate*.mp. or Walking/
 - 14 walk*.mp. or Locomotion/
 - 15 bed rest.mp. or Bed Rest/
 - 16 immobilisation.mp. or Immobilization/
 - 17 immobilization.mp.
 - 18 locomotion.mp.
 - 19 Early Ambulation/
 - 20 ambulat*.mp.
 - 21 1 or 2 or 3 or 4 or 5
 - 22 6 or 7 or 8 or 9 or 10
 - 23 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20
 - 24 21 and 22 and 23
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