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Wound Healing in the Long-Term Acute Care Setting Using an Air Fluidized Therapy/Continuous Low-Pressure Therapeutic Bed

A Multiple Case Series

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ABSTRACT

BACKGROUND: We evaluated a new bed that updates the functionality of the current air fluidized therapy (AFT)/continuous low-pressure (CLP) pressure redistributing beds. This bed was evaluated in conjunction with standard wound care interventions in a long-term acute care hospital (LTACH). The AFT feature is designed to provide pressure distribution via a fluid-like medium that forces air through millions of tiny silicone beads that float the patient's body to achieve maximum immersion and envelopment. The CLP feature of the bed provides pressure distribution for the upper body. Standard wound care was provided that included debridement, topical treatments, and biophysical therapies such as negative pressure wound therapy, as indicated.

CASES: Our multiple case series comprised 10 medically compromised patients with 25 wounds. Their mean age was 63 years, 50% were male, and the mean cumulative Braden Scale score was 12.4 out of 23, indicating a high risk for pressure injury (PI). Seven of 10 patients were incontinent of urine, 6 had fecal incontinence, and 2 had ostomies. Types of wounds treated included 2 large tissue defects from surgical excisions for the treatment of gangrene and 23 PIs. On admission, wounds had an average surface area of 139.1 cm². The mean percentage of reduction in wound surface area was 59.3% over an average of 31.3 days of therapy. No new wounds formed during their course of care despite being at elevated risk.

CONCLUSIONS: Findings from this multiple case series suggest that the AFT/CLP bed facilitates healing of advanced wounds in medically complex patients when included as part of a wound care program. Despite mild to high risk, no new PIs developed, and severe PIs and large tissue defects significantly improved or completely resolved. One hundred percent of surveyed staff members recommend use of the AFT/CLP bed.

KEY WORDS: Air fluidized therapy, Complex wounds, Pressure injury, Pressure ulcer, Support surface.

INTRODUCTION

Wound management can be challenging even for the most experienced clinicians, especially in the long-term acute care hospital (LTACH) environment. Patients transferred to an LTACH have typically been in an acute care facility for an extended stay due to major illness or injury. In addition, the population we serve frequently suffers from multiple comorbid conditions that complicate wound management. Wounds of all etiologies are highly prevalent in our LTACH environment, including pressure injuries (PIs), surgical wounds, and arterial/venous ulcers.

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Complete wound healing is not always the goal of wound care in the LTACH; alternative goals include a reduction in wound surface area or substantial improvement in the wound indicated by the influx of granulation tissue or significant reduction in wound volume prior to discharge to a rehabilitation facility or home care.

The majority of patients admitted to our LTACH have experienced an acute care hospital setting and commonly come directly from an acute care intensive care unit (ICU). Approximately 60% are admitted with wounds. As a result, we developed a wound care program based on the Wound, Ostomy and Continence Nursing (WOCN) Society's guidelines for PI prevention and management, the NPUAP/EPUAP/PPPIA (National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel, and Pan Pacific Pressure Injury Alliance) guidelines, and advanced education resources to manage our seriously ill patients with large complex wounds.¹⁻³

Upon admission, each patient who enters our facility is evaluated for support surface selection criteria. We employ clinical judgment based on the WOCN PU/PI Prevention and Treatment Guidelines.⁴⁻⁶ On admission, all patients are placed on a low air loss (LAL) surface. Patients qualify for air fluidized therapy based on the clinical judgment of certified WOC nurses. These patients commonly have multiple stage 3 and/or 4 PIs, worsening wounds, or post-surgical flap or graft. Patients

with unstageable PIs and/or deep tissue pressure injury (DTPI) are only placed on AFT when they have a particularly large wound or multiple wounds affecting the sacrococcygeal and/or gluteal area. We evaluated an updated improved AFT bed and continuous low pressure (CLP) in the upper body (Envella™ Air Fluidized Therapy Bed Hillrom, Batesville, Indiana). Air fluidized therapy redistributes pressure via a fluid-like medium providing maximum immersion (depth of penetration into the support surface) and envelopment (the ability of a support surface to mold around the body). This medium is created by forcing air through millions of tiny silicone beads that float the patient's body. The upper-body section uses a weight-based algorithm that distributes air into bladders aiming to distribute pressure over the maximum amount of the patient's body surface area. The bed we evaluated includes many enhancements: incorporation of enhanced pressure redistribution in the upper body section as previously described, a modified softer lumbar transition bladder for enhanced patient comfort, new functionality features including controls for fluidization on foot pedals to assist during dressing changes allowing "hands free fluidization," blower pump modifications to reduce noise and limit heat production in the room, side surface transfer technology to enhance mobilization, and an integrated scale. This Challenges in Practice describes our experience caring for 10 patients with complex wounds who were cared for in our LTACH using this specialty bed with AFT and CLP features.

INCLUSION/EXCLUSION CRITERIA AND TOPICAL WOUND MANAGEMENT

Inclusion criteria for placement on the specialty bed were: 18 or more years of age, full-thickness (stage 3 and/or 4) PI(s) or multiple PIs (any stage) on 2 or more turning surfaces, recent flap surgery, and the ability to comfortably fit in the bed with adequate room for repositioning. Exclusion criteria were patients with an unstable spinal cord injury and those weighing more than 350 lb, which is the weight limit of the specialty bed. Patients with palliative care goals or who were considered to be near death were also excluded.

Our evaluation focused on the specialty bed with AFT/CLP features; our wound care protocol remained consistent. Standard wound care includes negative pressure wound therapy (NPWT), antimicrobial hydrogel, and foam dressings for stage 2 PIs and greater as indicated. Patients receive surgical debridement as needed during admission. Progress toward wound healing or maintenance is documented weekly. Assessments include wound measurements, weekly photographic documentation, and assessment of signs and symptoms of infection.

CASES

The bed evaluation study was deemed exempt by the RML Specialty Hospital Investigational Review Board, which determined that individual informed consent was not required for placement on the specialty bed. Patients who met all inclusion criteria were approached with the option of signing a release form for wound photographs to be published. After using the bed, patients and staff were given the option to complete a voluntary satisfaction survey.

Twelve patients were initially enrolled in the evaluation; however, 2 were excluded from analysis; one patient spent minimal time on the bed before discharged and one was

TABLE 1.
Patient Demographics

N = 10	
Age, mean, y	63.7
Gender: Male	5 (50%)
Ethnicity	
White	5 (50%)
African American	3 (30%)
Hispanic	2 (20%)
Weight, mean, lb	170.1
Height, mean, in	67.6
Braden Scale risk score on admission, mean	12.4
Overall health status	
Normal	2
Compromised	5
Severely compromised	3
Urinary incontinence	7
Urinary catheter	7
Fecal incontinence	
Yes	6
No	4
NA (colostomy/ileostomy)	2

Abbreviation: NA, not applicable.

diagnosed with skin failure and changed to palliative care goals 1 day after enrollment. Therefore, this multiple case series describes our experience with 10 patients (Table 1). Eight patients had PIs only, one had extensive tissue loss secondary to wide local excision of gangrene, and one had local excision for gangrene along with a PI. These 10 patients had a total of 23 PIs; one was a stage 1 PI; 3 were stage 2 PIs; 5 were stage 3 PIs; 8 were stage 4 PIs; one was categorized as a DTPI; and 5 were categorized as unstageable.

The majority (n = 22; 88%) of wounds treated during the study improved, with an overall average reduction in wound area of 59.3% at discharge. Five wounds completely resolved, no new PIs developed, 1 PI remained the same size, and 2 unstageable PIs increased in size (both patients had other PIs that decreased in size). No adverse device-related injuries were reported during the evaluation.

The clinical course of the 10 patients managed by the AFT/CLP bed is described below. Patients spent an average of 31.3 days on the specialty bed. Photographs of wounds on admission and discharge from the LTACH facility are presented in Table 2. Photographs were not available for cases 5, 7, 8, and 10; these patients did not provide publication release of their wound photographs.

Case 1

Mr L. was an 88-year-old white man who was admitted to our LTACH to recover from 2 major wounds: a large stage 4 PI on his coccyx measuring 8.0 × 6.5 × 2.0 cm (area = 52.0 cm²; volume = 104 cm³) (Table 2) and extensive tissue loss of his medial thigh, scrotum, penis, and perineal areas from a wide local excision to treat Fournier gangrene (28 × 19.5 × 4.5 cm; area = 546 cm²; volume = 2457 cm³) (Table 2). He was admitted with a Braden Scale for Pressure Sore Risk (Braden Scale) score of 16 indicating mild risk; he was alert and oriented. His body mass index (BMI) on admission was

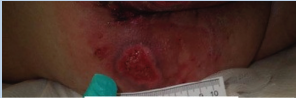
TABLE 2.
Wound Photographs at Study Entry and Nearing Discharge

Patient #		At Admission	At Discharge
1	Gangrene		
1	Coccyx stage 4 PI		
2	Gangrene		
3	Gluteal cleft and coccyx stage 3 with DTPI in wound bed		Coccyx: Wound improved and was 1.2 × 1.0 cm at D/C 
3	R gluteal cleft stage 2		
3	R buttocks DTI		Gluteal cleft: Resolved in 11 d R buttock: Blanching erythema in 11 d/completely resolved in 20 d Ischial tuberosity medial: resolved in 11 d Ischial tuberosity lateral: Resolved in 11 d
3	R ischial tuberosity medial stage 2 PI		
3	R ischial tuberosity stage 1 PI		
4	Sacrum stage 4 PI		

(continues)

TABLE 2.

Wound Photographs at Study Entry and Nearing Discharge (Continued)

Patient #		At Admission	At Discharge
7	Coccyx stage 4 PI		
9	Coccyx (stage 2 PI)/R gluteal (stage 3 PI)		
9	L gluteal fold (stage 3 PI)		

Abbreviations: D/C, discharge; DTPI, deep tissue pressure injury; L, left; PI, pressure injury; R, right.

21.0 kg/m². Mr L. had an in indwelling urinary catheter on admission, a diverting colostomy, and a gastrostomy tube for feeding that had been placed during his stay in acute care. His history was significant for severe weight loss resulting in generalized weakness and multiple falls requiring use of a walker for ambulation.

Treatment goals encompassed primary healing and/or possible graft or flap procedure for the large tissue defect. Upon admission, Mr L. was placed on our standard AFT/CLP bed. He complained of pressure associated with the cushion that divided the AFT. He was transferred to the new ATF/CLP bed because of its lumbar transitional bladder, which improved his level of comfort.

Additional wound care during LTACH admission comprised an expansion flap to partially cover the large tissue defect of his thigh, scrotum, penis, and perianal area. His stage 4 coccyx PI was treated with NPWT for approximately 1 month, followed by use of a collagen dressing (Promogran Prisma Matrix; KCI Medical, San Antonio, Texas). Mr L.'s course of treatment was complicated by low hemoglobin (8.8 g/dL) and low albumin levels (~2.2 g/dL) indicating compromised nutritional status, *Clostridium difficile*-associated diarrhea, and a medical adhesive-related skin injury (skin tear) during a single dressing change next to his coccygeal PI.

Mr L. remained on the new AFT/CLP bed for 65 days before being discharged to a rehabilitation facility. Upon discharge, he had a well-granulated PI measuring 7.2 × 5.1 × 0.5 cm (area = 36.7 cm²; volume = 18.4 cm³), reflecting an 82% volume reduction from baseline (Table 2). In addition, Mr L. had complete epithelial tissue coverage of almost all areas of the extensive Fournier gangrene defect and his wound measured 2 × 13.5 × 1.5 cm (area = 27 cm²; volume = 40.5 cm³), reflecting a 98% volume reduction from baseline (Table 2). Mr L.'s primary wound care nurse's opinion was that the pressure off-loading capabilities of the AFT/CLP bed may have accelerated tissue recovery in both wounds. Mr L. completed a voluntary satisfaction survey and rated the new bed extremely comfortable, finding it superior to the standard AFT/CLP bed.

Case 2

Mr H. was a 42-year-old African American man who was admitted to our LTACH following wide local excision of extensive Fournier gangrene involving his right thigh and hip, scrotum, penis, and perineal area measuring 56.0 × 35.0 × 8.0 cm (area = 1960 cm²; volume = 15,680 cm³) (Table 2). Mr H.'s medical history included schizophrenia, hypertension, cerebral vascular accident (stroke), and insulin-dependent diabetes mellitus. His BMI was 18.4 kg/m², indicating poor nutrition and low body weight.⁷ His cumulative Braden Scale score was 14, indicating moderate risk for PI development. Mr H. had a colostomy and a suprapubic catheter that had been placed prior to admission to our facility to prevent contamination of his wounds.

Treatment goals included sufficient granulation of the wound, enabling placement of a skin graft and primary healing. His course of treatment included NPWT and placement on the AFT/CLP bed to promote healing of his PI and prevent development of other PIs. Because Mr H. had limited tolerance for NPWT dressing changes, surgical graft coverage was indicated as soon as the wound had granulated sufficiently.

Mr H.'s wound gradually improved over the 25 days of treatment, and he was discharged to an acute care facility to undergo split-thickness skin grafting. Postoperatively, Mr H. returned to the LTACH for 1 week and was discharged home with 100% wound coverage (Table 2). No new PIs developed during his time on the AFT/CLP bed. Mr H. completed a satisfaction survey and ranked the specialty bed as extremely comfortable. Prior to being placed on the AFT/CLP bed, Mr H. was restless and constantly removing his dressings. The additional comfort due to the envelopment of NPWT tubing and dressings allowed Mr H. greater comfort and promoted sleep, creating a more ideal environment for healing. Like case 1, Mr H.'s excisional lesion was almost completely resolved.

Case 3

Mr T. was a 23-year-old African American man admitted to our LTACH with 5 PIs: (1) a stage 3 DTPI of the coccyx, with a wound bed measuring 3.2 × 3.0 × 0.01 cm (area = 9.6 cm²;

(2) a stage 2 PI of the gluteal cleft that measured 0.8×0.5 cm; (3) a DTPI of the right buttock; (4) a right medial ischial tuberosity stage 2 PI measuring 2.5×2.0 cm; and (5) a right lateral ischial tuberosity stage 1 PI that measured 3.0×2.5 cm. His pressure injuries developed during a prolonged admission to an acute care facility following a motor vehicle accident resulting in C5 spinal cord injury with quadriplegia. Upon LTACH admission, he was alert and oriented $\times 3$, had a BMI of 24.4 kg/m^2 , and had a cumulative Braden Scale score of 12 indicating high risk for further PI development.

When Mr T. was admitted to our facility, he was initially placed on a LAL bed. The DTPI increased in size, and all PIs showed signs of worsening while on the LAL surface. He was then placed on the AFT/CLP bed to treat his multiple PIs and DTPI, to manage limited turning surfaces. In addition to the new AFT/CLP bed, Mr T.'s coccygeal PI was treated with a hydrogel dressing (Skintegrity; Medline, Chicago, Illinois), antimicrobial sheet dressing (Cutimed Sorbact; BSN Medical, Luxemburg), and covered with sacral foam dressing (Mepilex; Mölnlycke, Norcross, Georgia). Both PIs on the right medial ischial tuberosity and the gluteal cleft were treated with a hydrocolloid dressing (Duoderm; ConvaTec, Bridgewater, New Jersey) and covered with a foam dressing. The right buttock PI was treated with antimicrobial sheet and covered with foam dressing. His right lateral ischial tuberosity was also covered with a foam dressing.

Mr T. was maintained on the AFT/CLP specialty bed for 27 days before discharge to a rehabilitation facility. During this time, 4 of the 5 PIs resolved within 11 days and the DTPI reversed completely after only a couple of days. No new PIs developed despite being at high risk. Furthermore, there was an 87.5% reduction in his stage 3 coccyx wound (wound area went from 9.6 cm^2 to 1.2 cm^2) (Table 2).

Case 4

Ms B. was an 87-year-old white woman admitted to our LTACH for the treatment of a back incision and a large, painful stage 4 sacrococcygeal PI measuring $17.5 \times 19.5 \times 4.7$ cm (area = 341 cm^2 ; volume = 1603.8 cm^3), with exposed bone and periwound moisture-associated skin damage (MASD) (Table 2). She had multiple comorbid conditions including acute kidney injury, respiratory failure, atrial fibrillation, type 2 diabetes mellitus, chronic venous disease, hypothyroidism, and hypertension. Her BMI was 34.2 kg/m^2 , indicating obesity but she also suffered from a low serum albumin ranging from 1.4 to 1.7 g/dL , indicating malnutrition.⁷ Her cumulative Braden Scale score was 10, indicating a high risk for further PI development. She previously suffered a stroke and had experienced a fall resulting in vertebral fractures which were managed by surgical fixation. Unfortunately, her back incision dehiscence. She had an indwelling urinary catheter and a fecal management system to contain urine and stool and prevent wound contamination.

To alleviate her severe pain, maximize pressure redistribution of her wounds, and promote wound healing, Ms B. was placed on the AFT/CLP bed. Additional treatment goals were to eliminate necrotic tissue. Negative pressure wound therapy with installation therapy (Veraflo; KCI Medical) was initially used on her sacrococcygeal PI. However, an adequate seal could not be maintained due to the proximity of the wound to the anus. Standard vacuum-assisted closure was then implemented (V.A.C.; KCI Medical). The incisional wound on her back was treated with hydrogel dressing.

After 37 days, Ms B. was discharged to a skilled nursing facility (SNF) with a clean granulating sacrococcygeal wound and the previously exposed bone covered with granulation tissue. Her stage 4 PI measured $16.8 \times 19.0 \times 3.5$ cm (area = 319 cm^2 ; volume = 1117.2 cm^3), reflecting a 30% decrease in volume (Table 2), and the surgical incision wound on her back was healed. The staff opined that the AFT/CLP bed helped alleviate Ms B.'s pain at the site of the wound. Despite her low Braden Scale scores, no new PIs developed during her admission. Her periwound MASD also resolved.

Case 5

Ms C. was an 82-year-old African American woman admitted to our LTACH for treatment of a stage 4 sacral PI measuring $14.0 \times 17.0 \times 2.5$ cm (volume = 595 cm^3). Ms C.'s medical history included chronic kidney disease, diabetes mellitus, and anemia. She was overweight (BMI of 25.5 kg/m^2), with a cumulative Braden Scale score of 11 upon admission indicating a high risk for further PI development. She was incontinent of stool.

Ms C.'s sacral PI was treated with NPWT. She was initially placed on an LAL surface, but her wound was not improving, so she was transferred to the AFT/CLP bed for advanced pressure off-loading, wound healing, and pain reduction. Ms C. underwent incision and drainage of a thigh abscess, resulting in significant blood loss; she was emergently discharged to acute care after 21 days of therapy. Her last wound assessment before discharge showed a 62% PI volume reduction (measurements: $13.5 \times 13.0 \times 1.3$ cm; volume = 228.1 cm^3).

Case 6

Mr Z. was a 50-year-old Hispanic man who was admitted to our LTACH for treatment of 5 PIs: (1) a stage 3 PI of the coccyx that measured $3.0 \times 3.5 \times 0.01$ cm (area = 10.5 cm^2) with periwound MASD (Table 2); (2) a left ischial stage 4 PI that measured $10.0 \times 8.5 \times 3.0$ cm, with 2.0-cm circumferential undermining and 3.5-cm tunneling and with erythema and periwound MASD with sanguineous drainage; (3) a right ischial stage 4 PI that measured $5.0 \times 6.5 \times 2.0$ cm, with 1.5-cm circumferential undermining and periwound MASD; (4) a left lateral lower-leg stage 4 PI that measured $0.5 \times 0.5 \times 0.01$ cm; and (5) an unstable PI of the left posterior upper thigh measuring 2.5×1.0 cm.

Mr Z.'s medical history included chronic kidney disease, paraplegia, hypertension, congestive heart failure, and gastroesophageal reflux disease. Surgical history included repair of an aortic aneurysm and cardiac surgery as an infant. He had significant anatomic deformities from pelvic fractures and scoliosis. When Mr Z. was admitted, he was incontinent of stool. He was alert and oriented $\times 3$ and clinically obese (BMI of 35.6 kg/m^2), with a cumulative Braden Scale score of 12 indicating a high risk for PI. Treatment goals included off-loading and repositioning every 2 hours to promote healing of his multiple PIs. Repositioning Mr Z. was challenging due to the location of his wounds on the left, right, and medial areas, resulting in limited turning surfaces.

Mr Z. was placed on the AFT/CLP bed for maximum off-loading and prevention of future PIs. His coccyx and ischial wounds were treated with NPWT. His left posterior upper thigh was treated with hydrocolloid, and left lateral lower leg was treated with antimicrobial sheet and hydrogel dressing. However due to his anatomic deformities, a NPWT seal could not be maintained, and his treatment plan was changed to

topical therapy comprising an antimicrobial sheet and hydrogel dressings.

After 12 days of treatment, Mr Z. was discharged to a nursing home, with most wounds showing marked improvement. The surface area of his coccygeal PI was reduced by 98%, measuring $0.5 \times 0.5 \times 0.01$ cm (area = 0.25 cm^2), and his periwound MASD had resolved (Table 2). His left ischial PI measured $7.0 \times 3.0 \times 1.8$ cm with no erythema, no edema, serous drainage, and improvement in undermining (from 2.0 to 1.2 cm) and tunneling (from 3.5 to 2.0 cm). His right ischial PI measured $3.0 \times 3.0 \times 2.0$ cm with no erythema, no edema, and 1.0-cm undermining (reduced from 1.5 cm). His left lateral lower-leg PI remained the same size. His left posterior upper thigh stage 2 PI, which was previously unstageable, healed from the base measuring 3.0×1.5 cm. Despite being at high risk, no new PIs developed during his time on the AFT/CLP bed.

Case 7

Mr M. was a 73-year-old white man admitted to our LTACH for care of a stage 4 coccygeal PI measuring $6.5 \times 9.5 \times 0.2$ cm (area = 61.8 cm^2 ; volume = 12.4 cm^3). His medical history included chronic kidney disease, coronary artery disease, atrial fibrillation, diabetes mellitus, anemia, hypertension, and a colostomy. He was alert and oriented $\times 3$, with a BMI of 27.7 kg/m^2 indicating overweight; he had a cumulative Braden Scale score of 13, indicating moderate risk. Mr M. was incontinent of urine.

Upon admission, Mr M. was placed on an LAL mattress and treated conservatively. During this time, his coccygeal stage 4 PI deteriorated, exhibiting a DTPI within the wound bed, and developed eschar covering 50% of the wound surface and exposed bone. He reported significant pain at his wound site; treatment goals were promotion of wound healing and alleviation of pain.

In order to stop wound progression from the DTPI, he was transferred to the new AFT/CLP bed. The wound was locally treated with an antimicrobial foam and sheet. After a few days, 30% of eschar and the DTPI within the wound bed completely resolved. Thirteen days after transfer to the AFT/CLP bed, the eschar was completely resolved. Mr M. was discharged to an SNF with the coccygeal wound much improved, measuring $5.8 \times 7.8 \times 0.01$ cm (area = 45.2 cm^2 ; volume = 0.45 cm^3 ; area reduced by 27% and volume reduced by 96%), with bone completely covered by granulation tissue. Mr M. completed a satisfaction survey and rated the bed very comfortable.

Case 8

Ms S. was a 92-year-old white woman admitted to our facility with 3 PIs: (1) an unstageable coccygeal PI measuring $7.5 \times 5.8 \times 0.01$ cm (area = 43.5 cm^2 ; volume = 0.435 cm^3); assessment also revealed +2 edema and periwound MASD. She also had a stage 3 PI of the right elbow, measuring $2.2 \times 2.1 \times 0.5$ cm (area = 4.62 cm^2 ; volume = 2.31 cm^3) with periwound MASD and serous drainage, and a stage 2 PI measuring $1.8 \times 1.5 \times 0.01$ cm (area = 2.7 cm^2 ; volume = 0.027 cm^3) with periwound MASD +2 edema, and serous drainage. Ms S.'s medical history included dementia, hypertension, stroke, neurosarcoidosis, antiphospholipid antibody syndrome, fibromyositis, dyslipidemia, scoliosis, osteoporosis, bilateral hip replacements, and ileostomy. Upon admission, Ms S. was alert and oriented $\times 1$, with a significantly underweight BMI of 14.8 kg/m^2 indicating malnutrition⁷ and a cumulative Braden Scale score of 12 indicating high risk.

Ms S. suffered from significant wound pain. To alleviate pain and promote healing of her multiple PIs, she was placed on the AFT/CLP bed. Her coccyx PI could not be debrided secondary to cachexia; alternatively, we treated her with a hydrocolloid dressing to promote autolytic debridement. Her right elbow stage 3 PI was treated with a hydrogel dressing and antimicrobial sheet. Her mid-spine stage 2 PI was treated with antimicrobial absorbent foam and sheet and foam 4×4 dressing.

After 34 days of therapy, her wounds exhibited significant improvement and she was discharged. Her unstageable coccyx wound surface area reduced by 83% (measured $3.0 \times 2.5 \times 0.3$ cm; area = 7.5 cm^2 ; volume = 2.25 cm^3) with no erythema or edema. Her stage 3 right elbow PI wound surface area reduced by 99% (measured $0.2 \times 0.2 \times 0.01$ cm; area = 0.04 cm^2 ; volume = 0.0004 cm^3) with no erythema or edema, and the mid-spine PI area decreased by 94% and showed no erythema or edema (measured $0.5 \times 0.3 \times 0.01$ cm; area = 0.15 cm^2 ; volume = 0.0015 cm^3). Despite being at high risk, no new PIs developed. After placement on the new AFT/CLP bed, Ms S.'s pain subsided, with the exception of low-intensity pain with dressing changes.

Case 9

Ms L. was a 29-year-old Hispanic woman admitted to our LTACH following an extensive ICU stay for treatment of injuries sustained in a motor vehicle accident. During this ICU admission, she underwent spinal fusion which included a spinal cord injury resulting in quadriplegia. She was admitted to our LTACH for care of 3 PIs including bilateral stage 3 PIs on her gluteal area and 1 stage 2 PI on her coccyx. The right gluteal PI measured $4.5 \times 3.8 \times 0.5$ cm (area = 17.1 cm^2 ; volume = 8.55 cm^3) (Table 2), the left gluteal PI measured $3.2 \times 1.8 \times 0.5$ cm (area = 5.8 cm^2 ; volume = 2.88 cm^3) (Table 2), and stage 2 coccyx PI measured $3.0 \times 1.0 \times 0.01$ cm (area = 3.0 cm^2 ; volume = 0.03 cm^3).

Upon admission, Ms L. was alert and oriented, with a BMI of 31.4 kg/m^2 indicating clinically obese and a cumulative Braden Scale score of 12 indicating high risk. She required mechanical ventilation via tracheostomy. She initially exhibited signs of severe depression and at times resisted care and food. Due to her refusal of care, Ms L.'s stage 2 coccyx PI deteriorated to an unstageable PI and subsequently evolved to a stage 3 PI measuring $3.5 \times 3.2 \times 2.2$ cm (area = 11.2 cm^2 ; volume = 24.6 cm^3).

Ms L. was initially placed on an LAL mattress and repositioned every 2 hours. Even after repositioning, Ms L. was very uncomfortable on the LAL surface. Admission treatment goals were to advance her nutritional status and promote wound healing. Her PIs were treated with a hydrogel dressing combined with antimicrobial sheets. During her stay, Ms L.'s depression gradually subsided and her appetite and caloric intake improved. She was placed on the AFL/CLP bed to off-load here multiple PIs, promote wound healing, and provide comfort. She commented that the specialty bed was "extremely comfortable for pain management."

After 46 days of treatment, both the right and left gluteal fold PIs showed 83% and 94% reductions in surface area, respectively. The coccyx PI had increased in size during the time that she had refused care but, at discharge, was showing signs of improvement. The overall change in the coccyx PI was an increase in area from 3.0 cm^2 on admission to 4.8 cm^2 at discharge. This case demonstrates that even the best care cannot overcome a refusal in care, such as patient refusal of nutrition, wound dressing changes, and repositioning efforts.

Case 10

Ms C. was a 71-year-old white woman admitted with a stage 4 PI located on her coccyx measuring $3.0 \times 2.2 \times 1.5$ cm (area = 6.6 cm^2 ; volume = 9.9 cm^3) with undermining. Additionally, she had an unstageable PI on her right trochanter measuring $6.0 \times 5.0 \times 1.5$ cm (area = 30.0 cm^2 ; volume = 45.0 cm^3) with tunneling and undermining. Her medical history included multiple sclerosis, systemic lupus erythematosus, hypothyroidism, frequent episodes of respiratory distress and hypotension, acute kidney injury, metabolic acidosis, hyponatremia, and heart failure. Upon admission, Ms C. was comatose with a BMI of 30.9 kg/m^2 and a cumulative Braden Scale score of 12 indicating high risk for PI. Treatment goals for this medically fragile woman were to remove the necrotic tissue in her wound bed, close the undermining and tunneling, and off-load her wounds with frequent repositioning.

Upon admission, Ms C. was placed on the AFT/CLP specialty bed due to the severity of her PIs and complicated medical problems. Her stage 4 coccyx PI was treated with hydrogel and, following debridement, was treated with NPWT. The unstageable right trochanter PI was treated with sodium chloride-impregnated gauze (Mesalt; Mölnlycke, Gothenburg, Sweden) and a hydrogel dressing until adequate debridement was achieved. She was subsequently managed with NPWT.

After 33 days of treatment, Ms C. was discharged to a rehabilitation facility. During her course of care in our facility, the surface area of her coccygeal PI shrank by 70% (measured $2.0 \times 1.0 \times 0.4$ cm; area = 2.0 cm^2 ; volume = 0.8 cm^3) with no undermining. Her right trochanter PI area was reduced by 75% (measured $3.0 \times 2.5 \times 0.7$ cm; area = 7.5 cm^2 ; volume = 5.25 cm^3). Despite Ms C.'s medically complex and fragile condition, no new PIs formed.

DISCUSSION

The purpose of this case series was to describe our experience during the evaluation of a new AFT/CLP specialty bed. Air fluidized therapy is an important component in the overall care of patients with complex, and often painful, wounds such as PIs. This technology was developed in the 1960s, and multiple studies have demonstrated its superior healing properties for treatment of PIs over other mattress types.^{8,9} Efficacy is believed to be associated with the fluid environment that is fundamentally different from the support provided by surfaces constructed of solid materials.¹⁰ Fluid support envelopes the body while reducing shear, friction, pressure, and mechanical forces applied to the skin and subcutaneous tissue. The bed described in our multiple case series combines AFT and CLP to achieve maximal pressure redistribution, which enhances pain management and supports wound healing.

The 10 patients had 25 wounds including 23 PIs and 2 large tissue defects from surgical excisions for treatment of gangrene. The largest wound we treated had an area of 1960 cm^2 , with an average area of all wounds at admission of 139.1 cm^2 . Patients spent an average of 31.3 days on the AFT/CLP bed; every patient experienced improvement in at least one wound and 88% of all wounds reduced in size. Reduction in wound area averaged 59.3%, and no new PIs formed despite being at elevated risk.

Six patients who enrolled on the study started treatment on a standard of care surface (LAL mattress or our standard AFT/CLP bed system) before being transitioned to the new AFT/CLP bed. While on the LAL surface, 5 out of 5 patients experienced worsening of wounds, which then improved when moved to the new AFT/CLP specialty bed. One patient was initially placed on our standard AFT/CLP bed and was transitioned to the evaluation bed during his course of treatment. While on the study bed, this patient's stage 4 PI improved by 82% and his excision to treat Fournier gangrene improved 98%. While our study design prohibits a direct comparison of the new AFT/CLP bed to other beds, these study observations support the superiority of the new AFT/CLP bed over our standard of care beds that are typical components of wound care programs.

CONCLUSION

Complex wounds need complex solutions. The newly updated AFT/CLP bed demonstrated success as a component of a wound management program for treatment of patients with complex wounds. This study demonstrates that with provision of the right care including the right support surface, wounds can move toward healing, even in this medically fragile patient population.

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