

MIST Therapy[®] System: Thoughts on Therapy

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CASE SERIES #7

In our practice at St. Agnes Continuing Care Center, the Mercy Rehabilitation wound team has been using the MIST Therapy[®] System (Celleration[®], Inc) consistently since August 2006 on a variety of patients and wounds, including wounds of surgical, diabetic, arterial, pressure, and atypical origin. Our patients are often very medically complex with multiple comorbidities. For this case series, we selected 6 consenting patients based on the availability of clear photographs of their wounds taken on days that corresponded with wound measurements. MIST Therapy was initiated in these patients to assist with debridement of significant amounts of necrotic tissue and to reduce topical signs of infection—typically, excessive drainage and foul odor.

The MIST Therapy System is a noncontact, therapeutic ultrasound device cleared by the Food and Drug Administration to promote wound healing through wound cleansing and maintenance debridement by the removal of yellow slough, fibrin, tissue exudate, and bacteria. The low-frequency ultrasound waves of the

MIST Therapy System are delivered via a sterile saline mist. Treatments are painless because the device does not contact the wound.

As specified in the product labeling, we administered MIST Therapy 2–3 times weekly. Typically, wounds are treated for 3–5 minutes per treatment, but treatment time ultimately depends on the size of the wound. For the larger wounds in this series, we used longer treatment durations. Also, all wounds were treated with sharp debridement as needed to remove necrotic tissue.

It is important to note that, in our facility, MIST Therapy is primarily used to stabilize and improve wounds so that patients can be moved to a more aggressive rehabilitation facility for therapy. Thus, patients often leave our facility prior to complete wound closure. Wound healing was evaluated on the basis of wound dimensions, exudate, and tissue characteristics (granulation, slough, or eschar) over time. Due to comorbid conditions that affected patients' ability to sense or communicate pain, we could not obtain patient-reported ratings of wound pain.

PATIENT #1: This 75-year-old female had 3 full-thickness wounds of the left lower extremity that communicated with one another. She also had partial- and full-thickness wounds on the perirectal/buttocks area with significant fungal irritation resulting from skin irritation associated with frequent bowel movements. The lower extremity wounds developed at the site of a vein-harvest procedure performed on July 18, 2006. The perirectal/buttocks wounds developed in September of 2006. Her medical history was extensive, including ventilator-dependent respiratory failure (VDRF), cerebrovascular accident, aortic aneurysm, coronary artery bypass graft (CABG), atrial fibrillation, anemia, methicillin-resistant *Staphylococcus aureus* (MRSA) cultured from her wounds, and vancomycin-resistant enterococcus (VRE). As would be expected, her medication regimen was also extensive—acyclovir, lorazepam, heparin, furosemide, lisinopril, metoprolol, papain/urea, vancomycin, sertraline hydrochloride, linezolid, metronidazole, and morphine. The perirectal/buttocks wounds were dressed with nystatin and a balsam of Peru/trypsin/castor oil mixture applied and left open to air. The lower extremity wounds were initially dressed with hydrofiber with silver, followed by a collagen/oxidized regenerated cellulose (ORC)/silver dressing, followed by a hydrocolloid dressing until closure. After attempted treatment with negative pressure wound therapy (NPWT) on the lower extremity wounds, she presented to our facility with a 95% necrotic base and MRSA infection. MIST Therapy was initiated on both wound areas on September 11, 2006, with treatment times of 11 minutes for the lower extremity wounds and 5 minutes for the perirectal/buttocks wounds. MIST Therapy was discontinued on September 29, 2006 for the perirectal/buttocks wounds (total of 9 treatments) and on October 6, 2006 for the lower extremity wounds (total of 12 treatments). The patient was ventilator-dependent, and her neurologic status precluded her rating wound pain. Pre-medication with morphine was initially required for the first MIST sessions because she was very agitated during treatment, but after 3–4 MIST sessions, she no longer required it. As shown below, both wounds were completely epithelialized after 5 weeks of MIST Therapy. Also, the drainage problem in the lower extremity wound improved substantially after 2 weeks of MIST treatments and consisted of minimal, serosanguineous fluid within 4 weeks.

PATIENT #1: PERIRECTAL/BUTTOCKS							
Time Point	Dimensions, cm			Drainage	Tissue color, %		
	Length	Width	Depth		Red/Pink (Granulating)	Yellow (Slough)	Black (Eschar)
9/8/06	9	9	0.1	Minimal-moderate serosanguineous	20	80	0
9/15/06	8	12	0.1	Minimal	90	10	0
9/22/06	7.5	7.0	0		100	0	0
9/29/06	3	2.5	0	Scant	100	0	0
10/6/06	Epithelialized			None	100	0	0



The perirectal/buttocks wound on 9/18/06



9/22/06



9/29/06



The left lower extremity wound on 9/8/06



9/18/06



10/6/06

PATIENT #1: LEFT LOWER EXTREMITY							
Time Point	Dimensions, cm			Drainage	Tissue color, %		
	Length	Width	Depth		Red/Pink (Granulating)	Yellow (Slough)	Black (Eschar)
9/8/06							
Proximal	2.8	1.5	1.0	Copious purulent	0	100	0
Middle	3.6	2.0	1.0				
Distal	3.6	2.0	1.0				
9/15/06							
Proximal	2.5	1.4	0.9	Moderate-maximal seropurulent	90	10	0
Middle	3.9	2.0	1.2		70	30	0
Distal	3.5	2.0	0.9		80	20	0
9/22/06							
Proximal	2.0	1.0	0.5	Moderate serosanguineous	100	0	0
Middle	3.5	2.0	0.8				
Distal	3.1	1.8	0.8				
9/29/06							
Proximal	1.0	0.6	0	Moderate serosanguineous	100	0	0
Middle	2.9	1.2	0.5				
Distal	3.0	1.2	0.5				
10/6/06							
Proximal	0.8	0.3	0	Moderate serosanguineous	100	0	0
Middle	2.4	0.7	0				
Distal	2.6	0.5	0.3				
10/16/06							
Proximal	Epithelialized			Scant	100	0	0
Middle	Epithelialized						
Distal	0.8	0.5	0				

PATIENT #2: This 56-year-old female presented to our facility status post-excision and debridement of a chronic right plantar foot ulcer. Her medical history was extensive, including insulin-dependant diabetes mellitus, chronic renal failure (CRF), VDRF, pneumonia, anemia, peripheral vascular disease, thyroiditis, epilepsy, obstructive sleep apnea, osteomyelitis, recurrent urinary tract infections, previous MRSA in the wound, and prior amputations of right first and second toes. The list of her concomitant medications was also extensive: piperacillin/tazobactam, amoxicillin clavulanate, famotidine, heparin, insulin, levothyroxine sodium, lisinopril, raglan, metoprolol, sertraline hydrochloride, simvastatin, morphine, haloperidol, epoetin alpha, and lorazepam. The wound resulted from an infected diabetic foot ulcer diagnosed in 2006 that was surgically debrided on January 28, 2007. Prior to arrival at our facility, the wound was treated with papain/urea/chlorophyllin copper complex sodium and NPWT. This patient was also ventilator-dependent and had varying states of alertness. This wound did not appear to be very painful for her, and she had very poor sensation in the foot. In an effort to reduce the copious seropurulent drainage and promote granulation, MIST Therapy was initiated 2–3 times per week on February 19, 2007 for 8 minutes per session and eventually decreased to 6 minutes as drainage and granulation improved. Throughout the MIST treatment period, dressings included papain/urea/chlorophyllin copper complex sodium, hydrofiber with silver, collagen/ORC/silver, or hydrogel based on wound appearance and characteristics. MIST was discontinued on March 21, 2007 after a total of 11 treatments. As shown atop page 39, the wound was fully granulated within 2 weeks of starting MIST Therapy. Additionally, copious amounts of seropurulent drainage were replaced with moderate serosanguineous fluid within 2 weeks and minimal drainage by 4 weeks. Due to medical complications not associated with her wound, this patient was discharged back to an acute care facility before the wound had closed completely.

PATIENT #2: RIGHT PLANTAR

Time Point	Dimensions, cm			Drainage	Tissue color, %		
	Length	Width	Depth		Red/Pink (Granulating)	Yellow (Slough)	Black (Eschar)
2/13/07	6.8	8.5	2.3	Copious seropurulent	20	40	40
2/21/07	6.8	7.0	1.8	Moderate-copious seropurulent	80	10	10
2/28/07	6.8	7.0	1.5	Moderate serosanguineous	98	2	0
3/6/07	6.3	6.1	0.5		100	0	0
3/15/07	6.0	5.5	0.2	Minimal serosanguineous	95	5	0
3/21/07	5.2	5.1	0.1		100	0	0



The wound on 2/13/07



2/28/07



3/21/07

PATIENT #3: This 85-year-old woman had a large, MRSA-positive abdominal wound with purulent drainage very close to a colostomy site. She had undergone a colosigmoid resection with transverse colostomy on April 8, 2007 for treatment of diverticulitis with sepsis and perforated viscous. Her medical history also included atrial fibrillation; breast cancer (status post-mastectomy and radiation therapy); congestive heart failure; B-type plural effusions; and hypothyroidism. She was taking the following medications: levothyroxine sodium, metoprolol, nitroglycerin, pravastatin, temazepam, clonazepam, docusate sodium, enalapril, escitalopram, esomeprazole magnesium, furosemide, and heparin. Prior to starting MIST Therapy, the wound had been treated with NPWT with silver foam dressing for an undetermined duration at an acute care facility. MIST was administered 3 times per week from May 25 to June 22, 2007 for a total of 12 treatments. Treatments were started at 8 minutes per session but reduced to 7 minutes as drainage and granulation improved and wound dimensions decreased. Throughout the MIST Therapy period, the wound was dressed with silver alginate. As shown below, the large amounts of purulent drainage improved to moderate serosanguineous drainage in 4 weeks of MIST Therapy, at which point wound dimensions began to decrease dramatically. The patient was discharged to a sub-acute rehabilitation facility on June 22 with the wound at 100% granulation tissue.

PATIENT #3: ABDOMEN/COLOSTOMY SITE

Time Point	Dimensions, cm			Drainage	Tissue color, %		
	Length	Width	Depth		Red/Pink (Granulating)	Yellow (Slough)	Black (Eschar)
5/23/07	15	6.5	4	Copious purulent	75	25	0
5/31/07	13.9	5.5	7	Moderate purulent	80	20	0
6/8/07	11.5	5.5	7.5	Moderate seropurulent	80	20	0
6/15/07	12	3.6	7		95	5	0
6/22/07	11	3.6	7	Moderate serosanguineous	100	0	0
7/11/07	7.5	3.0	6.3		100	0	0



The wound on 5/23/07



6/6/07



6/22/07

PATIENT #4: This 55-year-old male presented to our facility on July 28, 2006 with a pressure ulcer of the buttocks/sacrum, a hypoperfusion/atypical wound of the scrotum, and a surgical site wound of the left groin that was VRE-positive on August 8, 2006. His medical history included diabetes mellitus, hypertension, chronic obstructive pulmonary disease, coronary artery disease, VDRF, cardiogenic shock with multiple pressor dependency, mediastinal clot requiring 2 open chest surgeries, CABG, CRF on hemodialysis, bilateral above-the-knee amputations, and an undiagnosed spinal cord injury. Concomitant medications included clopidogrel, vitamin supplement for dialysis, raglan, metoprolol succinate, sertraline hydrochloride, esomeprazole magnesium, fluconazole, calcium acetate, epoetin alpha, bacitracin, and hydromorphone hydrochloride. The buttocks and scrotum had previously been treated with papain/urea ointment, the groin with dry sterile dressing. MIST Therapy was initiated on August 8, 2006 in an effort to promote granulation, which seemed to have stalled, and address the drainage problem in the groin wound. MIST was administered for 3 minutes, 8 minutes, and 9 minutes (decreasing to 6 minutes) per session for the scrotum, groin, and buttocks, respectively. Dressings included papain/urea and gauze on the scrotum, papain/urea then papain/urea/chlorophyllin copper complex sodium on the buttocks, and hydrofiber with silver on the groin. The left groin wound had increased in depth with MIST and debridement. Eventually a “clamp” was discovered at the vein donor site. After the clamp (believed to be generating a foreign-body reaction) was removed on August 11, the wound began to close and heal in a more normal sequence. MIST Therapy was discontinued on August 24, 2006 after a total of 9 treatments. The patient was discharged to a rehabilitation facility the next day, where his wounds eventually came to closure in less than 3 weeks. This patient had minimal pain throughout treatment, which could not be explained at the time. Later, the patient was found to have an undiagnosed incomplete spinal cord injury. As shown below, granulation increased substantially during the MIST treatment period, reaching complete granulation within 2 weeks. In the case of the groin wound, the copious purulent drainage was gradually replaced by moderate serosanguineous fluid within 3 weeks.

PATIENT #4: ANTERIOR SCROTUM

Time Point	Dimensions, cm			Drainage	Tissue color, %		
	Length	Width	Depth		Red/Pink (Granulating)	Yellow (Slough)	Black (Eschar)
8/8/06	3.1	5.4	0	Moderate serosanguineous	20	0	80
8/14/06	2.3	3.5	0	Minimal	90	10	0
8/21/06	1.3	2.0	0		100	0	0
8/25/06	1.0	2.0	0		100	0	0

PATIENT #4: LEFT GROIN

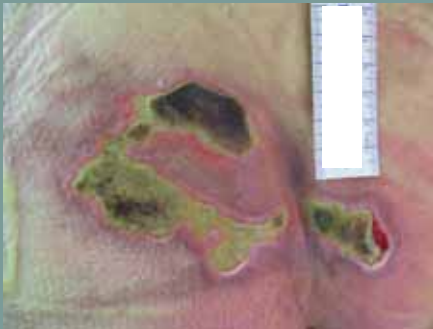
Time Point	Dimensions, cm			Drainage	Tissue color, %		
	Length	Width	Depth		Red/Pink (Granulating)	Yellow (Slough)	Black (Eschar)
8/8/06	7.6	2.5	1.0	Copious purulent	10	80	10
8/14/06	6.0	2.4	4.0	Moderate purulent	70	30	0
8/21/06	4.7	3.0	2.8	Moderate less purulent	90	10	0
8/25/06	5.0	3.2	1.9	Moderate serosanguineous	95	5	0

PATIENT #4: RIGHT BUTTOCK

Time Point	Dimensions, cm			Drainage	Tissue color, %		
	Length	Width	Depth		Red/Pink (Granulating)	Yellow (Slough)	Black (Eschar)
8/8/06	2.0	2.5	0.2	Moderate serosanguineous	60	40	0
8/14/06	1.8	3.0	0.2	Moderate	80	20	0
8/21/06	1.5	2.9	0.1		100	0	0
8/25/06	1.5	2.7	0	Minimal serosanguineous	100	0	0

PATIENT #4: LEFT BUTTOCK

Time Point	Dimensions, cm			Drainage	Tissue color, %		
	Length	Width	Depth		Red/Pink (Granulating)	Yellow (Slough)	Black (Eschar)
8/8/06	5.9	6.0	0	Moderate serosanguineous	60	40	0
8/14/06	6.0	7.0	0.2	Moderate	80	20	0
8/21/06	5.9	6.3	0.1		100	0	0
8/25/06	Sup. 1.0 Inf. 2.5	3.1 4.6	0	Minimal serosanguineous	100	0	0



The left buttock wound on 7/28/06



8/8/06



8/15/06

PATIENT #5: This 79-year-old male with VDRF, hypertension, diabetes mellitus, status post-fall with subdural hematoma, and *Clostridium difficile* infection presented to our facility for treatment of a sacral pressure ulcer. He was taking insulin, simvastatin, metoprolol, cefepime, esomeprazole magnesium, tamsulosin hydrochloride, and oxycodone/acetaminophen. The wound had been treated with a papain/urea ointment. The patient was ventilator-dependent and minimally responsive to any pain stimuli. We initiated MIST Therapy on June 28, 2007 for 8 minutes per session to aid in removing necrotic tissue and, hopefully, avoid surgical debridement, which would have required transferring this medically unstable patient to another facility. The wound was dressed with papain/urea then papain/urea/chlorophyllin copper complex sodium as the percentage of necrotic tissue decreased. MIST was discontinued July 11, 2007 after a total of 8 treatments over 2 weeks because we had achieved our goal of removing the necrotic tissue. This patient had been scheduled for surgical debridement, but the procedure was cancelled due to the substantial improvements in granulation and drainage (see below). As of July 30, 2007, the wound had not closed; however, the family had decided on less aggressive care as this patient had become eligible for

PATIENT #5: SACRUM

Time Point	Dimensions, cm			Drainage	Tissue color, %		
	Length	Width	Depth		Red/Pink (Granulating)	Yellow (Slough)	Black (Eschar)
6/8/07	10	7.1	1.1	Moderate seropurulent	60	40	0
7/3/07	9.8	7.1	1.0	Moderate serosanguineous	80	20	0
7/11/07	9.2	6.2	0.7		90	10	0



hospice. The wound on 6/22/07



6/29/07



7/11/07

PATIENT #6: This 82-year-old woman had a pressure ulcer on her right hip in addition to numerous other medical conditions, including VDRF, subarachnoid hemorrhage, sepsis, intra-abdominal diverticular abscess treated by resection of the sigmoid and transverse colon, atrial fibrillation, hypertension, and Hodgkin's lymphoma. Her current medications were ceftriaxone, albuterol, furosemide, ipratropium bromide, esomeprazole magnesium, heparin, levothyroxine sodium, amiodarone hydrochloride, diltiazem hydrochloride, and insulin. The wound was acquired in a continuing care facility and was evaluated by the physical therapy wound care team on June 4, 2007. Prior to starting MIST Therapy, the wound had been treated with ¼-strength sodium hypochlorite solution, NPWT, and surgical debridement performed on June 13, 2007. The patient was minimally responsive to pain stimuli. The wound had foul-smelling, purulent drainage and multiple organisms present by culture. MIST treatments 3–4 times per week were started on June 15, 2007 in an attempt to reduce the purulent drainage. Initially, MIST was administered for 10 minutes per session and then reduced to 8 minutes per session as the percentage of necrotic tissue declined. During the MIST treatment period, the wound was initially dressed with ¼-strength sodium hypochlorite solution for 3 days. The care plan after this time consisted of papain/urea, hydrofiber with silver, or collagen/ORC/silver dressing depending on the presentation of the wound. MIST was discontinued on July 5, 2007, after 10 treatments, because wound size had decreased substantially and very minimal nonviable tissue remained. As of July 30, 2007, the wound was very close to complete closure. As shown below, the amount and quality of drainage improved after 1 week of MIST Therapy. In addition, the necrotic tissue declined by 50% after 1 week of treatment and granulation reached nearly 90% approximately 2 weeks after starting MIST.

PATIENT #6: RIGHT HIP

Time Point	Dimensions, cm			Drainage	Tissue color, %		
	Length	Width	Depth		Red/Pink (Granulating)	Yellow (Slough)	Black (Eschar)
6/6/07	4.5	4.3	1.8	Copious, foul purulent	0	0	100
6/14/07	5.5	4.7	4.2		0	50	50
6/19/07	5.3	4.6	3.3	Moderate serosanguineous	20	80	0
6/22/07	5.1	4.4	4.0		90	10	0
6/29/07	5.1	4.5	3.2		100	0	0
7/7/07	3.9	3.5	2.9		98	2	0



The wound on 6/14/07



6/19/07



6/29/07



7/11/07

CONCLUSION

Here we have reported on the use of MIST Therapy for debridement and drainage reduction in 4 women and 2 men ranging in age from 55–85 years. MIST was administered for 2–5 weeks at the standard 2–3 times per week. Treatment durations (3–11 minutes, median 8 minutes) were longer than the typical 3–5 minutes seen with MIST Therapy due to larger wound surface areas.

In this series of patients whose care was complicated by extensive medical comorbidity and associated polypharmacy, administration of MIST Therapy appeared to reduce purulent drainage and assist with debridement to promote the development of granulation tissue. Over treatment periods ranging

from 2–5 weeks, our objective of full granulation was achieved. It is important to remember that complete wound closure was not expected to occur in these patients while in our care. The care plans for these patients included discharge to a more aggressive rehabilitation facility prior to complete closure.

We have found MIST Therapy very effective for assisting with debridement of wounds with significant amounts of necrotic tissue. In our experience, using MIST in coordination with sharp debridement (as able) greatly increases the rate of removal of necrotic tissue. As illustrated in this case series, signs and symptoms of topical wound infection (ie, odor and drainage) typically decrease after only 3–5 MIST sessions. The achievement of

90–100% granulation tissue appeared to coincide with improvements in exudate from copious and purulent to moderate and serosanguineous. Although others have reported reductions in wound pain associated with MIST Therapy, we could not assess wound pain due to neurologic and mental status complications. Most importantly, we have seen promising healing rates with MIST Therapy that typically would not be expected even with similarly aggressive plans of care. ■

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