Complex wounds treated with MatriStem xenograft material: case series and cost analysis

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Abstract

Introduction
Complex wounds remain challenging to treat and heal, and those that involve additional risk factors such as immunosuppression, tobacco abuse, Crohn’s disease, diabetes and obesity pose increased risks of delayed healing, non-healing, reoperation and re-infection. Treatment of wounds is often costly, involving materials, personnel and procedures. MatriStem (Acell Inc., Columbia, MD) is a regenerative extracellular matrix material derived from the porcine bladder that has shown efficacy in facilitating the healing of complex wounds. In this analysis, 10 diverse cases of complex wounds treated with periodic MatriStem application at a single institution are examined, and the materials costs of treatment are calculated. These costs are compared with comparable wound care materials costs at the same institution using what has to date been the conventional wound treatment protocol: negative pressure wound therapy.

Case series
We present 10 cases of complex wounds treated with MatriStem xenograft material in repeat applications until the wound was maximally healed. In each case presented, the original surgery involved placement of a MatriStem graft, and the costs of this graft are represented based upon hospital contracted pricing. In subsequent weeks, patients were treated with bedside or in-office additional MatriStem material, either in the form of ground powder or in the form of single-layer wound sheets. The costs of these materials are also depicted, based upon the payment schedule from our facility. An analysis of the cost of care is provided and compared with weekly costs of care in the same institution when conventional methods using negative pressure wound therapy is utilised.

Results
Using weekly MatriStem applications, each patient achieved healing of the wound without infection or complication, and the median treatment time was 11 weeks. The average cost of materials per week for healing these wounds using MatriStem is $152 per week. The costs of materials for negative pressure wound therapy calculated from the same contracted pricing agreements by the same institution are $501 per week. MatriStem wound treatment is less costly for this diverse set of 10 wounds on a weekly basis than treatment with negative pressure wound therapy. This holds true even when the cost of the initial graft is included in the analysis. Further discussion illuminates why labour, transportation and miscellaneous supply costs are also lower for MatriStem treatment when compared with negative pressure wound therapy.

Discussion
Treating complex wounds is a challenging and costly process. The use of MatriStem (Acell Corporation) has proven effective in achieving and accelerating wound healing in other studies. In this study, treatment of a diverse array of complex wounds resulted in successful clinical healing of the wounds without complications, re-infection or reoperation.

Conclusion
Patients undergoing wound care with MatriStem report satisfaction with reduced need for visits, eliminating the need for wearing or carrying a negative pressure wound therapy device, elimination of the need for dressing changes and reduced interactions with both the medical personnel and the wound itself. The costs of materials for the treatment of these wounds are substantially less on a per-week basis than the costs at the same institution when negative pressure wound therapy is utilised.

Introduction
Complex wounds remain challenging to treat and heal, and those that involve additional risk factors such as immunosuppression, tobacco abuse, Crohn’s disease, diabetes and obesity pose increased risks of delayed healing, non-healing, reoperation and re-infection. Treatment of wounds is often costly, involving materials, personnel and procedures. MatriStem (Acell Inc., Columbia, MD) is a regenerative extracellular matrix (ECM) material derived from porcine bladder that has shown efficacy in attracting progenitor stem cells to the wound, promoting and accelerating the healing of complex wounds. MatriStem material has been shown to exhibit anti-infective properties, and it is applied to complex open wounds with bedside or office weekly or biweekly application. Negative pressure wound therapy (NPWT) has grown from applications in venous stasis ulcers to a wide array of complex wounds in our institution and elsewhere. In this analysis, 10 diverse cases of complex wounds...
Case series

Case 1
FO is a 61-year-old male with diabetes and coronary artery disease who had struggled with a non-healing stage IV sacral decubitus ulcer for 3 months prior to consultation for advanced wound medicine. During the 3 months, he had undergone both topical wound care treatments and 7 weeks of NPWT without success. He was taken to surgery for an outpatient wound debridement procedure and placement of an initial three-layer MatriStem graft. In the course of 6 weeks, five additional treatments were performed in the office, with application of MatriStem powder (MicroMatrix), MatriStem Wound Matrix or both (Figures 1–3). The sacral wound healed completely in 6 weeks.

Case 2
SV is a 27-year-old male with complex pilonidal disease and recurrent abscesses. He underwent a wide excision procedure and the sacrococcygeal wound was left open. A three-layer MatriStem graft was placed at the time of the initial wide excision. Over the course of 9 weeks, seven additional applications of MatriStem powder or wound sheets were applied until total healing was achieved (Figures 4 and 5).

Case 3
RB is a 67-year-old male with a history of tobacco abuse and diabetes who developed acute superior mesenteric artery (SMA) embolus and required open surgical SMA embolectomy. He required reoperation in the early postoperative period due to abdominal wall dehiscence and evisceration. The large open abdominal wall wound was treated at this reoperation with MatriStem xenograft powder. Over the course of the next 3 months prior to consultation for advanced wound medicine. During the 3 months, he had undergone both topical wound care treatments and 7 weeks of NPWT without success. He was taken to surgery for an outpatient wound debridement procedure and placement of an initial three-layer MatriStem graft. In the course of 6 weeks, five additional treatments were performed in the office, with application of MatriStem powder (MicroMatrix), MatriStem Wound Matrix or both (Figures 1–3). The sacral wound healed completely in 6 weeks.
33 weeks, he returned for intermittent wound care and 14 additional MatriStem powder or wound sheet treatments, until the wound was completely healed (Figures 6 and 7).

Case 4
TF is a 34-year-old-obese female who developed pain, redness and swelling at the lateral aspect of her low transverse hysterectomy scar. A CT scan demonstrated a fluid collection, and at surgery, a deep subfascial abscess was drained. The open wound was treated with 500 mg of MatriStem powder and a 7 × 10 cm wound sheet. Five additional applications of MatriStem powder or wound sheet xenograft material were applied over the course of the next 7 weeks, at which point the wound was completely healed (Figures 8 and 9).

Case 5
MH is a 67-year-old female with Crohn's disease and multiple previous intestinal resections, incisional hernia repairs with mesh and an ileostomy. She developed purulent drainage from the midline scar and required abdominal wall excision of infected synthetic mesh and wound debridement for a complex abdominal wall abscess. Initial treatment included placement of MatriStem powder and a single-layer wound sheet. Fourteen treatments with powder or wound sheets and over the course of 27 weeks led to complete healing of the wound (Figures 10 and 11).

Case 6
JS is a 51-year-old female with Crohn's disease and previous colorectal surgery involving creation of a loop ileostomy that had developed severe ulceration, drainage and dermatitis around it. She underwent resection and closure of the loop ileostomy with concomitant MatriStem xenograft placement in the form of 500 mg of MicroMatrix powder. Over the ensuing 10 weeks, she returned to the office for a total of seven additional treatments with MatriStem powder until the wound was fully healed (Figures 12 and 13).

Case 7
JZ is a 73-year-old female with a history of an ascending colon carcinoma resected a year previously and who developed a right psoriasis and right flank soft tissue abscess stemming from an indolent anastomotic fistula. She underwent open resection of the anastomoses, debridement of the flank and abdominal wall abscesses, and placement of single-layer and powder MatriStem materials in the open right flank wound. Over the ensuing 12 weeks, she received eight additional treatments of MatriStem powder and/or single-layer wound sheets until the wound was completely healed (Figures 14 and 15).

Case 8
JP is a 68-year-old male with a history of tobacco abuse and severe hidradenitis suppurativa. After recurrent infections and procedures, a wide excision of the skin and affected soft tissue of the buttock, thigh and perirectal regions was performed with placement of single-layer MatriStem sheets and powder. A large, approximately 30 × 20 cm irregular soft tissue wound remained. Over the ensuing 16 weeks, 10 additional applications of single-layer sheets and powder facilitated complete healing of the wound.

Case 9
ER is an 81-year-old female with a recurrent invasive leiomyosarcoma involving the right scapula and the subcapsularis and intercostal muscles. After repeated wide resections and external beam radiation, she struggled with a 15 × 10 cm non-healing wound. It was treated with serial applications of MatriStem over the course of 12 weeks and healed to a superficial and non-tender area of 7 × 6 cm with lack of complete healing due to the presence of persistent tumour.

Case 10
CH is a 48-year-old male with severe faecal incontinence related to remote trauma and a permanent colostomy. He had developed a colostomy stoma with retraction and an obstructing parastomal hernia and underwent open laparotomy with colostomy takedown and relocation. The old ostomy site was closed at the fascial level and treated with MatriStem wound sheet and powder, partially approximated at the subcutaneous level and covered with a vaseline gauze and dressing. Over the next 4 weeks the ostomy site wound healed completely with the application of one additional treatment in the office of MatriStem powder.

Results
The mean time to healing for these complex wounds using weekly MatriStem xenograft material applications was 13.6 weeks, and the median time to healing was 11 weeks. No patient required reoperation and none developed infection. No patient required visiting nurses, home wound care, visits to additional wound Centres, or the need to wear or carry a device. The median cost for the material including the initial graft and subsequent office visits was $2128. The cost of materials per week for the MatriStem wound protocol was $156 (Table 1).

In the same centre, an analysis was undertaken to examine the costs of wound care materials using NPWT. Not including labour, the costs per week of material for the NPWT protocol, utilising three-times-per-week changes, for the small, medium, large and extra-large systems are $410, $433, $782 and $932 respectively (Table 2).

Based on the aggregate size measurements and the expertise of the wound care nursing staff at our institution, the 10 cases represented here would require initially two small NPWT systems, three large, one extra...
Case series

Figure 5: Pilonidal wound healed.

Figure 6: Midline wound.

Figure 7: Midline wound after partial healing.

Figure 8: Low transverse abdominal wound.

Figure 9: Low transverse wound partially healed.

Figure 10: Midline wound near ostomy.

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**Case series**

**Figure 11:** Midline wound near ostomy healing.

**Figure 12:** Stomal and peristomal wound in Crohn’s disease.

**Figure 13:** Stomal and peristomal wounds healed.

**Figure 14:** Flank wound.

**Figure 15:** Flank wound healed.

**Figure 16:** Colostomy closure wound.

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large and four medium systems. The mean weekly cost for NPWT at the onset would be $583 per week. Assuming that the size of the wound decreased over the weeks to the point at which six small systems and four medium systems were utilised, in the later weeks, the average cost per week would be $419. Using a blended average, an estimated aggregate cost per week for NPWT materials is $501 per week.

Discussion
In this study, treatment of a diverse array of complex wounds using MatriStem xenograft application resulted in successful clinical healing of the wounds without complications, re-infection or reoperation. The median cost of materials per week using MatriStem is significantly less than that of the costs per week using NPWT, based on contracted pricing within the same facility. Using the NPWT method, more visits and more personnel costs increase the overall cost burden, as NPWT normally averages three times per week in our centre. Utilising MatriStem instead, a weekly or even biweekly dressing change is performed at the bedside, in the wound clinic or in the physician’s office, usually by a mid-level practitioner. There appears to be little adverse consequence of less frequent treatment of the wounds when weekly MatriStem application is the intended treatment plan. Thus, less material and less manpower costs are utilised than with NPWT, with excellent wound healing results. A randomised, prospective, controlled trial comparing wound treatment protocols with NPWT versus MatriStem is the subject of an ongoing investigation at our centre.

The use of MatriStem (ACell Inc.) has proven effective in achieving and accelerating wound healing across an array of complex clinical situations. The unique features of the porcine urinary bladder ECM include its potent chemotactic effect for host progenitor stem cells and macrophage M2 subtypes believed to be essential for constructive remodelling of site-specific tissue.

Table 1 Wounds Treated

<table>
<thead>
<tr>
<th>Wound anatomy</th>
<th>Duration to healing (weeks)</th>
<th>Cost of initial graft ($)</th>
<th>Number of additional grafts</th>
<th>Cost of additional grafts ($)</th>
<th>Total cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sacrum</td>
<td>6</td>
<td>1480</td>
<td>5</td>
<td>1028</td>
<td>2508</td>
</tr>
<tr>
<td>2. Sacrococcygeal</td>
<td>9</td>
<td>640</td>
<td>7</td>
<td>1294</td>
<td>1934</td>
</tr>
<tr>
<td>3. Abdominal wall</td>
<td>33</td>
<td>2052</td>
<td>14</td>
<td>2101</td>
<td>4153</td>
</tr>
<tr>
<td>4. Abdominal wall</td>
<td>7</td>
<td>1364</td>
<td>5</td>
<td>855</td>
<td>2219</td>
</tr>
<tr>
<td>5. Abdominal wall</td>
<td>27</td>
<td>729</td>
<td>14</td>
<td>1308</td>
<td>2037</td>
</tr>
<tr>
<td>6. Peristomal</td>
<td>10</td>
<td>1121</td>
<td>7</td>
<td>814</td>
<td>1935</td>
</tr>
<tr>
<td>7. Flank</td>
<td>12</td>
<td>729</td>
<td>8</td>
<td>1135</td>
<td>1864</td>
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<tr>
<td>8. Buttock</td>
<td>16</td>
<td>2538</td>
<td>10</td>
<td>3457</td>
<td>5995</td>
</tr>
<tr>
<td>9. Scapula</td>
<td>12</td>
<td>486</td>
<td>10</td>
<td>2280</td>
<td>2766</td>
</tr>
<tr>
<td>10. Ostomy closure</td>
<td>4</td>
<td>597</td>
<td>1</td>
<td>228</td>
<td>825</td>
</tr>
</tbody>
</table>

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Conclusion
In this series, patients who have undergone treatment of their wounds using MatriStem xenograft material did not have to carry or wear cumbersome negative pressure devices or tubing. None of the patients needed to perform dressing care at home. None of the patients were required to make daily or frequent trips to a wound care centre. Nor did they have visiting nurses. Although this paper examines costs of the materials involved, it is worth noting that patients experience a lower burden of travel, intrusions, physical encumbrments and visits when using MatriStem for wound healing than they would using NPWT at this institution.

It should also be noted that one of the cases presented herein describe the administration of MatriStem xenograft material after failed efforts with NPWT. In Case 1, a sacral stage IV decubitus ulcer had been treated for 3 months with conventional treatments, including 7 weeks of NPWT without success. The xenograft application and subsequent treatments resulted in a completely healed wound within 6 weeks. Although it is difficult to generalise on cost savings across many wounds, this case does imply a significant cost savings in at least this individual with diabetes, heart disease, obesity and a refractory stage IV sacral decubitus ulcer when the treatment strategy shifted to the use of MatriStem, instead of NPWT. If such historical comparisons are representative measures, then wounds such as stage IV sacral decubitus wounds and necrocyo-geal wounds may achieve a shorter time to total healing over conventional methods including NPWT, which would further reduce the costs involved. However, even if the total time to heal was equivalent, the costs on a weekly basis would be less and the burden to the patient lower when the wound is treated with MatriStem xenograft weekly applications.

Abbreviations list
ECM, extracellular matrix; NPWT: negative pressure wound therapy; SMA, superior mesenteric artery.

Consent
Written informed consent was obtained from all patients for publication of this series study and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

References