The American Stem Cell Therapy Association

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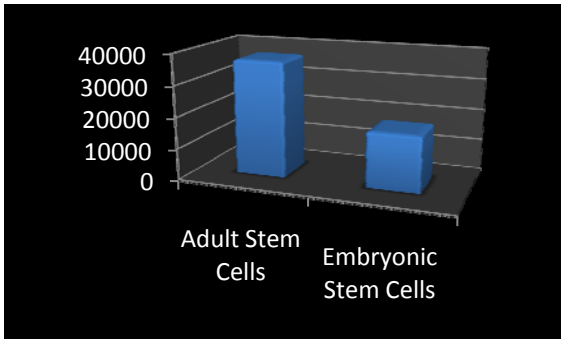
White Paper on Adult vs. Embryonic Stem Cells

Adult stem cell research made great strides vs. embryonic. Total research articles listed in the National Library of Medicine for major adult stem cell types vs. Embryonic (as of 5/6/09):



If we compare the National Library of Medicine searches for the following items:

- Cartilage Repair: 230 articles on embryonic vs. **1,113 for just one adult stem cell line** (mesenchymal stem cells)
- Myocardial Infarction: 186 for embryonic stem cells vs. **341 for adult mesenchymal stem cells, 69 for endothelial progenitor cells**
- Wound Healing: 114 for embryonic stem cells vs. **330 for adult mesenchymal stem cells, 565 for adult epithelial stem cells**

To delve further, the first 20 references for myocardial infarction for adult stem cells are almost all devoted to actual animal models of treatment, advanced concepts such as dosing, etc… Almost none of the 20 references in the same search for embryonic stem cells reveal any animal testing; the focus being review articles what about might be theoretically possible. **The conclusion, adult stem cells are much farther along in their development with regard to real world treatments.**

What have these actual animal and early human models shown that adult stem cells are capable of healing?

- Orthopedic tissues such as cartilage, bone, muscle, tendon, spinal disc, and ligament[1-25]
- Heart [26-40]
- Pancreas (Diabetes)[41-50]
- Wound Healing[51-61]

- Lungs[62-70]
- Brain (stroke, brain injury, Multiple Sclerosis, ALS)[71-94]
- Spinal Cord (Spinal Cord Injury)[95-99]
- Liver[100-110]
- Kidney[111-125]

1. Agung, M., et al., *Mobilization of bone marrow-derived mesenchymal stem cells into the injured tissues after intraarticular injection and their contribution to tissue regeneration.* Knee Surg Sports Traumatol Arthrosc, 2006. **14**(12): p. 1307-14.
2. Alhadlaq, A. and J.J. Mao, *Mesenchymal stem cells: isolation and therapeutics.* Stem Cells Dev, 2004. **13**(4): p. 436-48.
3. Ando, W., et al., *Cartilage repair using an in vitro generated scaffold-free tissue-engineered construct derived from porcine synovial mesenchymal stem cells.* Biomaterials, 2007. **28**(36): p. 5462-70.
4. Ando, W., et al., *In Vitro Generation of a Scaffold-Free Tissue-Engineered Construct (TEC) Derived from Human Synovial Mesenchymal Stem Cells: Biological and Mechanical Properties, and Further Chondrogenic Potential.* Tissue Eng Part A, 2008.
5. Barry, F.P., *Mesenchymal stem cell therapy in joint disease.* Novartis Found Symp, 2003. **249**: p. 86-96; discussion 96-102, 170-4, 239-41.
6. Bosnakovski, D., et al., *Chondrogenic differentiation of bovine bone marrow mesenchymal stem cells (MSCs) in different hydrogels: influence of collagen type II extracellular matrix on MSC chondrogenesis.* Biotechnol Bioeng, 2006. **93**(6): p. 1152-63.
7. Brisby, H., et al., *Cell therapy for disc degeneration--potentials and pitfalls.* Orthop Clin North Am, 2004. **35**(1): p. 85-93.
8. Bruder, S.P., D.J. Fink, and A.I. Caplan, *Mesenchymal stem cells in bone development, bone repair, and skeletal regeneration therapy.* J Cell Biochem, 1994. **56**(3): p. 283-94.
9. Caplan, A.I., *Mesenchymal stem cells.* J Orthop Res, 1991. **9**(5): p. 641-50.
10. Carter, D.R., et al., *Mechanobiology of skeletal regeneration.* Clin Orthop Relat Res, 1998(355 Suppl): p. S41-55.
11. Cassiede, P., et al., *Osteochondrogenic potential of marrow mesenchymal progenitor cells exposed to TGF-beta 1 or PDGF-BB as assayed in vivo and in vitro.* J Bone Miner Res, 1996. **11**(9): p. 1264-73.
12. Centeno, C.J., et al., *Regeneration of meniscus cartilage in a knee treated with percutaneously implanted autologous mesenchymal stem cells.* Med Hypotheses, 2008. **71**(6): p. 900-8.
13. Centeno, C.J., et al., *Increased knee cartilage volume in degenerative joint disease using percutaneously implanted, autologous mesenchymal stem cells.* Pain Physician, 2008. **11**(3): p. 343-53.
14. Dudics, V., et al., *Chondrogenic Potential of Mesenchymal Stem Cells from Patients with Rheumatoid Arthritis and Osteoarthritis: Measurements in a Microculture System.* Cells Tissues Organs, 2008.
15. Gao, J. and A.I. Caplan, *Mesenchymal stem cells and tissue engineering for orthopaedic surgery.* Chir Organi Mov, 2003. **88**(3): p. 305-16.
16. Ishii, I., et al., *Healing of full-thickness defects of the articular cartilage in rabbits using fibroblast growth factor-2 and a fibrin sealant.* J Bone Joint Surg Br, 2007. **89**(5): p. 693-700.

17. Koga, H., et al., *Local adherent technique for transplanting mesenchymal stem cells as a potential treatment of cartilage defect.* Arthritis Res Ther, 2008. **10**(4): p. R84.
18. Luyten, F.P., *Mesenchymal stem cells in osteoarthritis.* Curr Opin Rheumatol, 2004. **16**(5): p. 599-603.
19. Magne, D., et al., *Mesenchymal stem cell therapy to rebuild cartilage.* Trends Mol Med, 2005.
20. Murphy, J.M., et al., *Stem cell therapy in a caprine model of osteoarthritis.* Arthritis Rheum, 2003. **48**(12): p. 3464-74.
21. Noel, D., F. Djouad, and C. Jorgense, *Regenerative medicine through mesenchymal stem cells for bone and cartilage repair.* Curr Opin Investig Drugs, 2002. **3**(7): p. 1000-4.
22. Redman, S.N., S.F. Oldfield, and C.W. Archer, *Current strategies for articular cartilage repair.* Eur Cell Mater, 2005. **9**: p. 23-32; discussion 23-32.
23. Song, L., D. Baksh, and R.S. Tuan, *Mesenchymal stem cell-based cartilage tissue engineering: cells, scaffold and biology.* Cytotherapy, 2004. **6**(6): p. 596-601.
24. Uematsu, K., et al., *Cartilage regeneration using mesenchymal stem cells and a three-dimensional poly-lactic-glycolic acid (PLGA) scaffold.* Biomaterials, 2005. **26**(20): p. 4273-9.
25. Walsh, C.J., et al., *Meniscus regeneration in a rabbit partial meniscectomy model.* Tissue Eng, 1999. **5**(4): p. 327-37.
26. Chacko, S.M., et al., *Myocardial oxygenation and functional recovery in infarct rat hearts transplanted with mesenchymal stem cells.* Am J Physiol Heart Circ Physiol, 2009. **296**(5): p. H1263-73.
27. Chugh, A.R., E.K. Zuba-Surma, and B. Dawn, *Bone marrow-derived mesenchymal stems cells and cardiac repair.* Minerva Cardioangiol, 2009. **57**(2): p. 185-202.
28. Collins, J.M. and B. Russell, *Stem cell therapy for cardiac repair.* J Cardiovasc Nurs, 2009. **24**(2): p. 93-7.
29. Duffy, G.P., et al., *Bone Marrow DerivedMesenchymal Stem Cells Promote Angiogenic Processes in a Time and Dose Dependent Manner In Vitro.* Tissue Eng Part A, 2009.
30. Gnecchi, M., et al., *Early beneficial effects of bone marrow-derived mesenchymal stem cells overexpressing Akt on cardiac metabolism after myocardial infarction.* Stem Cells, 2009. **27**(4): p. 971-9.
31. Hare, J.M. and S.V. Chaparro, *Cardiac regeneration and stem cell therapy.* Curr Opin Organ Transplant, 2008. **13**(5): p. 536-42.
32. Hoogduijn, M.J., et al., *Donor-derived mesenchymal stem cells remain present and functional in the transplanted human heart.* Am J Transplant, 2009. **9**(1): p. 222-30.
33. Jin, J., et al., *Transplantation of mesenchymal stem cells within a poly(lactide-co-epsilon-caprolactone) scaffold improves cardiac function in a rat myocardial infarction model.* Eur J Heart Fail, 2009. **11**(2): p. 147-53.
34. Tan, M.Y., et al., *Repair of infarcted myocardium using mesenchymal stem cell seeded small intestinal submucosa in rabbits.* Biomaterials, 2009.
35. Vela, D.C., et al., *Histopathological study of healing after allogenic mesenchymal stem cell delivery in myocardial infarction in dogs.* J Histochem Cytochem, 2009. **57**(2): p. 167-76.
36. Wang, T., et al., *Mesenchymal stem cells improve outcomes of cardiopulmonary resuscitation in myocardial infarcted rats.* J Mol Cell Cardiol, 2009. **46**(3): p. 378-84.
37. Wang, Y.Q., et al., *Effect of transplanted mesenchymal stem cells from rats of different ages on the improvement of heart function after acute myocardial infarction.* Chin Med J (Engl), 2008. **121**(22): p. 2290-8.
38. Yang, X.J., et al., *Mesenchymal stem cells as a gene delivery system to create biological pacemaker cells in vitro.* J Int Med Res, 2008. **36**(5): p. 1049-55.
39. Yokokawa, M., et al., *Transplantation of mesenchymal stem cells improves atrioventricular conduction in a rat model of complete atrioventricular block.* Cell Transplant, 2008. **17**(10-11): p. 1145-55.

40. Zhu, H., et al., *Comparison of Intra-coronary Cell Transplantation after Myocardial Infarction: Autologous Skeletal Myoblasts versus Bone Marrow Mesenchymal Stem Cells.* J Int Med Res, 2009. **37**(2): p. 298-307.
41. Boumaza, I., et al., *Autologous bone marrow-derived rat mesenchymal stem cells promote PDX-1 and insulin expression in the islets, alter T cell cytokine pattern and preserve regulatory T cells in the periphery and induce sustained normoglycemia.* J Autoimmun, 2009. **32**(1): p. 33-42.
42. Chang, C., et al., *Mesenchymal stroma cells improve hyperglycemia and insulin deficiency in the diabetic porcine pancreatic microenvironment.* Cytotherapy, 2008. **10**(8): p. 796-805.
43. Liu, M. and Z.C. Han, *Mesenchymal stem cells: biology and clinical potential in type 1 diabetes therapy.* J Cell Mol Med, 2008. **12**(4): p. 1155-68.
44. Rosen, C.J., et al., *Marrow fat and the bone microenvironment: developmental, functional, and pathological implications.* Crit Rev Eukaryot Gene Expr, 2009. **19**(2): p. 109-24.
45. Shibata, T., et al., *Transplantation of bone marrow-derived mesenchymal stem cells improves diabetic polyneuropathy in rats.* Diabetes, 2008. **57**(11): p. 3099-107.
46. Sun, Y., et al., *Differentiation of bone marrow-derived mesenchymal stem cells from diabetic patients into insulin-producing cells in vitro.* Chin Med J (Engl), 2007. **120**(9): p. 771-6.
47. Urban, V.S., et al., *Mesenchymal stem cells cooperate with bone marrow cells in therapy of diabetes.* Stem Cells, 2008. **26**(1): p. 244-53.
48. Vija, L., et al., *Mesenchymal stem cells: Stem cell therapy perspectives for type 1 diabetes.* Diabetes Metab, 2009. **35**(2): p. 85-93.
49. Wu, X.H., et al., *Reversal of hyperglycemia in diabetic rats by portal vein transplantation of islet-like cells generated from bone marrow mesenchymal stem cells.* World J Gastroenterol, 2007. **13**(24): p. 3342-9.
50. Xu, Y.X., et al., *Mesenchymal stem cell therapy for diabetes through paracrine mechanisms.* Med Hypotheses, 2008. **71**(3): p. 390-3.
51. Garcia-Olmo, D., et al., *Expanded adipose-derived stem cells for the treatment of complex perianal fistula: a phase II clinical trial.* Dis Colon Rectum, 2009. **52**(1): p. 79-86.
52. Kwon, D.S., et al., *Treatment with bone marrow-derived stromal cells accelerates wound healing in diabetic rats.* Int Wound J, 2008. **5**(3): p. 453-63.
53. Lataillade, J.J., et al., *New approach to radiation burn treatment by dosimetry-guided surgery combined with autologous mesenchymal stem cell therapy.* Regen Med, 2007. **2**(5): p. 785-94.
54. Liu, P., et al., *Tissue-engineered skin containing mesenchymal stem cells improves burn wounds.* Artif Organs, 2008. **32**(12): p. 925-31.
55. Nambu, M., et al., *Accelerated wound healing in healing-impaired db/db mice by autologous adipose tissue-derived stromal cells combined with atelocollagen matrix.* Ann Plast Surg, 2009. **62**(3): p. 317-21.
56. Nie, C., D. Yang, and S.F. Morris, *Local delivery of adipose-derived stem cells via acellular dermal matrix as a scaffold: a new promising strategy to accelerate wound healing.* Med Hypotheses, 2009. **72**(6): p. 679-82.
57. Wu, Y., et al., *Bone marrow-derived stem cells in wound healing: a review.* Wound Repair Regen, 2007. **15 Suppl 1**: p. S18-26.
58. Yoshikawa, T., et al., *Wound therapy by marrow mesenchymal cell transplantation.* Plast Reconstr Surg, 2008. **121**(3): p. 860-77.
59. Cha, J. and V. Falanga, *Stem cells in cutaneous wound healing.* Clin Dermatol, 2007. **25**(1): p. 73-8.
60. Cho, H.J., et al., *Mobilized endothelial progenitor cells by granulocyte-macrophage colony-stimulating factor accelerate reendothelialization and reduce vascular inflammation after intravascular radiation.* Circulation, 2003. **108**(23): p. 2918-25.

61. Falanga, V., et al., *Autologous bone marrow-derived cultured mesenchymal stem cells delivered in a fibrin spray accelerate healing in murine and human cutaneous wounds.* Tissue Eng, 2007. **13**(6): p. 1299-312.
62. Iyer, S.S., C. Co, and M. Rojas, *Mesenchymal stem cells and inflammatory lung diseases.* Panminerva Med, 2009. **51**(1): p. 5-16.
63. Kumamoto, M., et al., *Minimally-cultured Bone Marrow mesenchymal stem cells ameliorate fibrotic lung injury.* Eur Respir J, 2009.
64. Mora, A.L. and M. Rojas, *Aging and lung injury repair: a role for bone marrow derived mesenchymal stem cells.* J Cell Biochem, 2008. **105**(3): p. 641-7.
65. Popov, B.V., et al., *Lung epithelial cells induce endodermal differentiation in mouse mesenchymal bone marrow stem cells by paracrine mechanism.* Tissue Eng, 2007. **13**(10): p. 2441-50.
66. Zhen, G., et al., *Mesenchymal stem cells transplantation protects against rat pulmonary emphysema.* Front Biosci, 2008. **13**: p. 3415-22.
67. Ortiz, L.A., et al., *Mesenchymal stem cell engraftment in lung is enhanced in response to bleomycin exposure and ameliorates its fibrotic effects.* Proc Natl Acad Sci U S A, 2003. **100**(14): p. 8407-11.
68. Rojas, M., et al., *Bone marrow-derived mesenchymal stem cells in repair of the injured lung.* Am J Respir Cell Mol Biol, 2005. **33**(2): p. 145-52.
69. Xu, J., et al., *Prevention of endotoxin-induced systemic response by bone marrow-derived mesenchymal stem cells in mice.* Am J Physiol Lung Cell Mol Physiol, 2007. **293**(1): p. L131-41.
70. Zhao, F., et al., *Therapeutic effects of bone marrow-derived mesenchymal stem cells engraftment on bleomycin-induced lung injury in rats.* Transplant Proc, 2008. **40**(5): p. 1700-5.
71. Andrews, E.M., et al., *Human adult bone marrow-derived somatic cell therapy results in functional recovery and axonal plasticity following stroke in the rat.* Exp Neurol, 2008. **211**(2): p. 588-92.
72. Danielyan, L., et al., *Intranasal delivery of cells to the brain.* Eur J Cell Biol, 2009. **88**(6): p. 315-24.
73. Hunt, D.P., et al., *Effects of direct transplantation of multipotent mesenchymal stromal/stem cells into the demyelinated spinal cord.* Cell Transplant, 2008. **17**(7): p. 865-73.
74. Keimpema, E., et al., *Early transient presence of implanted bone marrow stem cells reduces lesion size after cerebral ischaemia in adult rats.* Neuropathol Appl Neurobiol, 2009. **35**(1): p. 89-102.
75. Lee, P.H., et al., *Autologous mesenchymal stem cell therapy delays the progression of neurological deficits in patients with multiple system atrophy.* Clin Pharmacol Ther, 2008. **83**(5): p. 723-30.
76. Li, N., X.R. Li, and J.Q. Yuan, *Effects of bone-marrow mesenchymal stem cells transplanted into vitreous cavity of rat injured by ischemia/reperfusion.* Graefes Arch Clin Exp Ophthalmol, 2009. **247**(4): p. 503-14.
77. Liu, Y.P., et al., *The potential of neural stem cells to repair stroke-induced brain damage.* Acta Neuropathol, 2009. **117**(5): p. 469-80.
78. Pavlichenko, N., et al., *Mesenchymal stem cells transplantation could be beneficial for treatment of experimental ischemic stroke in rats.* Brain Res, 2008. **1233**: p. 203-13.
79. Skvortsova, V.I., et al., *Use of bone marrow mesenchymal (stromal) stem cells in experimental ischemic stroke in rats.* Bull Exp Biol Med, 2008. **145**(1): p. 122-8.
80. Wilkins, A., et al., *Human bone marrow-derived mesenchymal stem cells secrete brain-derived neurotrophic factor which promotes neuronal survival in vitro.* Stem Cell Res, 2009.
81. Yoo, S.W., et al., *Mesenchymal stem cells promote proliferation of endogenous neural stem cells and survival of newborn cells in a rat stroke model.* Exp Mol Med, 2008. **40**(4): p. 387-97.
82. Bai, L., et al., *Human bone marrow-derived mesenchymal stem cells induce Th2-polarized immune response and promote endogenous repair in animal models of multiple sclerosis.* Glia, 2009.

83. Dazzi, F., et al., *Cell therapy for autoimmune diseases.* Arthritis Res Ther, 2007. **9**(2): p. 206.
84. Ferrero, I., et al., *Bone marrow mesenchymal stem cells from healthy donors and sporadic amyotrophic lateral sclerosis patients.* Cell Transplant, 2008. **17**(3): p. 255-66.
85. Ikehara, S., *Bone marrow transplantation: a new strategy for intractable diseases.* Drugs Today (Barc), 2002. **38**(2): p. 103-11.
86. Mohyeddin Bonab, M., et al., *Does mesenchymal stem cell therapy help multiple sclerosis patients? Report of a pilot study.* Iran J Immunol, 2007. **4**(1): p. 50-7.
87. Boucherie, C., et al., *In vitro evidence for impaired neuroprotective capacities of adult mesenchymal stem cells derived from a rat model of familial amyotrophic lateral sclerosis (hSOD1(G93A)).* Exp Neurol, 2008. **212**(2): p. 557-61.
88. Kaspar, B.K., *Mesenchymal stem cells as trojan horses for GDNF delivery in ALS.* Mol Ther, 2008. **16**(12): p. 1905-6.
89. Mazzini, L., et al., *Stem cell therapy in amyotrophic lateral sclerosis: a methodological approach in humans.* Amyotroph Lateral Scler Other Motor Neuron Disord, 2003. **4**(3): p. 158-61.
90. Mazzini, L., et al., *Autologous mesenchymal stem cells: clinical applications in amyotrophic lateral sclerosis.* Neurol Res, 2006. **28**(5): p. 523-6.
91. Mazzini, L., et al., *Stem cell treatment in Amyotrophic Lateral Sclerosis.* J Neurol Sci, 2008. **265**(1-2): p. 78-83.
92. Mazzini, L., et al., *Mesenchymal stem cells for ALS patients.* Amyotroph Lateral Scler, 2009. **10**(2): p. 123-4.
93. Suzuki, M., et al., *Direct muscle delivery of GDNF with human mesenchymal stem cells improves motor neuron survival and function in a rat model of familial ALS.* Mol Ther, 2008. **16**(12): p. 2002-10.
94. Vercelli, A., et al., *Human mesenchymal stem cell transplantation extends survival, improves motor performance and decreases neuroinflammation in mouse model of amyotrophic lateral sclerosis.* Neurobiol Dis, 2008. **31**(3): p. 395-405.
95. Carvalho, K.A., et al., *Functional outcome of bone marrow stem cells (CD45(+)/CD34(-)) after cell therapy in chronic spinal cord injury in Wistar rats.* Transplant Proc, 2008. **40**(3): p. 845-6.
96. Hardy, S.A., D.J. Maltman, and S.A. Przyborski, *Mesenchymal stem cells as mediators of neural differentiation.* Curr Stem Cell Res Ther, 2008. **3**(1): p. 43-52.
97. Lee, K.H., et al., *Human mesenchymal stem cell transplantation promotes functional recovery following acute spinal cord injury in rats.* Acta Neurobiol Exp (Wars), 2007. **67**(1): p. 13-22.
98. Parr, A.M., et al., *Transplanted adult spinal cord-derived neural stem/progenitor cells promote early functional recovery after rat spinal cord injury.* Neuroscience, 2008. **155**(3): p. 760-70.
99. Urdzikova, L., et al., *Transplantation of bone marrow stem cells as well as mobilization by granulocyte-colony stimulating factor promotes recovery after spinal cord injury in rats.* J Neurotrauma, 2006. **23**(9): p. 1379-91.
100. Abdel Aziz, M.T., et al., *Therapeutic potential of bone marrow-derived mesenchymal stem cells on experimental liver fibrosis.* Clin Biochem, 2007. **40**(12): p. 893-9.
101. Choi, D., et al., *Hepatocyte-like cells from human mesenchymal stem cells engrafted in regenerating rat liver tracked with in vivo magnetic resonance imaging.* Tissue Eng Part C Methods, 2008. **14**(1): p. 15-23.
102. Conigliaro, A., et al., *Isolation and characterization of a murine resident liver stem cell.* Cell Death Differ, 2008. **15**(1): p. 123-33.
103. Dai, L.J., et al., *The therapeutic potential of bone marrow-derived mesenchymal stem cells on hepatic cirrhosis.* Stem Cell Res, 2009. **2**(1): p. 16-25.
104. Flohr, T.R., et al., *The use of stem cells in liver disease.* Curr Opin Organ Transplant, 2009. **14**(1): p. 64-71.

105. Miyazaki, M., et al., *Isolation of a bone marrow-derived stem cell line with high proliferation potential and its application for preventing acute fatal liver failure.* Stem Cells, 2007. **25**(11): p. 2855-63.
106. Najimi, M., et al., *Adult-derived human liver mesenchymal-like cells as a potential progenitor reservoir of hepatocytes?* Cell Transplant, 2007. **16**(7): p. 717-28.
107. Stock, P., et al., *Hepatocytes derived from adult stem cells.* Transplant Proc, 2008. **40**(2): p. 620-3.
108. van Poll, D., et al., *Mesenchymal stem cell-derived molecules directly modulate hepatocellular death and regeneration in vitro and in vivo.* Hepatology, 2008. **47**(5): p. 1634-43.
109. Xu, Y.Q. and Z.C. Liu, *Therapeutic potential of adult bone marrow stem cells in liver disease and delivery approaches.* Stem Cell Rev, 2008. **4**(2): p. 101-12.
110. Yovchev, M.I., et al., *Identification of adult hepatic progenitor cells capable of repopulating injured rat liver.* Hepatology, 2008. **47**(2): p. 636-47.
111. Bussolati, B. and G. Camussi, *Adult stem cells and renal repair.* J Nephrol, 2006. **19**(6): p. 706-9.
112. Bussolati, B., et al., *Contribution of stem cells to kidney repair.* Curr Stem Cell Res Ther, 2009. **4**(1): p. 2-8.
113. Bussolati, B., C. Tetta, and G. Camussi, *Contribution of stem cells to kidney repair.* Am J Nephrol, 2008. **28**(5): p. 813-22.
114. Cavaglieri, R.C., et al., *Mesenchymal stem cells delivered at the subcapsule of the kidney ameliorate renal disease in the rat remnant kidney model.* Transplant Proc, 2009. **41**(3): p. 947-51.
115. Chen, J., et al., *Kidney-derived mesenchymal stem cells contribute to vasculogenesis, angiogenesis and endothelial repair.* Kidney Int, 2008. **74**(7): p. 879-89.
116. Chhabra, P. and K.L. Brayman, *The use of stem cells in kidney disease.* Curr Opin Organ Transplant, 2009. **14**(1): p. 72-8.
117. Choi, S., et al., *The role of mesenchymal stem cells in the functional improvement of chronic renal failure.* Stem Cells Dev, 2009. **18**(3): p. 521-9.
118. Fang, B., et al., *Using human adipose tissue-derived mesenchymal stem cells as salvage therapy for hepatic graft-versus-host disease resembling acute hepatitis.* Transplant Proc, 2007. **39**(5): p. 1710-3.
119. Hopkins, C., et al., *Stem cell options for kidney disease.* J Pathol, 2009. **217**(2): p. 265-81.
120. Jung, S.I., et al., *In vivo MR imaging of magnetically labeled mesenchymal stem cells in a rat model of renal ischemia.* Korean J Radiol, 2009. **10**(3): p. 277-84.
121. Kunter, U., et al., *Mesenchymal stem cells prevent progressive experimental renal failure but maldifferentiate into glomerular adipocytes.* J Am Soc Nephrol, 2007. **18**(6): p. 1754-64.
122. McTaggart, S.J. and K. Atkinson, *Mesenchymal stem cells: immunobiology and therapeutic potential in kidney disease.* Nephrology (Carlton), 2007. **12**(1): p. 44-52.
123. Qian, H., et al., *Bone marrow mesenchymal stem cells ameliorate rat acute renal failure by differentiation into renal tubular epithelial-like cells.* Int J Mol Med, 2008. **22**(3): p. 325-32.
124. Sun, J.H., et al., *MR tracking of magnetically labeled mesenchymal stem cells in rat kidneys with acute renal failure.* Cell Transplant, 2008. **17**(3): p. 279-90.
125. Yokoo, T., T. Kawamura, and E. Kobayashi, *Stem cells for kidney repair: useful tool for acute renal failure?* Kidney Int, 2008. **74**(7): p. 847-9.