

3.6 HEMODİNAMİK VE VAZOPRESSÖR YÖNETİM

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Karaciğer, vücuttaki en büyük organlardan biri olup kardiyak debinin %25'ini almaktadır. Bu debinin %70-75'i portal ven aracılığıyla, geri kalan %25-30'u ise hepatik arter aracılığıyla sağlanır ^(1,2). Son evre karaciğer hastalığında (ESLD), belirgin şekilde artmış kardiyak debi ve azalmış sistemik vasküler direnç (SVR) ile karakterize hiperdinamik dolaşım, ilk olarak 1950'lerin başlarında Kowalski ve Abelman tarafından tanımlanmıştır ⁽³⁾. Bu fenomenin patofizyolojisi, aşırı aktif sempatik sinir sistemi, hastalıklı karaciğerin vazoaaktif maddeleri yeterince temizleyememesi, arteriyovenöz şantlar, nitrik oksit aracılı vazodilatasyon ve periferik dokularda göreceli hipoksi gibi faktörlere bağlanmıştır ⁽⁴⁻⁸⁾. SVR'deki bu belirgin azalmaya bağlı gelişen hemodinamik bozukluğu düzeltmek için bu hastalara yüksek miktarlarda intravenöz sıvı verilmesini gerekebilir ^(9,10). SVR'deki bu belirgin azalmaya neden, başlıca nitrik oksit (NO) ile ilişkilendirilmiştir ⁽¹¹⁾. NO ve endokannabinoidler negatif inotropik etkiye de sahiptirler ⁽¹²⁾. Hastalıklı karaciğerin endojen östrojenleri metabolize edememesinin de bu patofizyolojide rol oynadığı düşünülmektedir ^(13,14).

Endojen NO ve kanabinoidlerin her ikisi de guanilat siklaz sistemi aracılığıyla etki göstererek vazodilatasyona neden olur ^(15,16). Ayrıca ESLD kardiyak kontraktilite de azalmaya neden olmaktadır ^(17,18). Vazoaaktif mediyatörler, hepatik klirensin bozulması nedeniyle sistemik dolaşıma karışarak sekonder

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**Tablo 3.6.1 Vazoaktif ilaçların etkiledikleri reseptörler ve dozları**

İlaç	Doz aralığı	$\alpha 1$	$\beta 1$	$\beta 2$	DA	V1 v2
Dopamin	2.0 ile 20 $\mu\text{g kg}^{-1} \text{dak}^{-1}$ max 50 $\mu\text{g kg}^{-1} \text{min}^{-1}$	+++	+++++	++	+++++	
Dobutamin	2.0 ile 20 $\mu\text{g kg}^{-1} \text{dak}^{-1}$ Max 40 $\mu\text{g kg}^{-1} \text{min}^{-1}$	+	+++++	+++		
Norepinefrin	0.01 ile 3 $\mu\text{g kg}^{-1} \text{dak}^{-1}$	+++++	+++	++		
Epinefrin	0.01 ile 0.10 $\mu\text{g kg}^{-1} \text{dak}^{-1}$ max 0.2 mg/kg	+++++	++++	+++		
Fenilefrin	ile 05 mg IV bolus her 10-15 dakika ara ile İnfüzyon 0.4 ile 9.1 $\mu\text{g kg}^{-1} \text{dak}^{-1}$	+++++				
Efedrin		+	+			
Vazopressin	ile 0.1 U dak-1 bolus: 40U dak-1					+

KAYNAKLAR

1. Fede G, Privitera G, Tomaselli T, Spadaro L, Purrello F. Cardiovascular dysfunction in patients with liver cirrhosis. *Ann Gastroenterol.* 2015;28(1):31-40.
2. Siniscalchi A, Aurini L, Spedicato S. Hyperdynamic circulation in cirrhosis: Predictive factors and outcome following liver transplantation. *Minerva Anesthesiol.* 2013;79(1):15-23.
3. Kowalski HJ, Abelman WH. The cardiac output at rest in Laennec's cirrhosis. *J Clin Invest.* 1953; 32:1025-1033.
4. Benoit JN, Barrowman JA, Harper SL, Kviety PR, Granger DN. Role of humoral factors in the intestinal hyperemia associated with chronic portal hypertension. *Am J Physiol.* 1984; 247: G486-G493.
5. D'Souza MG, Plevak DJ, Kvols L, et al. Elevated neuropeptide levels decrease during liver transplant. *Transplant Proc.* 1993;25:1805-1806.
6. Kalb TH, Walter M, Mayer M, et al. Intra-allograft production and systemic release of tumor necrosis factor-alpha: detection upon reperfusion. *Transplant Proc.* 1993;25:1817-1818
7. Yokoyama I, Todo S, Miyata T Selby R, Tzakis AG, Starzl TE. Endotoxemia and human liver transplantation. *Transplant Proc.* 1989;21:3833-3841
8. Barron HV, Alam L, Lesh MD, Strunk A, Bass NM. Autonomic nervous system tone measured by baroreflex sensitivity is depressed in patients with end-stage liver disease. *Am J Gastroenterol.* 1999;94:986-989.
9. Kuo PC, Schroeder RA, Vagelos RH, et al. Volume-mediated pulmonary responses in liver transplant candidates. *Clin Transplant.* 1996;10:521 - 527.
10. Henderson JM, Gilmore GT, Mac Kay GJ Galloway JR, Dodson TE, Kutner MH. I-hemodynamics during liver transplantation: The interactions between cardiac output and portal venous and hepatic arterial flows. *Hepatology.* 1992;16:715 - 718.
11. Smith RE, Robinson NM, McPeake JR, et al. Induction and role of NO synthase in hypotensive hepatic failure. *Arterioscler Thromb Vasc Biol.* 1997;17:3079-3082.
12. Snipelisky DF, McRee C, Seeger K, Levy M, Shapiro BP. Coronary interventions before liver transplantation might not avert postoperative cardiovascular events. *Tex Heart Inst J.* 2015;42(5):438-42.



13. Mushlin PS, Gelman S. Anesthesia and the liver. In: Barash PS, Cullen BF, Stoelting RK, eds. *ClinicalAnesthesia. Clinical therapeutics* 4th ed. Philadelphia, Pa: Lippincott Williams & Wilkins; 2001:1067-1101.
14. Moezi L, Gaskari SA, Lee SS. Endocannabinoids and Liver Disease. Endocannabinoids as mediators of vascular and cardiac abnormalities in cirrhosis. *Am J Physiol Gastrointest Liver Physiol*. 2008;295(4):G649-53.
15. Speziale G, Ruvolo G, Marino B. A role for nitric oxide in the vasoplegic syndrome. *J Cardiovasc Surg (Torino)* 1996;37:301-3.
16. Jones JD, Carney ST, Vrana KE, Norford DC, Howlett AC. Cannabinoid receptor-mediated translocation of NO-sensitive guanylyl cyclase and production of cyclic GMP in neuronal cells. *Neuropharmacology*. 2008;54:23-30
17. Hori N, Okanoue T, Mori T, et al. Endogenous nitric oxide production is augmented as the severity advances in patients with liver cirrhosis. *Clin Exp Pharmacol Physiol*. 1996;23:30-5.
18. Batkai S, Pacher P. Endocannabinoids and cardiac contractile function: pathophysiological implications. *Pharmacol Res*. 2009;60:99-106.
19. Wray CL. Advances in the anesthetic management of solid organ transplantation. *Adv Anesth*. 2017;35(1):95-117.
20. Lee SS. Cardiac abnormalities in liver cirrhosis. *West J Med*. 1989;151:530-535.
21. Ripoll C, Yotti R, Bermejo J, Banares R. The heart in liver transplantation. *J Hepatol*. 2011;54:810-22.
22. Stekiel TA, Stekiel WJ, Bosnjak ZJ. The peripheral vasculature: Control and anesthetic actions. In: Yaksh TL, Lynch C, Zapol W, et al, eds. *Anesthesia: Biologic Foundations*. 1 st ed. Philadelphia, Pa: Lippincott – Raven; 1998:1135-1168.
23. Hannaman MJ, Hevesi ZG. Anesthesia care for liver transplantation. *Transplant Rev (Orlando)*. 2011;25(1):36-43.
24. Clevenger B, Mallett VS. Transfusion and coagulation management in liver transplantation. *World J Gastroenterol*. 2014;20(20):6146-58.
25. Vitin AA, Tomescu D, Azamfirei L. Hemodynamic Optimization Strategies in Anesthesia Care for Liver Transplantation. *Liver Cirrhosis*. 2017;9:173-195.
26. Vater Y, Levy A, Martay K, Hunter C, Weinbroum AA. Adjuvant drugs for end-stage liver failure and transplantation. *Med Sci Monit*. 2004;10(4):RA77-RA88.
27. Shangarw RE, Rabkin JM, Lopaschuk GD (1998) Hepatic pyruvate dehydrogenase activity in humans: effect of cirrhosis, transplantation, and dichloroacetate. *Am J Physiol*. 1998;274: G569-577.
28. Chrusch C, Bands C, Bose D, et al. Impaired hepatic extraction and increased splanchnic production contribute to lactic acidosis in canine sepsis. *Am J Respir Crit Care Med*. 200;161: 517-526.
29. Gregory JS, Bonfiglioglio MF, Dasta JF, et al. Experience with phenylephrine as a component of the pharmacological support of septic shock. *Crit Care Med*. 1991;19: 1395-1400.
30. Menon KVN, Kamath PS. Managing the complications of cirrhosis. *Mayo Clin Proc* 2000;75:501-509.
31. Dalal A, Lang JD. Anesthetic Considerations for Patients with Liver Disease, Hepatic Surgery. In: Abdeldayem H, eds. *Hepatic Surgery*. Ebook. 2013:61-81. <https://www.intechopen.com/chapters/42362>.
32. Schumann R, Mandell MS, Mercaldo N, et al. Anesthesia for liver transplantation in United States academic centers: intraoperative practice. *J Clin Anesth*. 2013;25: 542-50.
33. Massicotte L, Perrault MA, Denault AY, et al. Effects of phlebotomy and phenylephrine infusion on portal venous pressure and systemic hemodynamics during liver transplantation. *Transplantation*. 200;89:920-927.



34. Schroeder RA, Collins BH, Tuttle-Newhall E, et al. Intraoperative fluid management during orthotopic liver transplantation. *J Cardiothorac Vasc Anesth* 2004;18:438e41.
35. Massicotte L, Lenis S, Thibeault L, Sassine MP, Seal RF, Roy A. Effect of low central venous pressure and phlebotomy on blood product transfusion requirements during liver transplantations. *Liver Transpl*; 2006 Jan;12(1):117-23.
36. Xiao ZF, Zhu XS. Effects of low central venous pressure during preanhepatic phase on blood loss and liver and renal function in liver transplantation. *World J Surg*. 2010;34:1864e73.
37. Massicotte L, Carrier FM, Denault AY, et al. Development of a predictive model for blood transfusions and bleeding during liver transplantation. *J Cardiothorac Vasc Anesth*. 2018;32:1722e30.
38. Wang B, Bo HH. Effect of low central venous pressure on postoperative pulmonary complications in patients undergoing liver transplantation. *Surg Today*. 2013;43:777e81.
39. Massicotte L, Thibeault L, Roy A. Classical notions of coagulation revisited in relation with blood losses, transfusion rate for 700 consecutive liver transplantations. *Semin Thromb Hemost*. 2015;1:538e46.
40. Surgery LT. Restricted crystalloid fluid therapy during orthotopic liver transplant surgery and its effect on respiratory and renal insufficiency in the early post-operative period: a randomized clinical trial. *Int J Organ Transpl Med*. 2014;5:113e9.
41. Melendez JA, Arslan V, Fischer ME et al (1998) Perioperative outcomes of major hepatic resections under low central venous pressure anesthesia: blood loss, blood transfusion, and the risk of postoperative renal dysfunction. *J Am Coll Surg*. 1998;187:620–625
42. Weiskopf RB. Catecholamine-induced changes in the splanchnic circulation affecting. *Systemic Hemodynamics*. 2004: 434e9 (2).
43. Bennett TD, MacAnespie CL, Rothe CF. Active hepatic capacitance responses to neural and humoral stimuli in dogs. *Am J Physiol* 1982;242:H1000e9.
44. Rutlen DL, Supple EW, Powell WJ. Adrenergic regulation of total systemic distensibility. Venous distensibility effects of norepinephrine and isoproterenol before and after selective adrenergic blockade. *Am J Cardiol*. 1981;47:579e88.
45. Richardson PD. Physiological regulation of the hepatic circulation. *Fed Proc*. 1982;41:2111e6.
46. Mehrabi A, Golling M, Kashfi A et al (2005) Negative impact of systemic catecholamine administration on hepatic blood perfusion after porcine liver transplantation. *Liver Transpl*. 11:174–187.
47. Bakovic D, Pivac N, Eterovic D, et al. The effects of low-dose epinephrine infusion on spleen size, central and hepatic circulation and circulating platelets. *Clin Physiol Funct Imaging*. 2013;33(1):30e7.
48. Liang TB, Li DL, Liang Letal (2008) Intraoperative blood salvage during liver transplantation in patients with hepatocellular carcinoma: efficiency of leukocyte depletion filters in the removal of tumor cells. *Transplantation* 85:863–869.
49. Kang Y, Elia E. Anesthesia Management of Liver Transplantation. *Contemporary Liver Transplantation*. 2016;22:143–87.
50. Pappas G, Palmer WM, Martineau GL, Halgrimson CG, Penn I, Groth CG, Starzl TE. Hemodynamic changes in clinical orthotopic liver transplantation. *Surg Forum*. 1971;22:335-6.
51. Aggarwal S, Kang Y, Freeman JA, Fortunato FL Jr, Pinsky MR. Postreperfusion syndrome: hypotension after reperfusion of the transplanted liver. *J Crit Care*. 1993 Sep;8(3):154-60.
52. Ellis JE, Lichtor JL, Feinstein SB, et al. Right heart dysfunction, pulmonary embolism, and paradoxical embolization during liver transplantation. A transesophageal two-dimensional echocardiographic study. 1989; *Anesth Analg* 68:777–782
53. Suriani RJ, Cutrone A, Feerman D, Konstadt S. et al. Intraoperative transesophageal echocardiography during liver transplantation. *J Cardiothorac Vasc Anesth*. 1996;10:699–707.



54. Martin D. Fluid and electrolyte balance during liver transplantation. In: Winter PM, Kang YG, eds. Hepatic transplantation, anesthetic and perioperative management. Prager, Philadelphia. 1986.
55. Fayed N, Refaat EK, Yassein TE, Alwaraqy M. Effect of perioperative terlipressin infusion on systemic, hepatic, and renal hemodynamics during living donor liver transplantation. *J Crit Care*. 2013 Oct;28(5):775-82.
56. Wagener G, Gubitosa G, Renz J, et al. Vasopressin decreases portal vein pressure and flow in the native liver during liver transplantation. *Liver Transpl*. 2008;14:1664-1670
57. Cywinski JB, Mascha E, You J, et al. Central venous pressure during the post-anhepatic phase is not associated with early postoperative outcomes following orthotopic liver transplantation. *Minerva Anestesiol* 2010;76:795e804
58. Abel JJ, Taveau RD. On the decomposition products of epinephrine hydrate. *J Biol Chem*. 1905;1:1-32
59. Barger G, Dale HH. Chemical structure and sympathomimetic action of amines. *J Physiol*. 1910;41:19-59.
60. Tilley DG, Rockman HA. Role of beta-adrenergic receptor signaling and desensitization in heart failure: new concepts and prospects for treatment. *Expert Rev Cardiovasc Ther*. 2006;4:417-432.
61. Vincent JL, De Backer D. Circulatory shock. *N Engl J Med* 2013; 369: 1726-34.
62. Fellahi JL, Fischer MO, Daccache G, Gerard JL, Hanouz JL. Positive inotropic agents in myocardial ischemia-reperfusion injury: a benefit/risk analysis. *Anesthesiology* 2013; 118: 1460-5
63. Bangash MN, Kong ML, Pearse RM. Use of inotropes and vasopressor agents in critically ill patients. *Br J Pharmacol* 2012; 165: 2015-33
64. Li HT, Long CS, Rokosh DG, Honbo NY, Karliner JS. Chronic hypoxia differentially regulates 1-adrenergic receptor subtype mRNAs and inhibits 1-adrenergic receptor-stimulated cardiac hypertrophy and signaling. *Circulation*. 1995;92:918-925.
65. Modest VE, Butterworth JF IV. Effect of pH and lidocaine on beta adrenergic receptor binding: interaction during resuscitation? *Chest*. 1995;108:1373-1379.
66. Levy B, Collin S, Sennoun N, Ducrocq N, et al. Vascular hypo responsiveness to vasopressors in septic shock: From bench to bedside. *Intensive Care Medicine*. 2010;36:2019-2029
67. Nahas GG, Sutin KM, Fermon C, et al. Guidelines for the treatment of acidemia with THAM. *Drugs*. 1998;55(2):191-224.
68. Levy B, Fritz C, Tahon E, Jacquot A, Auchet T, Kimmoun A. Vasoplegia treatments: The past, the present, and the future. *Critical Care*. 2018;22(1):52.
69. Busse LW, Barker N, Petersen C. Vasoplegic syndrome following cardiothoracic surgery-review of pathophysiology and update of treatment options. *Crit Care* 2020;24(1):36.
70. Fischer, W, Bengtsson Y, Scarola S, Cohen E. Methylene Blue for vasopressor-resistant vasoplegia syndrome during liver transplantation. *Journal of Cardiothoracic & Vascular Anesthesia*. 2010 June;24(3):463-466.
71. Landry DW, Oliver JA. The pathogenesis of vasodilatory shock. *N Engl J Med*. 2001;345:588-595.
72. Bukowicka B, Akar RA, Olszewska A, Smoter P, Krawczyk M. The occurrence of postreperfusion syndrome in orthotopic liver transplantation and its significance in terms of complications and short-term survival. *Ann Transplant*. 2011;16:26-30.
73. Chui AK, Shi L, Tanaka K, et al. Postreperfusion syndrome in orthotopic liver transplantation. *Transplant Proc*. 2000;32:2116-2117.
74. Hilmi I, Horton CN, Planinsic RM, et al. The impact of postreperfusion syndrome on short-term patient and liver allograft outcome in patients undergoing orthotopic liver transplantation. *Liver Transpl*. 2008;14:504-508.
75. Ryu HG, Jung CW, Lee CS, Lee J. Nafamostat mesilate attenuates postreperfusion syndrome during liver transplantation. *Am J Transplant*. 2011;11:977-983.



76. Daniela K, Michael Z, Florian I, Silvia S, Estrella J, Doris D, Karl-Heinz T. Influence of retrograde flushing via the caval vein on the post-reperfusion syndrome in liver transplantation. *Clin Transplant*. 2004;18:638-641.
77. Gruttadauria S, Cintonino D, Musumeci A, et al. Comparison of two different techniques of reperfusion in adult orthotopic liver transplantation. *Clin Transplant*. 2006;20:159-162.
78. Ayanoglu HO, Ulukaya S, Tokat Y. Causes of postreperfusion syndrome in living or cadaveric donor liver transplantations. *Transplant Proc*. 2003; 35: 1442-1444.
79. Hudcova J, Ruthazer R, Bonney I, Schumann R. Sodium homeostasis during liver transplantation and correlation with outcomes. *Anesth Analg*. 2014; 119: 1420-8.
80. Deshpande R, Chadha RM, Doane MA, Poon C. Anaesthesia for Orthotopic Liver Transplantation
81. Fiegel M, Cheng S, Zimmerman M, Seres T, Weitzel NS. Postreperfusion syndrome during liver transplantation. *Semin Cardiothorac Vasc Anesth*. 2012; 16: 106-13.
82. Jones CJ, DeFily DV, Patterson JL, Chilian WM. Endothelium-dependent relaxation competes with 1- and 2-adrenergic constriction in the canine epicardial coronary microcirculation. *Circulation*. 1993;87:1264-1274.
83. Regueira T, Bänziger B, Djafarzadeh S, et al. Norepinephrine to increase blood pressure in endotoxaemic pigs is associated with improved hepatic
84. Takashi M, Hilmi IA, Planinsic RM, Humar A, Sakai A. Cardiac arrest during adult liver transplantation: A single institution's experience with 1238 deceased donor transplants. *Liver Transplantation*. 2012;18:1430-1439
85. Williams JW, Vera S, Peters TG, et al. Cholestatic jaundice after hepatic transplantation. An immunologically mediated event. *Am J Surg*. 1986; 151: 65-70.
86. Tune JD, Richmond KN, Gorman MW, Feigl EO. Control of coronary blood flow during exercise. *Exp Biol Med* (Maywood). 2002;227: 238-250.
87. Holmes CL. Vasoactive drugs in the intensive care unit. *Curr Opin Crit Care* 2005;11:413-7.
88. Hernandez G, Bruhn A, Romero C, et al. Management of septic shock with a norepinephrine-based haemodynamic algorithm. *Resuscitation*. 2005 Jul;66(1):63-9.
89. Martin C, Viviani X, Leone M, Thirion X. Effect of norepinephrine on the outcome of septic shock. *Crit Care Med*. 2000 Aug;28(8):2758-65.22.
90. Nolan JP, Soar J, Cariou A, et al. European Resuscitation Council and European Society of Intensive Care Medicine Guidelines. *Resuscitation*. 2015 95:202-22.
91. Argenziano M, Chen JM, Choudhri AF, et al. Management of vasodilatory shock after cardiac surgery: identification of predisposing factors and use of a novel pressor agent. *J Thorac Cardiovasc Surg*. 1998;116:973-80.
92. Dunser MW, Wenzel V, Mayr AJ, Hasibeder WR. Management of vasodilatory shock: defining the role of arginine vasopressin. *Drugs*. 2003;63:237-56.
93. Zhang LP, Li M, Yang L. Effects of different vasopressors in patients undergoing orthotopic liver transplantation. *Chin Med J*. 2005;118: 1952-1958.
94. Vater Y, Levy A, Martay K, Hunter C, Weinbroum AA. Adjuvant drugs for end-stage liver failure and transplantation. *Medical Science Monitor*. 2004;10:RA77-RA88.
95. Carrier FM, Vincelette C, Amzallag E, et al. Perioperative clinical practice in liver transplantation: an international survey. *Can Anesth*. [Epub ahead of print June 2, 2023].
96. Egi M, Bellomo R, Langenberg C, et al. Selecting a vasopressor drug for vasoplegic shock after adult cardiac surgery: a systematic literature review. *Ann Thorac Surg*. 2007;83:715-23
97. Nygren A, Thoren A, Ricksten SE. Norepinephrine and intestinal mucosal perfusion in vasodilatory shock after cardiac surgery. *Shock*. 2007;28:536-43.
98. Bennett SR, McKeown J, Drew P, Griffin S. Angiotensin in cardiac surgery: efficacy in patients on angiotensin converting enzyme inhibitors. *The Eur J Heart Failure*. 2001: 587-92.



99. Ryu HG, Jung CW, Lee HC, Cho YJ. Epinephrine and phenylephrine pretreatments for preventing postreperfusion syndrome during adult liver transplantation. *Liver Transpl.* 2012;18(12):1430-9.
100. Paugam-Burtz C, Kavafyan J, Merckx P, et al. Postreperfusion syndrome during liver transplantation for cirrhosis: outcome and predictors. *Liver Transpl.* 2009;15:522-9.
101. Tabaee A. Pharmacologic management of the hypotensive patient. In: *Intensive Care Medicine* (5 th ed.). Philadelphia: Lippincott Williams and Wilkins, 2003.
102. Meng L, Cannesson M, Alexander BS, et al. Effect of phenylephrine and ephedrine bolus treatment on cerebral oxygenation in anesthetized patients. *Br J Anaesth.* 2011;107:209-17.
103. Pennekamp CW, Immink RV, Moll FL, Buhre WF, de Borst GJ. Differential effect of phenylephrine and ephedrine on cerebral haemodynamics before carotid cross-clamping during carotid endarterectomy. *Br J Anaesth.* 2012;109:831-3.
104. Koch KU, Mikkelsen IK, Espelund US, et al. Cerebral macro- and microcirculation during ephedrine versus phenylephrine treatment in anesthetized brain tumor patients: a randomized clinical trial using magnetic resonance imaging. *Anesthesiology.* 2021;135:788-803.
105. T.C. Sağlık Bakanlığı. Türkiye İlaç ve Tıbbi Cihaz Kurumu. <https://titck.gov.tr/storage/kubK-tAttachments/6osZsEQ4HublbT.pdf>. Accessed December 30.12.2025.
106. Atashkhoyi S, Fardiazar Z, Marandi PH, Torab R. Comparison the effect of ephedrine and phenylephrine in treatment of hypotension after spinal anesthesia during cesarean section. *Open J Obstet Gynecol.* 2012;2:192-6.
107. Chung IS, Jee HS, Han S, et al. Effect of prereperfusion ephedrine on post reperfusion syndrome and graft function in living donor liver transplantation. *Transplant Proc.* 2017;49:1815-9.
108. Lee RW, Di Giamtomasso D, May C, Bellomo R. Vasoactive drugs and the kidney. *Best Pract Res Clin Anaesthesiol.* 2004;18(1):53-74.
109. Denton MD, Chertow GM, Brady HR. "Renal-dose" dopamine for the treatment of acute renal failure: scientific rationale, experimental studies and clinical trials. *Kidney Int.* 1996;50:4-14.
110. Tabaee A. Pharmacologic management of the hypotensive patient. In: *Intensive Care Medicine* (5 th ed.). Philadelphia: Lippincott Williams and Wilkins, 2003.
111. Ho-Geol R, Chul-Woo J, Hyung-Chul L, Youn-Joung C. Epinephrine and phenylephrine pretreatments for preventing postreperfusion syndrome during adult liver transplantation. *Liver Transplantation.* 2012;18:1430-1439.
112. Dünster MW, Mayr AJ, Ulmer H, et al. Arginine vasopressin in advanced vasodilatory shock. A prospective, randomized, controlled study. *Circulation.* 2003;107:2313-2319.
113. Ruffolo RR Jr. The pharmacology of dobutamine. *Am J Med Sci.* 1987; 294:244-248.
114. Girbes AR. Prevention of acute renal failure. role of vasoactive drugs, mannitol and diuretics. *Int J Artif Organs.* 2004;27(12):1049-53.
115. Rivers E, Nguyen B, Havstad S, et al. Early goal directed therapy in the treatment of severe sepsis and septic shock. *N Engl J Med.* 2001;345(19):1368-77.
116. Hong SH, Park CS, Jung HS, Choi H, Lee SR, Lee J, Choi JH. A comparison of intra-operative blood loss and acid-base balance between vasopressor and inotrope strategy during living donor liver transplantation: a randomised, controlled study. *Anaesthesia.* 2012;67(10):1091-100.
117. Turner RA, Pierce JG, du Vigneaud V. The purification and the amino acid content of vasopressin preparations. *J Biol Chem.* 1951;191:21-28.
118. Hupf H, Grimm D, Riegger GA, Schunkert H. Evidence for a vasopressin system in the rat heart. *Circ Res.* 1999;84:365-370.
119. Salzman AL, Vromen A, Denenberg A, Szabo C. K(ATP)-channel inhibition improves hemodynamics and cellular energetics in hemorrhagic shock. *Am J Physiol.* 1997;272:H688-H694.



120. Hamu Y, Kanmura Y, Tsuneyoshi I, Yoshimura N. The effects of vasopressin on endotoxin-induced attenuation of contractile responses in human gastroepiploic arteries in vitro. *Anesth Analg*. 1999;88:542–548.
121. Brezeanu LN, Brezeanu RC, Diculescu M, Droc G. Anaesthesia for Liver Transplantation: An Update. *J Crit Care Med (Targu Mures)*. 2020 May 6;6(2):91–100.
122. Di Giantomasso D, Morimatsu H, Bellomo R, May CN. Effect of low dose vasopressin infusion on vital organ flow in the conscious normal and septic sheep. *Anaesthesia and Intensive Care*. 2006;34:427–433;
123. Baik SK, Jeong PH, Ji SW, et al. Acute hemodynamic effects of octreo tide and terlipressin in patients with cirrhosis: A randomized comparison. *American Journal of Gastroenterology*. 2005;100:631–635.
124. Kam PC, Williams S, Yoong FF. Vasopressin and terlipressin: Pharmacology and its clinical relevance. *Anaesthesia*. 2004;59:993–1001.
125. Vitin AA, Martay K, Vater Y, Dembo G, Maziarz M. Effects of vasoactive agents on blood loss and transfusion requirements during pre-reperfusion stages of the Orthotopic Liver Transplantation. *Journal of Anesthesia and Clinical Research*. 2010;1:104.
126. Wagener G, Kovalevskaya G, Minhaz M, Mattis F, Emond JC, Landry DW. Vasopressin deficiency and vasodilatory state in end-stage liver disease. *J Cardiothorac Vasc Anesth*. 2011; 25: 665–70.
127. Roth JV. The use of vasopressin bolus to treat refractory hypotension secondary to reperfusion during orthotopic liver transplantation. *Anesth Analg* 2006; 103: 261.
128. Nilsson G, Lindblom P, Ohlin M, Berling R, Verneris E. Pharmacokinetics of terlipressin after single i.v. doses to healthy volunteers. *Drugs Exp Clin Res*. 1990;16(6):307–14.
129. Martin-Llahi M, is in shock states: From bench to bedside. *Critical Care*. 2015;19:175.
130. Koelzow H, Gedney JA, Baumann J, Snook NJ, Bellamy MC. The effect of methylene blue on the hemodynamic changes during ischemia reperfusion injury in orthotopic liver transplantation. *Anesth Analg* 2002; 94: 824–9.
131. Cheng SS, Berman GW, Merritt GR, et al. The response to methylene blue in patients with severe hypotension during liver transplantation. *J Clin Anesth* 2012; 24: 324–8.
132. Brady AJ, Poole-Wilson PA, Harding SE, Warren JB. Nitric oxide production within cardiac myocytes reduces their contractility in endotoxemia. *Am J Physiol*. 1992;263(6 Pt 2):H1963–6.
133. Kumar A, Brar R, Wang P, et al. Role of nitric oxide and cGMP in human septic serum-induced depression of cardiac myocyte contractility. *Am J Physiol*. 1999;276(1 Pt 2):R265–76.
134. Fukazawa K, Pretto EA. The effect of methylene blue during orthotopic liver transplantation on post reperfusion syndrome and postoperative graft function. *J Hepatobiliary Pancreat Sci*. 2011;18(3):406–413.
135. Moreau ME, Garbacki N, Molinaro G, Brown NJ, Marceau F, Adam A. The kallikrein–kinin system: Current and future pharmacological targets. *J Pharmacol Sci*. 2005; 99: 6–38.
136. Milroy SJ, Cottam S, Tan KC, Hilmi I, Oyesola B. Improved haemodynamic stability with administration of aprotinin during orthotopic liver transplantation. *Br J Anaesth*. 1995; 75: 747–751.
137. Molenaar IQ, Begliomini B, Martinelli G, Putter H, Terpstra OT, Porte RJ. Reduced need for vasopressors in patients receiving aprotinin during orthotopic liver transplantation. *Anesthesiology*. 2001;94(3):433–8.
138. Al-Horani RA. Recent advances on plasmin inhibitors for the treatment of fibrinolysis-related disorders. *Medicinal Research Reviews*. 2014;34(6):1168–1216.
139. 149. Ramjee MK, Henderson IM, McLoughlin SB, Padova A. The kinetic and structural characterization of the reaction of nafamostat with bovine pancreatic trypsin. *Thrombosis Research*. 2000;98(6): 559–569.



140. Ramjee MK, Patel S. Continuous-flow injection microfluidic thrombin assays: The effect of binding kinetics on observed enzyme inhibition. *Analytical Biochemistry*. 2017; 528: 38–46.
141. Okajima K, Uchiba M, Murakami K. Nafamostat mesilate. *Cardiovasc Drug Rev*. 1995; 13: 51–65.
142. Acosta F, Sansano T, Contreras RE, et al. Phenylephrine treatment of the postre perfusion syndrome in liver transplantation. *Transplant Proc*. 1999;31:2373-2374.