

ICM7068 - The Physiology of Shock, Shock Syndromes and Tools of Resuscitation

View Online



This module is designed to teach the student how to identify which patients require resuscitation and the tools by which this is achieved.

A code of practice for the diagnosis and confirmation of death - Academy of Medical Royal Colleges. (n.d.).
<http://www.aomrc.org.uk/publications/reports-guidance/code-practice-diagnosis-confirmation-death/>

A Comparison of Albumin and Saline for Fluid Resuscitation in the Intensive Care Unit. (2004). *New England Journal of Medicine*, 350(22), 2247–2256.
<https://doi.org/10.1056/NEJMoa040232>

A European One Health Action Plan against Antimicrobial Resistance. (n.d.).
https://ec.europa.eu/health/sites/health/files/antimicrobial_resistance/docs/amr_2017_action-plan.pdf

A Randomized Trial of Protocol-Based Care for Early Septic Shock. (n.d.). *The New England Journal of Medicine*, 370, 1683–1693.
<https://search.proquest.com/docview/1520423050?pq-origsite=summon>

Acute upper gastrointestinal bleeding in over 16s: management | Guidance and guidelines | NICE. (n.d.). <https://www.nice.org.uk/guidance/cg141/chapter/1-guidance>

Alhashemi, J. A., Cecconi, M., & Hofer, C. K. (2011). Cardiac output monitoring: an integrative perspective. *Critical Care*, 15(2). <https://doi.org/10.1186/cc9996>

American Journal of Physiology-Regulatory, Integrative and Comparative Physiology. (n.d.). <https://www.physiology.org/doi/full/10.1152/ajpregu.00304.2015>

An Ethical Framework for Controlled Donation after Circulatory Death: Executive Summary - Academy of Medical Royal Colleges. (n.d.).
<http://www.aomrc.org.uk/publications/reports-guidance/ethical-framework-controlled-donation-circulatory-death-executive-summary/>

Angus, D. C., Barnato, A. E., Bell, D., Bellomo, R., Chong, C.-R., Coats, T. J., Davies, A., Delaney, A., Harrison, D. A., Holdgate, A., Howe, B., Huang, D. T., Iwashyna, T., Kellum, J. A., Peake, S. L., Pike, F., Reade, M. C., Rowan, K. M., Singer, M., ... Young, J. D. (2015). A systematic review and meta-analysis of early goal-directed therapy for septic shock: the ARISE, ProCESS and ProMISe Investigators. *Intensive Care Medicine*, 41(9), 1549–1560.
<https://doi.org/10.1007/s00134-015-3822-1>

Angus, D. C., & van der Poll, T. (2013). *Severe Sepsis and Septic Shock*. *New England*

Journal of Medicine, 369(9), 840–851. <https://doi.org/10.1056/NEJMra1208623>

Antonelli, M., & Sandroni, C. (2013). Hydroxyethyl Starch for Intravenous Volume Replacement. *JAMA*, 309(7). <https://doi.org/10.1001/jama.2013.851>

Assessment of Global Incidence and Mortality of Hospital-treated Sepsis. Current Estimates and Limitations | *American Journal of Respiratory and Critical Care Medicine*. (n.d.). <https://www.atsjournals.org/doi/10.1164/rccm.201504-0781OC>

Association of Anaesthetists of Great Britain and Ireland. (n.d.). <http://www.aagbi.org/>

Aya, H. D., Rhodes, A., Chis Ster, I., Fletcher, N., Grounds, R. M., & Cecconi, M. (2017). Hemodynamic Effect of Different Doses of Fluids for a Fluid Challenge. *Critical Care Medicine*, 45(2), e161–e168. <https://doi.org/10.1097/CCM.0000000000002067>

Aya, H. D., Ster, I. C., Fletcher, N., Grounds, R. M., Rhodes, A., & Cecconi, M. (2016). Pharmacodynamic Analysis of a Fluid Challenge. *Critical Care Medicine*, 44(5), 880–891. <https://doi.org/10.1097/CCM.0000000000001517>

Blackstock, M. J., & Ray, D. C. (2014). Organ donation after circulatory death. *European Journal of Emergency Medicine*, 21(5), 324–329. <https://doi.org/10.1097/MEJ.0000000000000082>

Booth, R. A., Hill, S. A., Don-Wauchope, A., Santaguida, P. L., Oremus, M., McKelvie, R., Balion, C., Brown, J. A., Ali, U., Bustamam, A., Soheli, N., & Raina, P. (2014). Performance of BNP and NT-proBNP for diagnosis of heart failure in primary care patients: a systematic review. *Heart Failure Reviews*, 19(4), 439–451. <https://doi.org/10.1007/s10741-014-9445-8>

Brohi, K., Cohen, M. J., & Davenport, R. A. (2007). Acute coagulopathy of trauma: mechanism, identification and effect. *Current Opinion in Critical Care*, 13(6), 680–685. <https://doi.org/10.1097/MCC.0b013e3282f1e78f>

Burch, V. C., Tarr, G., & Morroni, C. (2008). Modified early warning score predicts the need for hospital admission and inhospital mortality. *Emergency Medicine Journal*, 25(10), 674–678. <https://doi.org/10.1136/emj.2007.057661>

Cannon, J. W., Khan, M. A., Raja, A. S., Cohen, M. J., Como, J. J., Cotton, B. A., Dubose, J. J., Fox, E. E., Inaba, K., Rodriguez, C. J., Holcomb, J. B., & Duchesne, J. C. (2017). Damage control resuscitation in patients with severe traumatic hemorrhage. *Journal of Trauma and Acute Care Surgery*, 82(3), 605–617. <https://doi.org/10.1097/TA.0000000000001333>

Cecconi, M., Hofer, C., Teboul, J.-L., Pettila, V., Wilkman, E., Molnar, Z., Della Rocca, G., Aldecoa, C., Artigas, A., Jog, S., Sander, M., Spies, C., Lefrant, J.-Y., & De Backer, D. (2015). Fluid challenges in intensive care: the FENICE study. *Intensive Care Medicine*, 41(9), 1529–1537. <https://doi.org/10.1007/s00134-015-3850-x>

Chappell, D., Bruegger, D., Potzel, J., Jacob, M., Brettner, F., Vogeser, M., Conzen, P., Becker, B. F., & Rehm, M. (2014). Hypervolemia increases release of atrial natriuretic peptide and shedding of the endothelial glycocalyx. *Critical Care*, 18(5). <https://doi.org/10.1186/s13054-014-0538-5>

Circulation. (n.d.). <https://www.ahajournals.org/doi/10.1161/CIR.0000000000000509>

Clarke, D. L., Chipps, J. A., Sartorius, B., Bruce, J., Laing, G. L., & Brysiewicz, P. (2016). Mortality rates increase dramatically below a systolic blood pressure of 105-mm Hg in septic surgical patients. *The American Journal of Surgery*, 212(5), 941–945. <https://doi.org/10.1016/j.amjsurg.2016.01.042>

Cook, I., Kirkup, A. L., Langham, L. J., Malik, M. A., Marlow, G., & Sammy, I. (2017). End of Life Care and Do Not Resuscitate Orders: How Much Does Age Influence Decision Making? A Systematic Review and Meta-Analysis. *Gerontology and Geriatric Medicine*, 3. <https://doi.org/10.1177/2333721417713422>

De Backer, D., Cecconi, M., Lipman, J., Machado, F., Myatra, S. N., Ostermann, M., Perner, A., Teboul, J.-L., Vincent, J.-L., & Walley, K. R. (2019). Challenges in the management of septic shock: a narrative review. *Intensive Care Medicine*. <https://doi.org/10.1007/s00134-019-05544-x>

Elliott, P. (2006). Rational use of inotropes. *Anaesthesia & Intensive Care Medicine*, 7(9), 326–330. <https://doi.org/10.1053/j.mpaic.2006.06.007>

EMCrit Blog - Emergency Department Critical Care & Resuscitation. (n.d.). <https://emcrit.org/>

Gayet-Ageron, A., Prieto-Merino, D., Ker, K., Shakur, H., Ageron, F.-X., Roberts, I., Kayani, A., Geer, A., Ndungu, B., Fawole, B., Gilliam, C., Adetayo, C., Barrow, C., Beaumont, D., Prowse, D., l'Anson, D., Balogun, E., Miah, H., Shakur, H., ... Pepple, T. (2018). Effect of treatment delay on the effectiveness and safety of antifibrinolytics in acute severe haemorrhage: a meta-analysis of individual patient-level data from 40 138 bleeding patients. *The Lancet*, 391(10116), 125–132. [https://doi.org/10.1016/S0140-6736\(17\)32455-8](https://doi.org/10.1016/S0140-6736(17)32455-8)

Glassberg, E., Nadler, R., Gendler, S., Abramovich, A., Spinella, P. C., Gerhardt, R. T., Holcomb, J. B., & Kreiss, Y. (2013). Freeze-Dried Plasma at the Point of Injury. *Shock*, 40(6), 444–450. <https://doi.org/10.1097/SHK.0000000000000047>

Glassford, N., Eastwood, G., & Bellomo, R. (2014). Physiological changes after fluid bolus therapy in sepsis: a systematic review of the contemporary literature. *Critical Care*, 18(S2). <https://doi.org/10.1186/cc14037>

Gonzalez, E. A., Moore, F. A., Holcomb, J. B., Miller, C. C., Kozar, R. A., Todd, S. R., Cocanour, C. S., Balldin, B. C., & McKinley, B. A. (2007). Fresh Frozen Plasma Should be Given Earlier to Patients Requiring Massive Transfusion. *The Journal of Trauma: Injury, Infection, and Critical Care*, 62(1), 112–119. <https://doi.org/10.1097/01.ta.0000250497.08101.8b>

Gray, A., Goodacre, S., Newby, D. E., Masson, M., Sampson, F., & Nicholl, J. (2008). Noninvasive Ventilation in Acute Cardiogenic Pulmonary Edema. *New England Journal of Medicine*, 359(2), 142–151. <https://doi.org/10.1056/NEJMoa0707992>

Guidelines | British Society for Haematology. (n.d.). <http://www.b-s-h.org.uk/guidelines/>

Guidet, B., & Ait-Oufella, H. (2014). Fluid resuscitation should respect the endothelial glycocalyx layer. *Critical Care*, 18(6). <https://doi.org/10.1186/s13054-014-0707-6>

Guyton, A. C., & Hall, J. E. (2016). *Guyton and Hall textbook of medical physiology* (Thirteenth edition). Elsevier.
<https://www-vlebooks-com.ezproxy.library.qmul.ac.uk/Vleweb/Product/Index/748473?page=0>

Haemodynamic Monitoring: ESICM EDIC PACT Study Tool. (n.d.).
<https://www.esicm.org/education/>

Handbook of Transfusion Medicine. (n.d.).
<https://www.transfusionguidelines.org/transfusion-handbook>

Helmerhorst, H. J. F., Roos-Blom, M.-J., van Westerlo, D. J., & de Jonge, E. (2015). Association Between Arterial Hyperoxia and Outcome in Subsets of Critical Illness. *Critical Care Medicine*, 43(7), 1508–1519. <https://doi.org/10.1097/CCM.0000000000000998>

Hogshire, L., & Carson, J. L. (2013). Red blood cell transfusion. *Current Opinion in Hematology*, 20(6), 546–551. <https://doi.org/10.1097/MOH.0b013e32836508bd>

Holcomb, J. B. (2011). Reconstitution: Reverse Engineering. *The Journal of Trauma: Injury, Infection, and Critical Care*, 70, S65–S67. <https://doi.org/10.1097/TA.0b013e31821a609c>

Holcomb, J. B., Tilley, B. C., Baraniuk, S., Fox, E. E., Wade, C. E., Podbielski, J. M., del Junco, D. J., Brasel, K. J., Bulger, E. M., Callcut, R. A., Cohen, M. J., Cotton, B. A., Fabian, T. C., Inaba, K., Kerby, J. D., Muskat, P., O'Keeffe, T., Rizoli, S., Robinson, B. R. H., ... van Belle, G. (2015). Transfusion of Plasma, Platelets, and Red Blood Cells in a 1:1:1 vs a 1:1:2 Ratio and Mortality in Patients With Severe Trauma. *JAMA*, 313(5).
<https://doi.org/10.1001/jama.2015.12>

Howell, M. D., Donnino, M., Clardy, P., Talmor, D., & Shapiro, N. I. (2007). Occult hypoperfusion and mortality in patients with suspected infection. *Intensive Care Medicine*, 33(11), 1892–1899. <https://doi.org/10.1007/s00134-007-0680-5>

Hutchings, S. D., Naumann, D. N., Watts, S., Wilson, C., Burton, C., Wendon, J., & Kirkman, E. (2016). Microcirculatory perfusion shows wide inter-individual variation and is important in determining shock reversal during resuscitation in a porcine experimental model of complex traumatic hemorrhagic shock. *Intensive Care Medicine Experimental*, 4(1).
<https://doi.org/10.1186/s40635-016-0088-z>

Jhanji, S., Lee, C., Watson, D., Hinds, C., & Pearse, R. M. (2009). Microvascular flow and tissue oxygenation after major abdominal surgery: association with post-operative complications. *Intensive Care Medicine*, 35(4), 671–677.
<https://doi.org/10.1007/s00134-008-1325-z>

Jhanji, S., Stirling, S., Patel, N., Hinds, C. J., & Pearse, R. M. (2009). The effect of increasing doses of norepinephrine on tissue oxygenation and microvascular flow in patients with septic shock*. *Critical Care Medicine*, 37(6), 1961–1966.
<https://doi.org/10.1097/CCM.0b013e3181a00a1c>

Jhanji, S., Vivian-Smith, A., Lucena-Amaro, S., Watson, D., Hinds, C. J., & Pearse, R. M. (2010). Haemodynamic optimisation improves tissue microvascular flow and oxygenation after major surgery: a randomised controlled trial. *Critical Care*, 14(4). <https://doi.org/10.1186/cc9220>

Jiwaji, Z., Brady, S., McIntyre, L. A., Gray, A., & Walsh, T. S. (2014). Emergency department management of early sepsis: a national survey of emergency medicine and intensive care consultants. *Emergency Medicine Journal*, 31(12), 1000–1005. <https://doi.org/10.1136/emered-2013-202883>

Kilgannon, J. H. (2010). Association Between Arterial Hyperoxia Following Resuscitation From Cardiac Arrest and In-Hospital Mortality. *JAMA*, 303(21). <https://doi.org/10.1001/jama.2010.707>

Laine, Loren, MD. (n.d.). Blood Transfusion for Gastrointestinal Bleeding. *The New England Journal of Medicine*, 368(8), 75–76. <https://search.proquest.com/docview/1266235512?pq-origsite=summon>

Lee, Y. K., Hwang, S. Y., Shin, T. G., Jo, I. J., Suh, G. Y., & Jeon, K. (2016). Prognostic Value of Lactate and Central Venous Oxygen Saturation after Early Resuscitation in Sepsis Patients. *PLOS ONE*, 11(4). <https://doi.org/10.1371/journal.pone.0153305>

Lord, J. M., Midwinter, M. J., Chen, Y.-F., Belli, A., Brohi, K., Kovacs, E. J., Koenderman, L., Kubes, P., & Lilford, R. J. (2014). The systemic immune response to trauma: an overview of pathophysiology and treatment. *The Lancet*, 384(9952), 1455–1465. [https://doi.org/10.1016/S0140-6736\(14\)60687-5](https://doi.org/10.1016/S0140-6736(14)60687-5)

Lucas, C. E., & Ledgerwood, A. M. (2013). FFP:RBC Resuscitation Ratio and Post-Shock Fluid Uptake. *JAMA Surgery*, 148(3). <https://doi.org/10.1001/jamasurg.2013.623>

Maitland, K., George, E. C., Evans, J. A., Kiguli, S., Olupot-Olupot, P., Akech, S. O., Opoka, R. O., Engoru, C., Nyeko, R., Mtove, G., Reyburn, H., Brent, B., Nteziyaremye, J., Mpoya, A., Prevatt, N., Dambisya, C. M., Semakula, D., Ddungu, A., Okuony, V., ... Gibb, D. M. (2013). Exploring mechanisms of excess mortality with early fluid resuscitation: insights from the FEAST trial. *BMC Medicine*, 11(1). <https://doi.org/10.1186/1741-7015-11-68>

Maitland, K., Kiguli, S., Opoka, R. O., Engoru, C., Olupot-Olupot, P., Akech, S. O., Nyeko, R., Mtove, G., Reyburn, H., Lang, T., Brent, B., Evans, J. A., Tibenderana, J. K., Crawley, J., Russell, E. C., Levin, M., Babiker, A. G., & Gibb, D. M. (2011a). Mortality after Fluid Bolus in African Children with Severe Infection. *New England Journal of Medicine*, 364(26), 2483–2495. <https://doi.org/10.1056/NEJMoa1101549>

Maitland, K., Kiguli, S., Opoka, R. O., Engoru, C., Olupot-Olupot, P., Akech, S. O., Nyeko, R., Mtove, G., Reyburn, H., Lang, T., Brent, B., Evans, J. A., Tibenderana, J. K., Crawley, J., Russell, E. C., Levin, M., Babiker, A. G., & Gibb, D. M. (2011b). Mortality after Fluid Bolus in African Children with Severe Infection. *New England Journal of Medicine*, 364(26), 2483–2495. <https://doi.org/10.1056/NEJMoa1101549>

Major trauma: assessment and initial management | Guidance and guidelines | NICE. (n.d.). <https://www.nice.org.uk/guidance/ng39>

- Marik, P. E., Baram, M., & Vahid, B. (2008). Does Central Venous Pressure Predict Fluid Responsiveness?*: A Systematic Review of the Literature and the Tale of Seven Mares. *Chest*, 134(1), 172–178. <https://doi.org/10.1378/chest.07-2331>
- Masip, J., Roque, M., Sánchez, B., Fernández, R., Subirana, M., & Expósito, J. A. (2005). Noninvasive Ventilation in Acute Cardiogenic Pulmonary Edema. *JAMA*, 294(24). <https://doi.org/10.1001/jama.294.24.3124>
- Mebazaa, A., Nieminen, M. S., Packer, M., Cohen-Solal, A., Kleber, F. X., Pocock, S. J., Thakkar, R., Padley, R. J., Pöder, P., Kivikko, M., & SURVIVE Investigators, for the. (2007). Levosimendan vs Dobutamine for Patients With Acute Decompensated Heart Failure. *JAMA*, 297(17). <https://doi.org/10.1001/jama.297.17.1883>
- Mellhammar, L., Wullt, S., Lindberg, Å., Lanbeck, P., Christensson, B., & Linder, A. (2016). Sepsis Incidence: A Population-Based Study. *Open Forum Infectious Diseases*, 3(4). <https://doi.org/10.1093/ofid/ofw207>
- Monge García, M. I., Guijo González, P., Gracia Romero, M., Gil Cano, A., Oscier, C., Rhodes, A., Grounds, R. M., & Cecconi, M. (2015). Effects of fluid administration on arterial load in septic shock patients. *Intensive Care Medicine*, 41(7), 1247–1255. <https://doi.org/10.1007/s00134-015-3898-7>
- Monnet, X., Rienzo, M., Osman, D., Anguel, N., Richard, C., Pinsky, M. R., & Teboul, J.-L. (2006). Passive leg raising predicts fluid responsiveness in the critically ill*. *Critical Care Medicine*, 34(5), 1402–1407. <https://doi.org/10.1097/01.CCM.0000215453.11735.06>
- Morelli, A., Donati, A., Ertmer, C., Rehberg, S., Kampmeier, T., Orecchioni, A., Di Russo, A., D'Egidio, A., Landoni, G., Lombrano, M., Botticelli, L., Valentini, A., Zangrillo, A., Pietropaoli, P., & Westphal, M. (2011). Effects of vasopressinergic receptor agonists on sublingual microcirculation in norepinephrine-dependent septic shock. *Critical Care*, 15(5). <https://doi.org/10.1186/cc10453>
- Morelli, A., Donati, A., Ertmer, C., Rehberg, S., Lange, M., Orecchioni, A., Cecchini, V., Landoni, G., Pelaia, P., Pietropaoli, P., Van Aken, H., Teboul, J.-L., Ince, C., & Westphal, M. (2010). Levosimendan for resuscitating the microcirculation in patients with septic shock: a randomized controlled study. *Critical Care*, 14(6). <https://doi.org/10.1186/cc9387>
- Myburgh, J. A., Finfer, S., Bellomo, R., Billot, L., Cass, A., Gattas, D., Glass, P., Lipman, J., Liu, B., McArthur, C., McGuinness, S., Rajbhandari, D., Taylor, C. B., & Webb, S. A. R. (2012). Hydroxyethyl Starch or Saline for Fluid Resuscitation in Intensive Care. *New England Journal of Medicine*, 367(20), 1901–1911. <https://doi.org/10.1056/NEJMoa1209759>
- Myles, P. S., Smith, J. A., Forbes, A., Silbert, B., Jayarajah, M., Painter, T., Cooper, D. J., Marasco, S., McNeil, J., Bussières, J. S., McGuinness, S., Byrne, K., Chan, M. T. V., Landoni, G., & Wallace, S. (2017). Tranexamic Acid in Patients Undergoing Coronary-Artery Surgery. *New England Journal of Medicine*, 376(2), 136–148. <https://doi.org/10.1056/NEJMoa1606424>
- Napp, L. C., Kühn, C., & Bauersachs, J. (2017a). ECMO in cardiac arrest and cardiogenic shock. *Herz*, 42(1), 27–44. <https://doi.org/10.1007/s00059-016-4523-4>

- Napp, L. C., Kühn, C., & Bauersachs, J. (2017b). ECMO in cardiac arrest and cardiogenic shock. *Herz*, 42(1), 27-44. <https://doi.org/10.1007/s00059-016-4523-4>
- Nevin, D. G., & Brohi, K. (2017). Permissive hypotension for active haemorrhage in trauma. *Anaesthesia*. <https://doi.org/10.1111/anae.14034>
- Nunes, T. S. O., Ladeira, R. T., Bafi, A. T., de Azevedo, L. C. P., Machado, F. R., & Freitas, F. G. R. (2014). Duration of hemodynamic effects of crystalloids in patients with circulatory shock after initial resuscitation. *Annals of Intensive Care*, 4(1). <https://doi.org/10.1186/s13613-014-0025-9>
- O'Grady, N. P., Alexander, M., Burns, L. A., Dellinger, E. P., Garland, J., Heard, S. O., Lipsett, P. A., Masur, H., Mermel, L. A., Pearson, M. L., Raad, I. I., Randolph, A. G., Rupp, M. E., & Saint, S. (2011). Guidelines for the prevention of intravascular catheter-related infections. *American Journal of Infection Control*, 39(4), S1-S34. <https://doi.org/10.1016/j.ajic.2011.01.003>
- Ospina-Tascon, G., Neves, A. P., Occhipinti, G., Donadello, K., Büchele, G., Simion, D., Chierago, M.-L., Silva, T. O., Fonseca, A., Vincent, J.-L., & De Backer, D. (2010). Effects of fluids on microvascular perfusion in patients with severe sepsis. *Intensive Care Medicine*, 36(6), 949-955. <https://doi.org/10.1007/s00134-010-1843-3>
- Oyenyi, B. T., Fox, E. E., Scerbo, M., Tomasek, J. S., Wade, C. E., & Holcomb, J. B. (2017). Trends in 1029 trauma deaths at a level 1 trauma center: Impact of a bleeding control bundle of care. *Injury*, 48(1), 5-12. <https://doi.org/10.1016/j.injury.2016.10.037>
- Perel, P., Roberts, I., & Ker, K. (2013). Colloids versus crystalloids for fluid resuscitation in critically ill patients. *Cochrane Database of Systematic Reviews*. <https://doi.org/10.1002/14651858.CD000567.pub6>
- Physiology of Ageing. (n.d.). <https://www.sciencedirect.com/science/article/abs/pii/S1357303916302298>
- Piehl, M. D., Manning, J. E., McCurdy, S. L., Rhue, T. S., Kocis, K. C., Cairns, C. B., & Cairns, B. A. (2008). Pulse contour cardiac output analysis in a piglet model of severe hemorrhagic shock*. *Critical Care Medicine*, 36(4), 1189-1195. <https://doi.org/10.1097/CCM.0B013E31816592A3>
- Pierrakos, C., Velissaris, D., Scolletta, S., Heenen, S., De Backer, D., & Vincent, J.-L. (2012a). Can changes in arterial pressure be used to detect changes in cardiac index during fluid challenge in patients with septic shock? *Intensive Care Medicine*, 38(3), 422-428. <https://doi.org/10.1007/s00134-011-2457-0>
- Pierrakos, C., Velissaris, D., Scolletta, S., Heenen, S., De Backer, D., & Vincent, J.-L. (2012b). Can changes in arterial pressure be used to detect changes in cardiac index during fluid challenge in patients with septic shock? *Intensive Care Medicine*, 38(3), 422-428. <https://doi.org/10.1007/s00134-011-2457-0>
- Pranskunas, A., Koopmans, M., Koetsier, P. M., Pilvinis, V., & Boerma, E. C. (2013). Microcirculatory blood flow as a tool to select ICU patients eligible for fluid therapy. *Intensive Care Medicine*, 39(4), 612-619. <https://doi.org/10.1007/s00134-012-2793-8>

Prytherch, D. R., Smith, G. B., Schmidt, P. E., & Featherstone, P. I. (2010). ViEWS—Towards a national early warning score for detecting adult inpatient deterioration. *Resuscitation*, 81(8), 932–937. <https://doi.org/10.1016/j.resuscitation.2010.04.014>

Reinhart, K., Daniels, R., Kissoon, N., Machado, F. R., Schachter, R. D., & Finfer, S. (2017). Recognizing Sepsis as a Global Health Priority — A WHO Resolution. *New England Journal of Medicine*, 377(5), 414–417. <https://doi.org/10.1056/NEJMp1707170>

Reynolds, H. R., & Hochman, J. S. (2008). Cardiogenic Shock: Current Concepts and Improving Outcomes. *Circulation*, 117(5), 686–697. <https://doi.org/10.1161/CIRCULATIONAHA.106.613596>

Rhodes, A., Evans, L. E., Alhazzani, W., Levy, M. M., Antonelli, M., Ferrer, R., Kumar, A., Sevransky, J. E., Sprung, C. L., Nunnally, M. E., Rochweg, B., Rubenfeld, G. D., Angus, D. C., Annane, D., Beale, R. J., Bellinghan, G. J., Bernard, G. R., Chiche, J.-D., Coopersmith, C., ... Shukri, K. A. (2017). Surviving Sepsis Campaign. *Critical Care Medicine*, 45(3), 486–552. <https://doi.org/10.1097/CCM.0000000000002255>

Rincon, F., Kang, J., Maltenfort, M., Vibbert, M., Urtecho, J., Athar, M. K., Jallo, J., Pineda, C. C., Tzeng, D., McBride, W., & Bell, R. (2014). Association Between Hyperoxia and Mortality After Stroke. *Critical Care Medicine*, 42(2), 387–396. <https://doi.org/10.1097/CCM.0b013e3182a27732>

Rodriguez, R. M., Lum-Lung, M., Dixon, K., & Nothmann, A. (2006). A prospective study on esophageal Doppler hemodynamic assessment in the ED. *The American Journal of Emergency Medicine*, 24(6), 658–663. <https://doi.org/10.1016/j.ajem.2006.02.006>

Sackner-Bernstein, J. D., Kowalski, M., Fox, M., & Aaronson, K. (2005). Short-term Risk of Death After Treatment With Nesiritide for Decompensated Heart Failure. *JAMA*, 293(15). <https://doi.org/10.1001/jama.293.15.1900>

Sammy, I., Lecky, F., Sutton, A., Leaviss, J., & O' Cathain, A. (2016). Factors affecting mortality in older trauma patients—A systematic review and meta-analysis. *Injury*, 47(6), 1170–1183. <https://doi.org/10.1016/j.injury.2016.02.027>

Sampson, Hugh AMuñoz-Furlong, AnneCampbell, Ronna LAdkinson, N FranklinBock, S Allan. (n.d.). Second symposium on the definition and management of anaphylaxis: Summary report--Second National Institute of Allergy and Infectious Disease/Food Allergy and Anaphylaxis Network symposium. *Journal of Allergy and Clinical Immunology*, 117(7), 391–397. <https://search.proquest.com/docview/1504744658?pq-origsite=summon>

Shackelford, S. A., del Junco, D. J., Powell-Dunford, N., Mazuchowski, E. L., Howard, J. T., Kotwal, R. S., Gurney, J., Butler, F. K., Gross, K., & Stockinger, Z. T. (2017). Association of Prehospital Blood Product Transfusion During Medical Evacuation of Combat Casualties in Afghanistan With Acute and 30-Day Survival. *JAMA*, 318(16). <https://doi.org/10.1001/jama.2017.15097>

Shoemaker, W. C., Appel, P. L., Kram, H. B., Waxman, K., & Lee, T.-S. (1988). Prospective Trial of Supranormal Values of Survivors as Therapeutic Goals in High-Risk Surgical Patients. *Chest*, 94(6), 1176–1186. <https://doi.org/10.1378/chest.94.6.1176>

Sieck, G. C. (2003). Physiology of aging. *Journal of Applied Physiology*, 95(4), 1333–1334. <https://doi.org/10.1152/jappphysiol.00718.2003>

Solomon, Caren GLaine, Loren. (n.d.). Upper Gastrointestinal Bleeding Due to a Peptic Ulcer. *The New England Journal of Medicine*, 374(4), 2367–2376. <https://search.proquest.com/docview/1798243079?pq-origsite=summon>

Spinella, P. C., Pidcoke, H. F., Strandenes, G., Hervig, T., Fisher, A., Jenkins, D., Yazer, M., Stubbs, J., Murdock, A., Sailliol, A., Ness, P. M., & Cap, A. P. (2016). Whole blood for hemostatic resuscitation of major bleeding. *Transfusion*, 56, S190–S202. <https://doi.org/10.1111/trf.13491>

Starodub, R., Abella, B. S., Grossestreuer, A. V., Shofer, F. S., Perman, S. M., Leary, M., & Gaieski, D. F. (2013). Association of serum lactate and survival outcomes in patients undergoing therapeutic hypothermia after cardiac arrest. *Resuscitation*, 84(8), 1078–1082. <https://doi.org/10.1016/j.resuscitation.2013.02.001>

Stub, D., Smith, K., Bernard, S., Nehme, Z., Stephenson, M., Bray, J. E., Cameron, P., Barger, B., Ellims, A. H., Taylor, A. J., Meredith, I. T., & Kaye, D. M. (2015). Air Versus Oxygen in ST-Segment–Elevation Myocardial Infarction. *Circulation*, 131(24), 2143–2150. <https://doi.org/10.1161/CIRCULATIONAHA.114.014494>

Tachon, G., Harrois, A., Tanaka, S., Kato, H., Huet, O., Pottecher, J., Vicaut, E., & Duranteau, J. (2014). Microcirculatory Alterations in Traumatic Hemorrhagic Shock*. *Critical Care Medicine*, 42(6), 1433–1441. <https://doi.org/10.1097/CCM.0000000000000223>

Tackling drug-resistant infections globally. (n.d.). https://amr-review.org/sites/default/files/160518_Final%20paper_with%20cover.pdf

The European Society of GI Endoscopy (ESGE) Guideline on the diagnosis and management of nonvariceal UGI haemorrhage. (n.d.). https://www.esge.com/assets/downloads/pdfs/guidelines/2015_s_0034_1393172.pdf

Thiele, H., Jobs, A., Ouweneel, D. M., Henriques, J. P. S., Seyfarth, M., Desch, S., Eitel, I., Pössl, J., Fuernau, G., & de Waha, S. (2017). Percutaneous short-term active mechanical support devices in cardiogenic shock: a systematic review and collaborative meta-analysis of randomized trials. *European Heart Journal*, 38(47), 3523–3531. <https://doi.org/10.1093/eurheartj/ehx363>

Thiele, H., Zeymer, U., Neumann, F.-J., Ferenc, M., Olbrich, H.-G., Hausleiter, J., Richardt, G., Hennersdorf, M., Empen, K., Fuernau, G., Desch, S., Eitel, I., Hambrecht, R., Fuhrmann, J., Böhm, M., Ebel, H., Schneider, S., Schuler, G., & Werdan, K. (2012). Intraaortic Balloon Support for Myocardial Infarction with Cardiogenic Shock. *New England Journal of Medicine*, 367(14), 1287–1296. <https://doi.org/10.1056/NEJMoa1208410>

Trzeciak, S., Dellinger, R. P., Parrillo, J. E., Guglielmi, M., Bajaj, J., Abate, N. L., Arnold, R. C., Colilla, S., Zanotti, S., & Hollenberg, S. M. (2007). Early microcirculatory perfusion derangements in patients with severe sepsis and septic shock: Relationship to hemodynamics, oxygen transport, and survival. *Annals of Emergency Medicine*, 49(1), 88–98.e2. <https://doi.org/10.1016/j.annemergmed.2006.08.021>

Tuma, M., Canestrini, S., Alwahab, Z., & Marshall, J. (2016). Trauma and Endothelial Glycocalyx. *SHOCK*, 46(4), 352–357. <https://doi.org/10.1097/SHK.0000000000000635>

Vincent, J. L. (2002). Anemia and Blood Transfusion in Critically Ill Patients. *JAMA*, 288(12). <https://doi.org/10.1001/jama.288.12.1499>

World Population Ageing 2015. (n.d.).

http://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015_Report.pdf

Xu, J., Ma, L., Sun, S., Lu, X., Wu, X., Li, Z., & Tang, W. (2013). Fluid Resuscitation Guided by Sublingual Partial Pressure of Carbon Dioxide During Hemorrhagic Shock in a Porcine Model. *Shock*, 39(4), 361–365. <https://doi.org/10.1097/SHK.0b013e31828936aa>

Young, P., Bailey, M., Beasley, R., Henderson, S., Mackle, D., McArthur, C., McGuinness, S., Mehrtens, J., Myburgh, J., Psirides, A., Reddy, S., & Bellomo, R. (2015a). Effect of a Buffered Crystalloid Solution vs Saline on Acute Kidney Injury Among Patients in the Intensive Care Unit. *JAMA*, 314(16). <https://doi.org/10.1001/jama.2015.12334>

Young, P., Bailey, M., Beasley, R., Henderson, S., Mackle, D., McArthur, C., McGuinness, S., Mehrtens, J., Myburgh, J., Psirides, A., Reddy, S., & Bellomo, R. (2015b). Effect of a Buffered Crystalloid Solution vs Saline on Acute Kidney Injury Among Patients in the Intensive Care Unit. *JAMA*, 314(16). <https://doi.org/10.1001/jama.2015.12334>

Young, P. P., Cotton, B. A., & Goodnough, L. T. (2011). Massive Transfusion Protocols for Patients With Substantial Hemorrhage. *Transfusion Medicine Reviews*, 25(4), 293–303. <https://doi.org/10.1016/j.tmr.2011.04.002>