

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.

1.

Guyton AC, Hall JE. Guyton and Hall textbook of medical physiology [Internet]. Thirteenth edition. Philadelphia, PA: Elsevier; 2016. Available from: <https://www.vlebooks-com.ezproxy.library.qmul.ac.uk/Vleweb/Product/Index/748473?page=0>

2.

Tuma M, Canestrini S, Alwahab Z, Marshall J. Trauma and Endothelial Glycocalyx. SHOCK. 2016 Oct;46(4):352-7.

3.

Piehl MD, Manning JE, McCurdy SL, Rhue TS, Kocis KC, Cairns CB, et al. Pulse contour cardiac output analysis in a piglet model of severe hemorrhagic shock*. Critical Care Medicine. 2008 Apr;36(4):1189-95.

4.

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

5.

Lord JM, Midwinter MJ, Chen YF, Belli A, Brohi K, Kovacs EJ, et al. The systemic immune response to trauma: an overview of pathophysiology and treatment. The Lancet. 2014 Oct;384(9952):1455-65.

6.

Brohi K, Cohen MJ, Davenport RA. Acute coagulopathy of trauma: mechanism, identification and effect. *Current Opinion in Critical Care*. 2007 Dec;13(6):680-5.

7.

Pranskunas A, Koopmans M, Koetsier PM, Pilvinis V, Boerma EC. Microcirculatory blood flow as a tool to select ICU patients eligible for fluid therapy. *Intensive Care Medicine* [Internet]. 2013 Apr;39(4):612-9. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3607718/>

8.

Trzeciak S, Dellinger RP, Parrillo JE, Guglielmi M, Bajaj J, Abate NL, et al. Early microcirculatory perfusion derangements in patients with severe sepsis and septic shock: Relationship to hemodynamics, oxygen transport, and survival. *Annals of Emergency Medicine*. 2007 Jan;49(1):88-98.e2.

9.

Jhanji S, Lee C, Watson D, Hinds C, Pearse RM. Microvascular flow and tissue oxygenation after major abdominal surgery: association with post-operative complications. *Intensive Care Medicine* [Internet]. 2009 Apr;35(4):671-7. Available from: <https://link.springer.com/article/10.1007/s00134-008-1325-z>

10.

Tachon G, Harrois A, Tanaka S, Kato H, Huet O, Pottecher J, et al. Microcirculatory Alterations in Traumatic Hemorrhagic Shock*. *Critical Care Medicine*. 2014 Jun;42(6):1433-41.

11.

Hutchings SD, Naumann DN, Watts S, Wilson C, Burton C, Wendon J, et al. 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*. 2016 Dec;4(1).

12.

Jhanji S, Stirling S, Patel N, Hinds CJ, Pearse RM. The effect of increasing doses of norepinephrine on tissue oxygenation and microvascular flow in patients with septic shock*. *Critical Care Medicine*. 2009 Jun;37(6):1961–6.

13.

Morelli A, Donati A, Ertmer C, Rehberg S, Kampmeier T, Orecchioni A, et al. Effects of vasopressinergic receptor agonists on sublingual microcirculation in norepinephrine-dependent septic shock. *Critical Care*. 2011;15(5).

14.

Morelli A, Donati A, Ertmer C, Rehberg S, Lange M, Orecchioni A, et al. Levosimendan for resuscitating the microcirculation in patients with septic shock: a randomized controlled study. *Critical Care*. 2010;14(6).

15.

Jhanji S, Vivian-Smith A, Lucena-Amaro S, Watson D, Hinds CJ, Pearse RM. Haemodynamic optimisation improves tissue microvascular flow and oxygenation after major surgery: a randomised controlled trial. *Critical Care*. 2010;14(4).

16.

Xu J, Ma L, Sun S, Lu X, Wu X, Li Z, et al. Fluid Resuscitation Guided by Sublingual Partial Pressure of Carbon Dioxide During Hemorrhagic Shock in a Porcine Model. *Shock*. 2013 Apr;39(4):361–5.

17.

Shoemaker WC, Appel PL, Kram HB, Waxman K, Lee TS. Prospective Trial of Supranormal Values of Survivors as Therapeutic Goals in High-Risk Surgical Patients. *Chest* [Internet]. 1988 Dec;94(6):1176–86. Available from: <https://www.sciencedirect.com/science/article/pii/S0012369216312995>

18.

Starodub R, Abella BS, Grossestreuer AV, Shofer FS, Perman SM, Leary M, et al. Association of serum lactate and survival outcomes in patients undergoing therapeutic hypothermia after cardiac arrest. *Resuscitation*. 2013 Aug;84(8):1078–82.

19.

Marik PE, Baram M, Vahid B. Does Central Venous Pressure Predict Fluid Responsiveness?*: A Systematic Review of the Literature and the Tale of Seven Mares. *Chest*. 2008 Jul;134(1):172–8.

20.

Pierrakos C, Velissaris D, Scolletta S, Heenen S, De Backer D, Vincent JL. Can changes in arterial pressure be used to detect changes in cardiac index during fluid challenge in patients with septic shock? *Intensive Care Medicine* [Internet]. 2012 Mar;38(3):422–8. Available from: <https://link.springer.com/article/10.1007/s00134-011-2457-0>

21.

Alhashemi JA, Cecconi M, Hofer CK. Cardiac output monitoring: an integrative perspective. *Critical Care*. 2011;15(2).

22.

Cecconi M, Hofer C, Teboul JL, Pettila V, Wilkman E, Molnar Z, et al. Fluid challenges in intensive care: the FENICE study. *Intensive Care Medicine* [Internet]. 2015 Sep;41(9):1529–37. Available from: <https://link.springer.com/article/10.1007%2Fs00134-015-3850-x>

23.

Pierrakos C, Velissaris D, Scolletta S, Heenen S, De Backer D, Vincent JL. Can changes in arterial pressure be used to detect changes in cardiac index during fluid challenge in patients with septic shock? *Intensive Care Medicine* [Internet]. 2012 Mar;38(3):422–8. Available from: <https://link.springer.com/article/10.1007%2Fs00134-011-2457-0>

24.

Monge García MI, Guijo González P, Gracia Romero M, Gil Cano A, Oscier C, Rhodes A, et al. Effects of fluid administration on arterial load in septic shock patients. *Intensive Care Medicine* [Internet]. 2015 Jul;41(7):1247–55. Available from: <https://link.springer.com/article/10.1007%2Fs00134-015-3898-7>

25.

Aya HD, Ster IC, Fletcher N, Grounds RM, Rhodes A, Cecconi M. Pharmacodynamic Analysis of a Fluid Challenge. *Critical Care Medicine*. 2016 May;44(5):880–91.

26.

Aya HD, Rhodes A, Chis Ster I, Fletcher N, Grounds RM, Cecconi M. Hemodynamic Effect of Different Doses of Fluids for a Fluid Challenge. *Critical Care Medicine*. 2017 Feb;45(2):e161–8.

27.

Nunes TSO, Ladeira RT, Bafi AT, de Azevedo LCP, Machado FR, Freitas FGR. Duration of hemodynamic effects of crystalloids in patients with circulatory shock after initial resuscitation. *Annals of Intensive Care*. 2014 Dec;4(1).

28.

Monnet X, Rienzo M, Osman D, Anguel N, Richard C, Pinsky MR, et al. Passive leg raising predicts fluid responsiveness in the critically ill*. *Critical Care Medicine*. 2006 May;34(5):1402–7.

29.

Clarke DL, Chipps JA, Sartorius B, Bruce J, Laing GL, Brysiewicz P. Mortality rates increase dramatically below a systolic blood pressure of 105-mm Hg in septic surgical patients. *The American Journal of Surgery*. 2016 Nov;212(5):941–5.

30.

Lee YK, Hwang SY, Shin TG, Jo IJ, Suh GY, Jeon K. Prognostic Value of Lactate and Central Venous Oxygen Saturation after Early Resuscitation in Sepsis Patients. *PLOS ONE*. 2016 Apr 7;11(4).

31.

Angus DC, van der Poll T. Severe Sepsis and Septic Shock. *New England Journal of Medicine*. 2013 Aug 29;369(9):840–51.

32.

A Randomized Trial of Protocol-Based Care for Early Septic Shock. *The New England Journal of Medicine* [Internet]. 370:1683–93. Available from:
<https://search.proquest.com/docview/1520423050?pq-origsite=summon>

33.

Mellhammar L, Wullt S, Lindberg Å, Lanbeck P, Christensson B, Linder A. Sepsis Incidence: A Population-Based Study. *Open Forum Infectious Diseases*. 2016 Oct;3(4).

34.

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

35.

Rhodes A, Evans LE, Alhazzani W, Levy MM, Antonelli M, Ferrer R, et al. Surviving Sepsis Campaign. *Critical Care Medicine*. 2017 Mar;45(3):486–552.

36.

Reinhart K, Daniels R, Kisson N, Machado FR, Schachter RD, Finfer S. Recognizing Sepsis as a Global Health Priority — A WHO Resolution. *New England Journal of Medicine*. 2017 Aug 3;377(5):414–7.

37.

Tackling drug-resistant infections globally [Internet]. Available from:
https://amr-review.org/sites/default/files/160518_Final%20paper_with%20cover.pdf

38.

A European One Health Action Plan against Antimicrobial Resistance [Internet]. Available from:
https://ec.europa.eu/health/sites/health/files/antimicrobial_resistance/docs/amr_2017_action-plan.pdf

39.

De Backer D, Cecconi M, Lipman J, Machado F, Myatra SN, Ostermann M, et al. Challenges in the management of septic shock: a narrative review. *Intensive Care Medicine* [Internet]. 2019 Feb 11; Available from: <https://link.springer.com/article/10.1007/s00134-019-05544-x>

40.

Reynolds HR, Hochman JS. Cardiogenic Shock: Current Concepts and Improving Outcomes. *Circulation*. 2008 Feb 5;117(5):686–97.

41.

Haemodynamic Monitoring: ESICM EDIC PACT Study Tool [Internet]. Available from:
<https://www.esicm.org/education/>

42.

Elliott P. Rational use of inotropes. *Anaesthesia & Intensive Care Medicine*. 2006 Sep;7(9):326–30.

43.

Napp LC, Kühn C, Bauersachs J. ECMO in cardiac arrest and cardiogenic shock. *Herz*. 2017 Feb;42(1):27–44.

44.

Mebazaa A, Nieminen MS, Packer M, Cohen-Solal A, Kleber FX, Pocock SJ, et al.

Levosimendan vs Dobutamine for Patients With Acute Decompensated Heart Failure. *JAMA*. 2007 May 2;297(17).

45.

Gray A, Goodacre S, Newby DE, Masson M, Sampson F, Nicholl J. Noninvasive Ventilation in Acute Cardiogenic Pulmonary Edema. *New England Journal of Medicine*. 2008 Jul 10;359(2):142-51.

46.

Masip J, Roque M, Sánchez B, Fernández R, Subirana M, Expósito JA. Noninvasive Ventilation in Acute Cardiogenic Pulmonary Edema. *JAMA*. 2005 Dec 28;294(24).

47.

Sackner-Bernstein JD, Kowalski M, Fox M, Aaronson K. Short-term Risk of Death After Treatment With Nesiritide for Decompensated Heart Failure. *JAMA*. 2005 Apr 20;293(15).

48.

Thiele H, Zeymer U, Neumann FJ, Ferenc M, Olbrich HG, Hausleiter J, et al. Intraaortic Balloon Support for Myocardial Infarction with Cardiogenic Shock. *New England Journal of Medicine*. 2012 Oct 4;367(14):1287-96.

49.

Thiele H, Jobs A, Ouweneel DM, Henriques JPS, Seyfarth M, Desch S, et al. Percutaneous short-term active mechanical support devices in cardiogenic shock: a systematic review and collaborative meta-analysis of randomized trials. *European Heart Journal*. 2017 Dec 14;38(47):3523-31.

50.

Circulation. Available from:
<https://www.ahajournals.org/doi/10.1161/CIR.0000000000000509>

51.

Booth RA, Hill SA, Don-Wauchope A, Santaguida PL, Oremus M, McKelvie R, et al. Performance of BNP and NT-proBNP for diagnosis of heart failure in primary care patients: a systematic review. *Heart Failure Reviews* [Internet]. 2014 Aug;19(4):439–51. Available from: <https://link-springer-com.ezproxy.library.qmul.ac.uk/article/10.1007/s10741-014-9445-8>

52.

Napp LC, Kühn C, Bauersachs J. ECMO in cardiac arrest and cardiogenic shock. *Herz*. 2017 Feb;42(1):27–44.

53.

Major trauma: assessment and initial management | Guidance and guidelines | NICE. Available from: <https://www.nice.org.uk/guidance/ng39>

54.

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

55.

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

56.

Solomon, Caren GLaine, Loren. Upper Gastrointestinal Bleeding Due to a Peptic Ulcer. *The New England Journal of Medicine* [Internet]. 374(4):2367–76. Available from: <https://search.proquest.com/docview/1798243079?pq-origsite=summon>

57.

Laine, Loren, MD. Blood Transfusion for Gastrointestinal Bleeding. *The New England Journal*

of Medicine [Internet]. 368(8):75–6. Available from:
<https://search.proquest.com/docview/1266235512?pq-origsite=summon>

58.

Oyeniya BT, Fox EE, Scerbo M, Tomasek JS, Wade CE, Holcomb JB. Trends in 1029 trauma deaths at a level 1 trauma center: Impact of a bleeding control bundle of care. *Injury*. 2017 Jan;48(1):5–12.

59.

Holcomb JB, Tilley BC, Baraniuk S, Fox EE, Wade CE, Podbielski JM, et al. 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*. 2015 Feb 3;313(5).

60.

Cannon JW, Khan MA, Raja AS, Cohen MJ, Como JJ, Cotton BA, et al. Damage control resuscitation in patients with severe traumatic hemorrhage. *Journal of Trauma and Acute Care Surgery*. 2017 Mar;82(3):605–17.

61.

Shackelford SA, del Junco DJ, Powell-Dunford N, Mazuchowski EL, Howard JT, Kotwal RS, et al. Association of Prehospital Blood Product Transfusion During Medical Evacuation of Combat Casualties in Afghanistan With Acute and 30-Day Survival. *JAMA*. 2017 Oct 24;318(16).

62.

Spinella PC, Pidcoke HF, Strandenes G, Hervig T, Fisher A, Jenkins D, et al. Whole blood for hemostatic resuscitation of major bleeding. *Transfusion*. 2016 Apr;56:S190–202.

63.

Holcomb JB. Reconstitution: Reverse Engineering. *The Journal of Trauma: Injury, Infection, and Critical Care*. 2011 May;70:S65–7.

64.

Glassberg E, Nadler R, Gendler S, Abramovich A, Spinella PC, Gerhardt RT, et al. Freeze-Dried Plasma at the Point of Injury. *Shock*. 2013 Dec;40(6):444-50.

65.

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

66.

A code of practice for the diagnosis and confirmation of death - Academy of Medical Royal Colleges [Internet]. Available from: <http://www.aomrc.org.uk/publications/reports-guidance/code-practice-diagnosis-confirmation-death/>

67.

Blackstock MJ, Ray DC. Organ donation after circulatory death. *European Journal of Emergency Medicine*. 2014 Oct;21(5):324-9.

68.

Sampson, Hugh AMuñoz-Furlong, AnneCampbell, Ronna LAdkinson, N FranklinBock, S Allan. 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* [Internet]. 117(7):391-7. Available from: <https://search.proquest.com/docview/1504744658?pq-origsite=summon>

69.

Jiwaji Z, Brady S, McIntyre LA, Gray A, Walsh TS. Emergency department management of early sepsis: a national survey of emergency medicine and intensive care consultants. *Emergency Medicine Journal*. 2014 Dec;31(12):1000-5.

70.

A Comparison of Albumin and Saline for Fluid Resuscitation in the Intensive Care Unit. *New England Journal of Medicine*. 2004 May 27;350(22):2247-56.

71.

Maitland K, Kiguli S, Opoka RO, Engoru C, Olupot-Olupot P, Akech SO, et al. Mortality after Fluid Bolus in African Children with Severe Infection. *New England Journal of Medicine*. 2011 Jun 30;364(26):2483-95.

72.

Myburgh JA, Finfer S, Bellomo R, Billot L, Cass A, Gattas D, et al. Hydroxyethyl Starch or Saline for Fluid Resuscitation in Intensive Care. *New England Journal of Medicine*. 2012 Nov 15;367(20):1901-11.

73.

Antonelli M, Sandroni C. Hydroxyethyl Starch for Intravenous Volume Replacement. *JAMA*. 2013 Feb 20;309(7).

74.

Young P, Bailey M, Beasley R, Henderson S, Mackle D, McArthur C, et al. Effect of a Buffered Crystalloid Solution vs Saline on Acute Kidney Injury Among Patients in the Intensive Care Unit. *JAMA*. 2015 Oct 27;314(16).

75.

Vincent JL. Anemia and Blood Transfusion in Critically Ill Patients. *JAMA*. 2002 Sep 25;288(12).

76.

Rodriguez RM, Lum-Lung M, Dixon K, Nothmann A. A prospective study on esophageal Doppler hemodynamic assessment in the ED. *The American Journal of Emergency Medicine*. 2006 Oct;24(6):658-63.

77.

Howell MD, Donnino M, Clardy P, Talmor D, Shapiro NI. Occult hypoperfusion and mortality in patients with suspected infection. *Intensive Care Medicine* [Internet]. 2007 Oct 23;33(11):1892–9. Available from: <https://link.springer.com/article/10.1007%2Fs00134-007-0680-5>

78.

Helmerhorst HJF, Roos-Blom MJ, van Westerloo DJ, de Jonge E. Association Between Arterial Hyperoxia and Outcome in Subsets of Critical Illness. *Critical Care Medicine*. 2015 Jul;43(7):1508–19.

79.

Kilgannon JH. Association Between Arterial Hyperoxia Following Resuscitation From Cardiac Arrest and In-Hospital Mortality. *JAMA*. 2010 Jun 2;303(21).

80.

Stub D, Smith K, Bernard S, Nehme Z, Stephenson M, Bray JE, et al. Air Versus Oxygen in ST-Segment-Elevation Myocardial Infarction. *Circulation*. 2015 Jun 16;131(24):2143–50.

81.

Rincon F, Kang J, Maltenfort M, Vibbert M, Urtecho J, Athar MK, et al. Association Between Hyperoxia and Mortality After Stroke. *Critical Care Medicine*. 2014 Feb;42(2):387–96.

82.

Perel P, Roberts I, Ker K. Colloids versus crystalloids for fluid resuscitation in critically ill patients. *Cochrane Database of Systematic Reviews*. 2013 Feb 28;

83.

Young P, Bailey M, Beasley R, Henderson S, Mackle D, McArthur C, et al. Effect of a

Buffered Crystalloid Solution vs Saline on Acute Kidney Injury Among Patients in the Intensive Care Unit. *JAMA*. 2015 Oct 27;314(16).

84.

Angus DC, Barnato AE, Bell D, Bellomo R, Chong CR, Coats TJ, et al. A systematic review and meta-analysis of early goal-directed therapy for septic shock: the ARISE, ProCESS and ProMISe Investigators. *Intensive Care Medicine* [Internet]. 2015 Sep;41(9):1549-60. Available from: <https://link.springer.com/article/10.1007%2Fs00134-015-3822-1>

85.

Maitland K, Kiguli S, Opoka RO, Engoru C, Olupot-Olupot P, Akech SO, et al. Mortality after Fluid Bolus in African Children with Severe Infection. *New England Journal of Medicine*. 2011 Jun 30;364(26):2483-95.

86.

Maitland K, George EC, Evans JA, Kiguli S, Olupot-Olupot P, Akech SO, et al. Exploring mechanisms of excess mortality with early fluid resuscitation: insights from the FEAST trial. *BMC Medicine*. 2013 Dec;11(1).

87.

Ospina-Tascon G, Neves AP, Occhipinti G, Donadello K, Büchele G, Simion D, et al. Effects of fluids on microvascular perfusion in patients with severe sepsis. *Intensive Care Medicine* [Internet]. 2010 Jun;36(6):949-55. Available from: <https://link.springer.com/article/10.1007%2Fs00134-010-1843-3>

88.

Glassford N, Eastwood G, Bellomo R. Physiological changes after fluid bolus therapy in sepsis: a systematic review of the contemporary literature. *Critical Care*. 2014 Apr;18(S2).

89.

Guidet B, Ait-Oufella H. Fluid resuscitation should respect the endothelial glycocalyx layer. *Critical Care*. 2014 Dec;18(6).

90.

Chappell D, Bruegger D, Potzel J, Jacob M, Brettner F, Vogeser M, et al. Hypervolemia increases release of atrial natriuretic peptide and shedding of the endothelial glycocalyx. *Critical Care*. 2014 Oct;18(5).

91.

Young PP, Cotton BA, Goodnough LT. Massive Transfusion Protocols for Patients With Substantial Hemorrhage. *Transfusion Medicine Reviews*. 2011 Oct;25(4):293-303.

92.

Hogshire L, Carson JL. Red blood cell transfusion. *Current Opinion in Hematology*. 2013 Nov;20(6):546-51.

93.

Lucas CE, Ledgerwood AM. FFP:RBC Resuscitation Ratio and Post-Shock Fluid Uptake. *JAMA Surgery*. 2013 Mar 1;148(3).

94.

Gonzalez EA, Moore FA, Holcomb JB, Miller CC, Kozar RA, Todd SR, et al. Fresh Frozen Plasma Should be Given Earlier to Patients Requiring Massive Transfusion. *The Journal of Trauma: Injury, Infection, and Critical Care*. 2007 Jan;62(1):112-9.

95.

Guidelines | British Society for Haematology [Internet]. Available from:
<http://www.b-s-h.org.uk/guidelines/>

96.

Association of Anaesthetists of Great Britain and Ireland [Internet]. Available from:
<http://www.aagbi.org/>

97.

Handbook of Transfusion Medicine [Internet]. Available from:
<https://www.transfusionguidelines.org/transfusion-handbook>

98.

EMCrit Blog - Emergency Department Critical Care & Resuscitation [Internet]. Available
from: <https://emcrit.org/>

99.

Nevin DG, Brohi K. Permissive hypotension for active haemorrhage in trauma. *Anaesthesia*.
2017 Sep 22;

100.

Myles PS, Smith JA, Forbes A, Silbert B, Jayarajah M, Painter T, et al. Tranexamic Acid in
Patients Undergoing Coronary-Artery Surgery. *New England Journal of Medicine*. 2017 Jan
12;376(2):136-48.

101.

Gayet-Ageron A, Prieto-Merino D, Ker K, Shakur H, Ageron FX, Roberts I, et al. 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*. 2018 Jan;391(10116):125-32.

102.

World Population Ageing 2015 [Internet]. Available from:
http://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015_Report.pdf

103.

Physiology of Ageing [Internet]. Available from:

<https://www.sciencedirect.com/science/article/abs/pii/S1357303916302298>

104.

Sieck GC. Physiology of aging. *Journal of Applied Physiology*. 2003 Oct;95(4):1333-4.

105.

Sammy I, Lecky F, Sutton A, Leaviss J, O'Cathain A. Factors affecting mortality in older trauma patients—A systematic review and meta-analysis. *Injury*. 2016 Jun;47(6):1170-83.

106.

Cook I, Kirkup AL, Langham LJ, Malik MA, Marlow G, Sammy I. 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*. 2017 Jan;3.

107.

O'Grady NP, Alexander M, Burns LA, Dellinger EP, Garland J, Heard SO, et al. Guidelines for the prevention of intravascular catheter-related infections. *American Journal of Infection Control*. 2011 May;39(4):S1-34.

108.

Prytherch DR, Smith GB, Schmidt PE, Featherstone PI. ViEWS—Towards a national early warning score for detecting adult inpatient deterioration. *Resuscitation*. 2010 Aug;81(8):932-7.

109.

Burch VC, Tarr G, Morroni C. Modified early warning score predicts the need for hospital admission and inhospital mortality. *Emergency Medicine Journal*. 2008 Oct 1;25(10):674-8.