

RECOMMENDATIONS

From the present study we can recommend the following:

- 1) All patients with TBI should be subjected to hyperoxia as an effective method of treatment for improving brain metabolism and outcome through HBOT or NBH.
- 2) HBOT should be started as soon as the patient is clinically stable enough to be transported to HBOT facility.
- 3) Patients who are not stable enough to be transported may receive NBH in the ICU till they are stable enough to be transported to receive HBOT.
- 4) HBOT units should be constructed in trauma centers to decrease the risk of transportation of TBI patients.
- 5) Monochamber units for HBOT may be more safe and suitable for ICU TBI patients.
- 6) Further studies on larger number of patients should be done to evaluate the effect of hyperoxia in traumatic brain injury patients.

REFERENCES

- 1) Alves OL, Bullock R. Excitotoxic damage in traumatic brain injury. In: Clark RSB, Kochanek P. Brain injury. Boston:Kluwer Academic Publishers;2001.1.
- 2) Goldstein M. Traumatic brain injury: a silent epidemic. *Ann Neural* 1990; 27:327-29.
- 3) Maas AI, Stocchetti N, Bullock R. Moderate and severe traumatic brain injury in adults. *Lancet neurol J* 2008;7(8):728-41.
- 4) Jennett B. Epidemiology of head injury. *J Neurol Neurosurgery Psychiatry* 1996;60:362-9.
- 5) Alaranta H, Koskinen S, Leppanen L. Nationwide epidemiology of hospitalized patients with first time traumatic brain injury with special reference to prevention. *Wien Med Wochenschr* 2000; 150:444-8.
- 6) Corrigan JD, Selassie AW, Orman JA. The epidemiology of traumatic brain injury. *J Head Trauma Rehabil* 2010;25(3):224.
- 7) Sharaf –Islam. Road traffic accidents in Egypt (road war). *Al Ahram* 1998.
- 8) Segun T. Traumatic brain injury. Definition, epidemiology and pathophysiology. [serial online]. Cited 2009; available from URL: <http://emedicine.medscape.com/article/326510-overview>.
- 9) Hardman JM, Manoukian A. pathology of head trauma. *Neuroimaging clinics of North America* 2002;12(2):175-87.
- 10) Rao V, Lyketsos C. Neuropsychiatric sequelae of traumatic brain injury. *Psychosomatics* 2000;41(2):95-103.
- 11) Saatman KE, Duhaim AC. Workshop scientific team and advisory panel members, classification of traumatic brain injury for targeted therapies. *J Neurotrauma* 2008;25(7):719-38.
- 12) Jennett B, Snoek J, Bond MR, Brooks N. Disability after severe head injury: observations on the use of Glasgow outcome scale. *J Neurol, Neurosurg, Psychiatr* 1981; 44:285-93.
- 13) Povlishock J.T. Katz D.I. Update of neuropathology and neurological recovery after traumatic brain injury. *J. Head Trauma Rehabil* 2005;20:76–94.
- 14) Blissit PA. Care of the critically ill patient with penetrating head injury. *Crit Care Nursing Clin of North Am* 2006;18(3):321-32.
- 15) Hannay HJ, Howieson DB, Loring DW, Fischer JS, Lezak MD. Neuropathology for neuropsychologists. Neuropsychological assessment. Oxfor: Oxford University Press; 2004. 158-62.
- 16) Seidenwurm DI. Introduction to brain imaging. *Fundamentals of diagnostic Radiology*. Philadelphia: Lippincott, Williams & Wilkins; 2007. 53-5.

References

- 17) Smith DH, Meaney DF, Shull WH. Diffuse axonal injury in head trauma. *J Head Trauma Rehab* 2003; 18(4):307-16.
- 18) Liao LM, Bergsneider M, Becker DP. Pathology and pathophysiology of head injury. In: Youmans JR (ed). *Neurological surgery*, 4th ed. Philadelphia, London: Saunders WB 1996;3:1549-94.
- 19) Xiong Y, Lee CP, Peterson PL. Mitochondrial dysfunction following traumatic brain injury. *Head trauma: basic, preclinical and clinical directions*. New York: John Wiley and sons 2000;257-80.
- 20) Park E, Bell JD, Baker AJ. Traumatic brain injury: can the consequences be stopped?. *Canad Med Assoc J* 2008;178(9):1163-70.
- 21) Sappenfield J, Galvagno S, Blenko J. Initial treatment priorities for the physiological optimization of patients with severe traumatic brain injury. *OA Emergency Medicine* 2013;1(1):2.
- 22) Gang Cheng, Rong -hua Kong, Jian-ning Zhang. Mitochondria in traumatic brain injury and mitochondrial targeted multipotential therapeutic strategies. *Br J Pharmacol* 2012;167(4):699-719.
- 23) Siesjö BK. Basic mechanisms of traumatic brain damage. *Ann Emerg Med* 1993;22:959-69.
- 24) Menzel M, Doppenberg EM, Zauner A, et al. Increased inspired oxygen concentration as a factor in improved tissue oxygenation and tissue lactate levels after severe human head injury. *J Neurosurg* 1999;91:1-10.
- 25) Valadka AB, Goodman JC, Gopinath SP, et al. Comparison of brain tissue oxygen tension to microdialysis based measures of cerebral ischemia in fatally head-injured humans. *J Neurotrauma* 1998;7:509-17.
- 26) Robertson CS, Narayan RK, Gokaslan ZL, et al. Cerebral arteriovenous oxygen difference as an estimate of cerebral blood flow in comatose patients. *J Neurosurg* 1989;70:222-30.
- 27) Marmarou A, Anderson RL, Ward JD. Impact of ICP instability and hypotension on outcome in patients with severe head trauma. *J Neurosurg* 1991;75:59.
- 28) Becker DP, Miller JD, Ward JD. The outcome from severe head injury with early diagnosis and intensive care management. *J Neurosurg* 1993;47:491.
- 29) Graham DI, Ford I, Adams JH. Ischemic brain damage is still common in fatal non-missile head injury. *J Neurol Neurosug Psychiatry* 1998;52:346-50.
- 30) Phillips SJ, Whisnant JP. Hypertension and the brain. *Arch Intern Med*. 1992;152: 938-45.
- 31) Rosner MJ, Daughton S: Cerebral perfusion pressure management in head injury. *J Trauma* 1990;30:933-41.

References

- 32) Eileen Maloney-Wilensky, Vicente Gracias, Arthur Itkin, Katherine Hoffman, Stephanie Bloom, et al. Brain tissue oxygen and outcome after severe traumatic brain injury : A systemic review. *Crit Care Med* 2009;37:2057-63.
- 33) Lee J, Kelly D, Oertel M. Carbon dioxide reactivity, pressure autoregulation and metabolic suppression activity after head injury: a transcranial Doppler study . *J Neurosurg* 2001;95:222-32.
- 34) Childers MK, Rupright J, Smith DW. Post-traumatic hyperthermia in acute brain injury rehabilitation. 1994;8(4):335-43.
- 35) Betty J. Tsuei, Paul A. Kearney. Hypothermia in the trauma patient. *Injury* 2004;35:7-15.
- 36) Griesdale DE, Tremblay MH, McEwen J, Chittock DR. Glucose control and mortality in patients with severe traumatic brain injury. *Neurocrit Care* 2009;11(3):311-6.
- 37) Meier R, Béchir M, Ludwig S, Sommerfeld J, Keel M, et al. Differential temporal profile of lowered blood glucose levels (3.5 to 6.5 mmol/l versus 5 to 8 mmol/l) in patients with severe traumatic brain injury. *Crit Care* 2008; 12:R98
- 38) Jeremitsky E, Omert L, Dunham CM, Protetch J, Rodriguez A. Harbingers of poor outcome the day after severe brain injury: hypothermia, hypoxia, and hypoperfusion. *J Trauma* 2003, 54(2):312-9.
- 39) Kate Bradshaw, Martin Smith. Disorders of sodium balance after brain injury. *Contin Educ Anaesth Crit Care* 2008; 8(4):129-33.
- 40) Froelich M, Ni Q, Wess C, Ougorets I, Härtl R: Continuous hypertonic saline therapy and the occurrence of complications in neurocritically ill patients. *Crit Care Med* 2009, 37(4):1433-41.
- 41) Maas AI, Hukkelhoven CW, Marshall LF, et al. Prediction of outcome in traumatic brain injury with computed tomographic characteristics: A comparison between the computed tomographic classification and combinations of computed tomographic predictors. *Neurosurgery* 2005;57:1173–82.
- 42) Arlinghaus KA, Shoaib AM, Price TRP. Neuropsychiatric assessment. In : Silver JM, McAllister TW, Yudofsky SC (eds). *Textbook of traumatic brain injury*. Washington DC: American Psychiatric Association; 2005;63–5.
- 43) NINDS Traumatic Brain Injury Information Page. National Institute of Neurological Disorders and Stroke 2008-09-15. Retrieved 2008-10-27.
- 44) Parikh S, Koch M, Narayan RK. Traumatic brain injury. *International Anesthesiol Clinic* 2007;45(3):119–35.
- 45) Initial assessment and management. *Advanced trauma life support for doctors: Student course manual*. Chicago, IL: American College of Surgeons; 1997; 21-46.

References

- 46) Robinson A, Philip J. Radionuclide imaging of the brain. In: Sutton D (ed). Text book of radiology and imaging. London: Churchill Livingstone; 2003;1812-6.
- 47) Levin HS, Ampro E, Eisenberg HM. Magnetic resonance imaging and computed tomography in relation to the neurobehavioral sequelae of mild and moderate head injuries. *J Neurosurg* 1987;66:706-10.
- 48) Hassler PJ, Steinmets H, Gawlowski J. Transcranial doppler ultrasonography in raised pressure and intracranial circulatory arrest. *J Neurosurg* 1998;68:745-51.
- 49) Miller JD. Head injury. *J Neurol Neurosurg Psychiatry* 1993; 56: 440-7.
- 50) Marshall LF, Marshall SB, Klauber MR, Clark M. A new classification of head Injury based on computerized tomography. *J Neurosurg* 1991;75:14-20.
- 51) Sliegh JW. Somatosensory evoked potential in severe traumatic head injury. *J Neurosurg* 1999;91(4):577-80.
- 52) David W Nelson, Björn Thornquist, Robert M MacCallum, Harriet Nyström, Anders Holst, et al. Analyses of cerebral microdialysis in patients with traumatic brain injury: relations to intracranial pressure, cerebral perfusion pressure and catheter placement. *BMC Medicine* 2011; 9:21.
- 53) Cruz J, Hoffstad OJ, Jaggi JL. Cerebral lactate oxygen index in acute brain injury. *Crit Care Med* 1994;22:1465-70.
- 54) Claudia S, Robertson, Shankar P, Gopinath, J. Clay Goodman, et al. SjvO₂ Monitoring in Head-Injured Patients. *Journal of Neurotrauma* 1995;12(5):891-6.
- 55) Marik PE, Varon J, Trask T. Management of head trauma. *Crit Care Review* 2002; 122(2): 1-25.
- 56) Stocchetti N, Furlan A, Volta F. Hypoxemia and arterial hypotension at the accident scene in head injury. *J Trauma* 1996;40:764-7.
- 57) Tator CH, Fehlings MG. Review of the secondary injury theory of acute spinal cord trauma with emphasis on vascular mechanisms. *J Neurosurg* 1994;75:15-26.
- 58) Hills MW, Deane SA. Head injury and facial injury: is there an increased risk of cervical spine injury?. *J Trauma* 1993;34:549-53.
- 59) Brain trauma foundation and AANS/CNS joint section on neurotrauma and critical care. Guide lines for the management of severe traumatic brain injuries 3rd ed. Marry Ann Liebert , *Am J neurotrauma* 2007;24(1):1-116.
- 60) Wright M. Resuscitation of the multi trauma patient with head injury. *AACN Clin Issues* 1999;10:32-45.
- 61) Christos T, Spyros S. Initial evaluation and management of CNS injury. [Serial online].[Cited 2008 Jun 13]; Available from: URL: <http://emedicine.medscape.com/article/434261-overview>.

References

- 62) Felice S, Ramesh R, Jimmy H. Neurointensive care for traumatic brain injury. [Serial online]. [Cited 2009 Jun 26]
- 63) Lang EW, Chesnut RM. Intracranial pressure and cerebral perfusion pressure in severe head injury. *New Horizons* 1995;3:400-9.
- 64) Leonardo Rangel-Castello, Shankar Gopinath, Claudia S. Robertson. Management of intracranial hypertension. *Neurol Clin* 2008;26(2):521-41.
- 65) Cremer OL, van Dijk GW, van Wensen E, et al. Effect of intracranial pressure monitoring and targeted intensive care on functional outcome after severe head injury. *Crit Care Med* 2005;33(10):2207-13.
- 66) Bullock R, Chesnut RM, Clifton G, et al: Guidelines for the management of severe traumatic brain injury. *J Neurotrauma* 2000; 17: 451–553
- 67) Visish M. Srinivasan, Brent R. O'Neill, Diana Jho, Donald M. Whiting, Michael Y. Oh. The history of external ventricular drainage. *Journal of Neurosurgery* 2013;1:1-9.
- 68) Zhong J, Dujovny M, Park HK, Perez E, Perlin AR, et al. Advances in ICP monitoring techniques. *Neurol Res.* 2003;25(4):339-50.
- 69) Muizelaar JP, Wei EP, Kontos HA. Mannitol causes compensatory cerebral vasoconstriction and vasodilatation to blood viscosity changes. *J Neurosurg* 1983;59:822-8.
- 70) Barry KG, Berman AR. The acute effect of the intravenous infusion of mannitol on blood and plasma volume. *N Eng J Med* 1961;264:1085-8.
- 71) Brown FD, Johns L, Jafar JJ. Detailed monitoring of the effect of mannitol following experimental head injury. *J Neurosurg* 1979;50:423-32.
- 72) Zornow MH. Hypertonic saline as a safe and efficacious treatment intracranial hypertension. *J Neurosurg Anaesthesiol* 1996;8:175-7.
- 73) Bancks C, Furyk J. Hypertonic saline use in the emergency department. *Emerg Med Australas* 2008; 20:294-305.
- 74) Prough DS, Whitely JM, Taylor CL. Regional cerebral blood flow following resuscitation from hemorrhagic shock with hypertonic saline. Influence of a subdural mass. *Anaesthesiol* 1991; 75:319-27.
- 75) Pollay M, Fullenwider C, Roberts A. Effect of mannitol and furosemide on blood-brain osmotic gradient and intracranial pressure. *J Neurosurg* 1983; 59:945-50.
- 76) Muizelaar JP, Marmarou A, Ward JD. Adverse effects of prolonged hyperventilation in patients with severe head injury: a randomized clinical trial. *J Neurosurg* 1991;75:731-9.
- 77) Smith AL. Barbiturate protection in cerebral hypoxia. *Anesthesiol* 1977;47:285-90.

References

- 78) Schalen W, Messeter K, Nordstrom CH. Complications and side effects during thiopentone therapy in patients with severe head injuries. *Acta Anaesthesiol Scand* 1992;36:369-77.
- 79) Shiozaki T, Sugimoto H, Taneda M. Selection of severely head injured patients for mild hypothermia therapy. *J Neurosurg* 1998; 89:206-9.
- 80) McIntyre LA, Fergusson DA, Hebert PC. Prolonged therapeutic hypothermia after traumatic brain injury in adults: a systematic review. *JAMA* 2003; 289:2992-5.
- 81) Chestnut RM. The management of severe traumatic head injury. *Emerg Med Clin North Am* 1997; 15: 581-604.
- 82) Venkatesh B, Townsend S, Boots RJ. Does splanchnic ischemia occur in isolated neurotrauma a prospective observational study. *Crit Care Med* 1999; 27: 1175-80.
- 83) Hanisch EW, Encke A, Naujoks F. A randomized double-blinded trial for stress ulcer prophylaxis shows no evidence of increased pneumonia. *Am J Surg* 1998; 176: 453-4.
- 84) Geerts WH, Code KI, Jay RM. A prospective study of venous thromboembolism after major trauma. *N Engl J Med* 1994; 331: 1601-6.
- 85) Geerts WH, Jay RM, Code KI. A comparison of low-dose heparin with low-molecular-weight heparin as prophylaxis against venous thromboembolism after major trauma. *N Engl J Med* 1996; 335: 701-7.
- 86) Wade DT, Crawford S, Wended FJ. Does routine follow up after head injury help? a randomized controlled trial. *J Neurol Neurosurg Psychiatry* 1997; 62: 478-84.
- 87) Agrawal A, Timothy J, Pandit L, Manju M. Post-traumatic epilepsy: an overview. *Clin Neurol Neurosurg* 2006; 108(5):433-9.
- 88) Frey LC. Epidemiology of posttraumatic epilepsy: a critical review. *Epilepsia* 2003; 44(Suppl 10):11-7.
- 89) Braakman R, Habbema JD, Gelpke GJ. Prognosis and prediction of outcome in comatose head injured patients. *Acta Neurochir Suppl (Wien)* 1986; 36:112-7.
- 90) Marshall LF, Smith RW, Shapiro HM. The outcome with aggressive treatment in severe head injuries. Part1: the significance of intracranial pressure monitoring. *J Neurosurg* 1979; 50:20-4.
- 91) Bowers SA, Marshall LF. Outcome in 200 consecutive cases of severe head injury treated in San Diego County: a prospective analysis. *Neurosurgery* 1980; 6:237-40.
- 92) Victor Nell, DLitt et Phil, David W. Yates, Johan Kruger. An extended Glasgow Coma Scale (GCS-E) with enhanced sensitivity to mild brain injury. *Archives of Physical Medicine and Rehabilitation* 2000;81(5):614-7.
- 93) Clarke, Van Reekum, et al. An appraisal of the psychometric properties of the Clinician version of the Apathy Evaluation Scale (AES-C)." *Int J Methods Psychiatr Res* 2007;16(2):97-110.

References

- 94) Nichol, et al. Measuring Functional and Quality of Life Outcomes Following Major Head Injury: Common Scales and Checklists. *Injury, Int J.* 2011;42:281-7.
- 95) Gill AL, Bell CN: Hyperbaric Oxygen: Its Uses, Mechanisms of Action and Outcomes. *QJM* 2004; 97:385-95.
- 96) Edwards ML. Hyperbaric oxygen therapy. Part 1: history and principles. *J Vet Emerg Crit Care (San Antonio)*. 2010;20(3):284-8.
- 97) Zauner A, Daugherty WP, Bullock MR, et al. Brain oxygenation and energy metabolism : Part 1: Biological function and pathophysiology. *Neurosurgery* 2002;51:289-301.
- 98) Ganong WF. Review of medical physiology. New York: McGraw-Hill 2003.
- 99) D F Treacher, R M Leach. Oxygen transport- 1.Basic principles .*BMJ* 1998;317(168):1302-6.
- 100) Guyton AC, Hall JE. Textbook of medical physiology. Philadelphia, PA:W.P. Saunders company, 2000.
- 101) Calvert JW, Cahill J, Zhang JH: Hyperbaric Oxygen and Cerebral Physiology. *Neurol Res* 2007;29:132-41.
- 102) Muthuraju S, Pati S, Rafiqul M, Abdullah JM, Jaffar H . Effect of normobaric hyperoxia treatment on neuronal damage following fluid percussion injury in the striatum of mice: A morphological approach. *J Biosci* 2013;38(1)1-11.
- 103) Menzel M. Doppenberg, Zauner A., Soukup J, Reinert M.M., Clausen T, et al. Cerebral oxygenation in patients after severe head injury: monitoring and effects of arterial hyperoxia on cerebral blood flow, metabolism and intracranial pressure. *J Neurosurg Anesthesiol* 1999;11:240-51.
- 104) Leonardo-Rangel Castello, Lucia Revera Lara. Cerebral haemodynamic effects of acute hyperoxia and hyperventilation after severe traumatic brain injury. *J Neurotrauma* 2010;27:1853-63.
- 105) Sandra Rossi, Nino Stocchetti, Luca Longhi, Marcella Balestreri, Diego Spagnoli, et al. Brain oxygen tension, oxygen supply, and oxygen consumption during arterial hyperoxia in a model of progressive cerebral ischemia. *Journal Of Neurotrauma* 2001;18(2):163-74.
- 106) Rockswold SB, Rockswold GL, Zaun DA, Zhang X, Cerra CE, Bergman TA, et al.: A Prospective, Randomized Clinical Trial to Compare the Effect of Hyperbaric to Normobaric Hyperoxia on Cerebral Metabolism, Intracranial Pressure, and Oxygen Toxicity in Severe Traumatic Brain Injury. *J Neurosurg* 2010; 112:1080-94.
- 107) Knighton DR, Halliday B, Hunt TK. Oxygen as an antibiotic: the effect of inspired oxygen on infection. *Arch Surg* 1984; 119:199–204.
- 108) Ravi Prakash Popat, Parita Ravi Popat. Role of hyperbaric oxygen therapy in the treatment of periodontitis. *SRM Journal* 2014;5(2);102-5.

References

- 109) Sheikh AY, Gibson JJ, Rollins MD, et al. Effect of hyperoxia on vascular endothelial growth factor levels in a wound model. *Arch Surg* 2000;135(11):1293-7.
- 110) Carden DL, Granger DN. Pathophysiology of ischaemia-reperfusion injury. *J Pathol* 2000;190(3):255-66.
- 111) Myers RAM. Hyperbaric oxygen therapy for trauma: crush injury, compartment syndrome, and other acute traumatic peripheral ischaemias. *Int Anesthesiol Clin* 2000;38:139-51.
- 112) Zamboni WA, Roth AC, Russell RC, Graham B, Suchy H, et al. Morphological analysis of the microcirculation during reperfusion of ischaemic skeletal muscle and the effect of hyperbaric oxygen. *Plastic Reconstr Surg* 1993; 91:1110-23.
- 113) Thom SR. Antagonism of carbon monoxide-mediated brain lipid peroxidation by hyperbaric oxygen. *Toxicol Appl Pharmacol* 1990; 105:340-4.
- 114) Villanucci S, Di Marzio GE, Scholl M, et al. Cardiovascular changes induced by hyperbaric oxygen therapy. *Undersea Biomed Res* 1990; 17:116-7.
- 115) Wattel F, Mathieu D, Neviere R, Bocquillon N. Hyperbaric therapy: acute peripheral ischaemia and compartment syndrome: a role for hyperbaric oxygenation. *Anaesthesia* 1998; 53:63-5.
- 116) Undersea and Hyperbaric Medical Society. *Indications for Hyperbaric Oxygen Therapy* 2014.
- 117) Palmquist B-M, Philipson B, Barr P-O. Nuclear cataract and myopia during hyperbaric oxygen therapy. *Br J Ophthalmol* 1984; 68:113-7.
- 118) Bert P. *La pression barométrique, recherches e physiologie expérimentale*. Paris, Masson, 1878.
- 119) Hampson N, Atik D. Central nervous system oxygen toxicity during routine hyperbaric oxygen therapy. *Undersea Hyperb Med* 2003; 30:147-53.
- 120) Brown M, Jones J, Krohmer J. Pseudoephedrine for the prevention of barotitis media. A controlled clinical trial in underwater divers. *Ann Emerg Med* 1992; 21:849-52.
- 121) Sheffield PJ, Desautels DA. Hyperbaric and hypobaric chamber fires: a 73 year analysis. *Undersea Hyperb Med* 1997; 24:153-64.
- 122) Foster JH. Hyperbaric oxygen treatment complications and contraindications. *J Maxillofac Surg* 1992;50(10):1081-95.
- 123) UHMS Hyperbaric Oxygen Safety Committee. *Safe design and operation of hyperbaric chambers* 2012
- 124) Feldmeier J. *Hyperbaric Oxygen: Indications and Results- The Hyperbaric Oxygen Therapy Committee Report*. Kensington, Maryland: Undersea and Hyperbaric Medical Society, Inc. 2003
- 125) Klein J. Normobaric pulmonary oxygen toxicity. *Anesth Analg* 1990;70:195-207.

References

- 126) Mantell LL, Horowitz S, Davis JM, et al. Hyperoxia induced cell death in the lung: the correlation of apoptosis, necrosis and inflammation. *Ann NY Acad Sci* 1999;887:171-80.
- 127) Deaton PR, McKellar CT, Culbreth R, et al. Hyperoxia stimulates interleukin-8 release from alveolar macrophage and U937 cells: attenuation by dexamethasone. *Am J Physiol* 1994;267:87-92.
- 128) Muehlstedt SG, Richardson CJ, Lyte M, et al. Cytokines and the pathogenesis of nosocomial pneumonia. *Surgery* 2001;130:602-9.
- 129) Wright WP. Use of the university of pennsylvania institute for environmental procedure for calculation of cumulative pulmonary oxygen toxicity. *US Navy Experimental Diving Unit* 1972.
- 130) Ikeda Y, Long DM. The molecular basis of brain injury and brain edema: The role of oxygen free radicals. *Neurosurgery* 1990;27:1-11.
- 131) Rogatsky GG, Shifrin EG, Mayevsky A. Physiologic and biochemical monitoring during hyperbaric oxygenation. *Undersea Hyperbar Med* 1999;26(2):111-22.
- 132) US NEDU. Hyperbaric safe medical equipment 2005.
- 133) Jacek Kot. Medical equipment for multiplace hyperbaric chambers. *European journal of underwater and hyperbaric medicine* 2005;6:115-20.
- 134) Dohgomori H, Arikawa K, Kanmura Y. Accuracy of infusion pump during hyperbaric oxygen therapy. *Undersea Hyperbar Med* 2003;30(3):216-7.
- 135) Swaby K, Swaby G, Fife C, Smith L. Testing considerations for fluid infusion systems used in the hyperbaric environment. *Undersea Hyperbar Med* 2003;30(3):262.
- 136) Sutton T, Freeses M, Saur S, Swaby G, Berry J, et al. testing of portable blood gas analyser under hyper/hypobaric conditions. *UHM* 1994;21:50.
- 137) Germopre P, Baekelandt D, Braynus T. Ventilatory parameter monitoring during intensive care hyperbaric treatments. *EUBS Ajaccio, France* 2004;112-5.
- 138) Ratzenhofer, Komenda B, Offner A, Klemen H, Berger J, et al. Hemodynamic and oxygenation profiles in the early period after hyperbaric oxygen therapy. *Acta anaesthesiol scand* 2003;47(5):554-8.
- 139) Jacek Kot. Medical equipment for multiplace hyperbaric chambers. *European journal of underwater and hyperbaric medicine* 2006;7:9-11.
- 140) Galinski M, Treoux V, Garigoue B, et al. Intracuff pressures of endotracheal tubes in the management of airway emergencies: the need for pressure monitoring. *Ann Emerg Med* 2006;47:545-7.
- 141) Walker KJ, Millar IL, Fock A. The performance and safety of a pleural drainage unit under hyperbaric conditions. *Anaesth intensive care* 2006;34:61-67.

References

- 142) Moon RE, Bergquist LV, Conklin B, Miller JN: Monaghan 225 ventilator use under hyperbaric conditions. *Chest* 1986;89:846-51.
- 143) National fire, Protection Association. Manual on fire hazards in oxygen enriched atmospheres. NEPA 53-94. Boston, MA. National fire protection Association 1994.
- 144) Lars I Eriksson, Ronald D. Miller, Jeanine P. Wiener, Lee Fleisher, William L. Young, et al. Evaluation of a patient for safety of hyperbaric oxygen treatment. *Anesthesia: 2-Volume Set* 2009;5(80):2500-1.
- 145) Kumaria A, Tolia CM: Normobaric Hyperoxia Therapy for Traumatic Brain Injury and Stroke: A Review. *Br J Neurosurg* 2009;23:576-84.
- 146) Tolia CM, Reinert M, Seiler R, Gilman C, Scharf A, et al. Normobaric Hyperoxia--Induced Improvement in Cerebral Metabolism and Reduction in Intracranial Pressure in Patients with Severe Head Injury: A Prospective Historical Cohort-Matched Study. *J Neurosurg* 2004, 101:435-444
- 147) Narotam PK, Morrison JF, Nathoo N: Brain Tissue Oxygen Monitoring in Traumatic Brain Injury and Major Trauma: Outcome Analysis of a Brain Tissue Oxygen-Directed Therapy. *J Neurosurg* 2009; 111:672-82.
- 148) Nortje J, Coles JP, Timofeev I, Fryer TD, Aigbirhio FI, Smielewski P, et al.: Effect of Hyperoxia on Regional Oxygenation and Metabolism after Severe Traumatic Brain Injury: Preliminary Findings. *Crit Care Med* 2008; 36:273-281.
- 149) Wenlan Liu, Jell Hendren, Ke Jan Liu, et al. Normobaric hyperoxia reduces the neurovascular complications associated with delayed tissue plasminogen activator treatment in a rat model of focal cerebral ischemia. *Stroke* 2009;40(7):2526-31.
- 150) Kim HY, Singhal AB, Lo EH. Normobaric hyperoxia extends the reperfusion window in focal cerebral ischemia. *Ann Neurol* 2005;57:571-5.
- 151) Liu S, Liu W, Ding W, Miyake M, Rosenberg GA, et al. Electron paramagnetic resonance-guided normobaric hyperoxia treatment protects the brain by maintaining penumbral oxygenation in a rat model of transient focal cerebral ischemia. *J Cereb Blood Flow Metab* 2006;26:1274-84.
- 152) Leslie E, Geoffrey J and James M(eds). *Statistical analysis. In: Interpretation and uses of medical statistics (4th ed).* Oxford Scientific Publications(pub). 1991, pp.411-6.
- 153) Kirkpatrick LA, Feeney BC. *A simple guide to IBM SPSS statistics for version 20.0.* Student ed. Belmont, Calif.: Wadsworth, Cengage Learning; 2013. x, 115 p. p.
- 154) Carli P, Orliaguet G. Severe traumatic brain injury in children *Lancet.* 2004;363(9409):584-5..
- 155) Hilaire J, Thompson, Wayne C, McCormick, Sarah H. Kagan. Traumatic brain injury in adults: Epidemiology, outcomes, and future implications. *J Am Geriatr Soc.* 2008;54(10)1590-5.

References

- 156) Hardman JM, Manoukian A. Pathology of head trauma. *Neuroimag Clin North Am* 2002;12:175-87.
- 157) David Kushner. Traumatic Brain Injury. Toward Understanding Manifestations and Treatment. *Arch Intern Med* 1998;158(15):1617-24.
- 158) McDonagh M, Helfand M, Carson S, Russman BS. Hyperbaric oxygen therapy for traumatic brain injury: A systemic review of the evidence. *Arch phys Med Rehab* 2004;85:1198-204.
- 159) Lin JW, Tsai JT, Lee LM, Lin CM, Hung CC, Hung KS, et al. Effect of hyperbaric oxygen on patients with traumatic brain injury. *Acta Neurochir Suppl* 2008; 101:145-9.
- 160) Narotam PK, Morrison JF, Nathoo N: Brain Tissue Oxygen Monitoring in Traumatic Brain Injury and Major Trauma: Outcome Analysis of a Brain Tissue Oxygen-Directed Therapy. *J Neurosurg* 2009;111:672-82.
- 161) Martin M. Tisdall, Llias Tachtsidis, Terence S Leung, Clare E Elwell, Martin Smith. Increase in cerebral aerobic metabolism by normobaric hyperoxia after traumatic brain injury. *Journal of Neurosurgery* 2008; 109(3):424-32.
- 162) Sukoff MH, Ragatz RE. Oxygenation for the treatment of acute cerebral edema. *Neurosurgery* 1982;10:29-38.
- 163) Zhou Z, Daugherty WP, Sun D, Levasseur JE, Altememi N, et al. Protection of mitochondrial function and improvement in cognitive recovery in rats treated with hyperbaric oxygen following lateral fluid percussion injury. *J Neurosurgery* 2007;106(4):687-94.
- 164) Wang GH, Zhang XG, Jiang ZL, Li X, Peng LL, Li YC, et al. Neuroprotective Effects of Hyperbaric Oxygen Treatment on Traumatic Brain Injury in the Rat. *J Neurotrauma* 2010;27:1733-43.
- 165) Samir H Haddad, Yaseen M Arab. Critical care management of severe traumatic brain injury in adults. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine* 2012; 20:12.
- 166) A Thiagarajan, P D Goverdhan, P Chari, K Somasunderam. The effect of hyperventilation and hyperoxia on cerebral venous oxygen saturation in patients with traumatic brain injury. *Anesth Analg.* 1998 ;87(4):850-3.
- 167) Rockswold SB, Rockswold GL, Vargo JM, Erickson CA, Sutton RL, et al. Effects of hyperbaric oxygenation therapy on cerebral metabolism and intracranial pressure in severely brain injured patients. *J Neurosurg.* 2001;94(3):403-11.
- 168) Nakamura T, Kuroda Y, Yamashita S, Kawakita K, Kawai N, et al. Hyperbaric oxygen therapy for consciousness disturbance following head injury in subacute phase. *Acta Neurochir Suppl* 2008;102:21-4.
- 169) Sarah B. Rockswold, Gaylan L. Rockswold, David A. Zaun, Jiannong Liu. A prospective, randomized Phase II clinical trial to evaluate the effect of combined hyperbaric and normobaric hyperoxia on cerebral metabolism, intracranial pressure, oxygen toxicity, and clinical outcome in severe traumatic brain injury. *J Neurosurgery* 2013;118(6):1317-28.

الملخص العربي

تعتبر اصابات المخ الناتجة عن الحوادث من المشاكل الصحية الخطيرة التي تؤدي الى العديد من الوفيات و تسبب الاعاقة لشريحة مهمة من المجتمع وهم الشباب و الأطفال لأنهم الأكثر عرضة لهذه الأصابات مما يؤثر على انتاجية الفرد و الأسرة و المجتمع.

ولقد أجريت بعض الأبحاث على استخدام العلاج بالأكسجين في حالات اصابات المخ لتحسين الايض المخي و تحسين درجة الوعي لهؤلاء المرضى. و هناك طريقتان لاستخدام العلاج بالاكسجين في هذه الحالات وهما: الاكسجين المظغوط ويعنى تنفس المريض نسبة عاليه من الاكسجين تحت ضغط اعلى من الضغط الجوى المعتاد. والطريقة الاخرى هي الاكسجين ذو الكثافة العالية و يعنى تنفس المريض لنسبة عالية من الاكسجين تحت الضغط الجوى المعتاد.

كان الهدف من هذا البحث هو مقارنة تأثير العلاج بالأكسجين المضغوط و الأكسجين ذو الكثافة العالية على مرضى اصابات المخ المتوسطة من حيث الأيض المخي و تحديد مصير هؤلاء المرضى.

وقد تم تقييم هذه التأثيرات من خلال قياس نتائج الأيض وهي: اللاكتات و الأكسجين من خلال الوريد العنقى وباستخدام مصير جلاسكو في فترة عشرون يوما.

وقد أجريت هذه الدراسة على خمس و سبعين مريضا من مرضى الأصابات المخية المتوسطة والذين يتلقون العلاج بوحدة العناية المركزة. و تم تقسيم المرضى الى ثلاث مجموعات:

المجموعة الاولى: والتي تلقت العلاج التحفظي الكامل بالاضافة الى العلاج بالاكسجين المضغوط (جلسة واحدة يوميا لمدة ساعة لمدة عشرون يوما تحت ضغط واحد و نصف جو).

المجموعة الثانية: و التي تلقت العلاج التحفظي الكامل بالاضافة الى العلاج بالاكسجين ذو الكثافة العالية (ثلاث ساعات يوميا لمدة عشرون يوما)

المجموعة الثالثة: والتي تلقت العلاج التحفظي الكامل فقط.

وقد أسفرت الدراسة عن النتائج الآتية:

- معظم المصابين بأصابات المخ من الشباب صغار السن، و أن أكثرهم من الذكور.
- لا يوجد فارق ذو دلالة احصائية بين الثلاث مجموعات من حيث السن و الجنس و النتائج المعملية مثل: نسبة الهيموجلوبين، وظائف الكلى، و أملاح الدم.
- تحسن معدلات الايض لللاكتات و الاكسجين من خلال الوريد العنقى و كذلك تحسن مصير جلاسكو بعد جلسات الاكسجين المضغوط بصورة اكبر من الاكسجين عالى الكثافة، و تحسنتها بعد جلسات الاكسجين عالى الكثافة بصورة أكبر من العلاج التحفظي الكامل فقط.

وقد أظهرت الدراسة الاستنتاجات و التوصيات الآتية:

- أن علاج مرضى الاصابات المخية المتوسطة بالأكسجين المضغوط يؤدي الى تحسن ملحوظ في أبيض المخ و كذلك تحسن مصير هؤلاء المرضى بدرجة أكبر كثيرا من الأكسجين عالى الكثافة.
- كما نوصى من خلال نتائج هذا البحث بعلاج مرضى اصابات المخ باستخدام الأكسجين المضغوط اذا كانت الحالة مستقرة و تسمح بالنقل لمكان تلقى جلسات الأكسجين.
- اذا كانت الحالة لا تسمح بالنقل لمكان تلقى جلسات الاكسجين المضغوط فيمكن اسنخدام الاكسجين عالى الكثافة داخل العناية المركزة للاستفادة من مزايا العلاج بالأكسجين الى ان تسمح حالة المريض بالنقل لتلقى الاكسجين المضغوط.



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رسالة مقدمة

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ضمن متطلبات درجة

الماجستير

فى

الطب الحرج

من

محمد قدرى بلتاچى موسى منسى

بكالوريوس الطب والجراحة، ٢٠٠٦

كلية الطب، جامعة الإسكندرية

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رسالة مقدمة من

محمد قدرى بلتاغى موسى منسى

للحصول على درجة

الماجستير

فى

الطب الحرج

التوقيع

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