

PULSION Medical Systems
PiCCO Technology Literature

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- Very highly recommended
- Highly recommended
- Recommended

'This document is intended to provide information to an international audience outside of the US'

1. Reviews

1.1 General

Assaad S, Popescu W, Perrino A

Fluid management in thoracic surgery

Curr Opin Anaesthesiol 2013; 26(1): 31-9

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Sakka SG, Reuter DA, Perel A

The transpulmonary thermodilution technique

J Clin Monit Comput 2012; 26: 347-53

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Oren-Grinberg A.

The PiCCO Monitor

International Anesthesiology Clinics 2010; 48(1): 57 – 85

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Reuter D, Huang C, Edrich T, Shernan SK, Eltzschig HK

Cardiac output monitoring using indicator-dilution techniques: basics, limits, and perspectives

Anesth Analg, 2010; 110(3): 799-811

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King D & Price AM.

Measuring cardiac output using the PiCCO system

British Journal of Cardiac Nursing 2008; 3 (11): 512-519

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Malbrain M, De Potter P, Deeren D.

Cost Effectiveness of minimally invasive hemodynamic monitoring

In: Vincent JL (Ed.), Yearbook of Intensive Care and Emergency Medicine 2005: 603-18

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Genahr A, McLuckie A

Transpulmonary thermodilution in the critically ill

Brit J Int Care 2004: 6-10

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1.2 Cardiac Output

Reuter D, Goetz AE

[Messung des Herzzeitvolumens] (Article in German)

Anaesthesist 2005; 54:1135-53

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1.3 Preload

Eichhorn V, Goepfert MS, Eulenburg C, Malbrain ML, Reuter DA

Comparison of values in critically ill patients for global end-diastolic volume and extravascular lung water measured by transcardiopulmonary thermodilution: A metaanalysis of the literature

Med Intensiva 2012; 36(7): 467-74

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Della Rocca G, Costa MG, Pietropaoli P.

How to measure and interpret volumetric measures of preload

Curr Opin Crit Care 2007; 13(3): 297-302

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1.4 Lung Water

Zhang Z, Lu B, Ni H.

Prognostic value of extravascular lung water index in critically ill patients: A systematic review of the literature

J Crit Care 2012; 27(4): 420 e.1-9

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Maharaj R.

Extravascular lung water and acute lung injury

Cardiol Res Pract 2011; 2012: 407035

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Fernandez-Mondejar E, Guerrero-López F, Colmenero M.

How important is the measurement of extravascular lung water?

Curr Opin Crit Care 2007; 13: 79-83

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Michard F.

Bedside assessment of extravascular lung water by dilution methods: temptations and pitfalls

Crit Care Med 2007; 35(4):1186-92

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Isakow W, Schuster DP.

Extravascular lung water measurements and hemodynamic monitoring in the critically ill: bedside alternatives to the pulmonary artery catheter

Am J Physiol Lung Cell Mol Physiol 2006; 291: 1118-33

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1.5 Pediatric

Lemson J, Nusmeier A, van der Hoeven JG

Advanced Hemodynamic Monitoring in Critically Ill Children

Pediatrics 2011; 128(3): 560-71

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2. Guidelines and Standard Operating Procedures

Reinhart K, Brunkhorst FM, Bone HG, Bardutzky J, Dempfle CE, Forst H, Gastmeier P, Gerlach H et al.

Prevention, diagnosis, treatment, and follow-up care of sepsis. First revision of the S2k Guidelines of the German Sepsis Society (DSG) and the German Interdisciplinary Association for Intensive and Emergency Care Medicine (DIVI)

Anaesthesist 2010; 59(4): 347-70

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Carl M, Alms A, Braun J, Dongas A, Erb J, Goetz A, Goepfert M, Gogarten W, Grosse J, Heller AR et al.

S3 guidelines for intensive care in cardiac surgery patients: hemodynamic monitoring and cardiocirculatory system

Ger Med Sci 2010; 8: Doc12 (article in German)

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Brierley J, Choong K, Cornell T, Decaen A, Deymann A, Doctor A, Davis A, Duff J, Dugas MA et al.

2007 American College of Critical Care Medicine clinical practice parameters for hemodynamic support of pediatric and neonatal septic shock

Crit Care Med 2009; 37(2): 666 – 688

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Dellinger RP, Levy MM, Carlet JM, Bion J, Parker MM, Jaeschke R, Reinhart K, Angus DC, Brun-Buisson C et al.
Surviving Sepsis Campaign: International guidelines for management of severe sepsis and septic shock: 2008
Intensive Care Med 2008; 34(1): 17-60

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Kortgen A, Niederprün P, Bauer M.

Implementation of an evidence-based „standard operating procedure“ and outcome in septic shock
Crit Care Med 2006; 34(4): 939-9

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3. Outcome papers

Lu NF, Zheng RQ, Lin H, Shao J, Yu JQ, Yang G

Improved sepsis bundles in the treatment of septic shock: a prospective clinical study

Am J Emerg Med 2015; 33(8): 1045 - 9

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Mutoh T, Kazumata K, Terasaka S, Taki Y, Suzuki A, Ishikawa T.

Early Intensive Versus Minimally Invasive Approach to Postoperative Hemodynamic Management After Subarachnoid Hemorrhage

Stroke 2014; 45(5): 1280-4

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Hu W, Lin CW, Liu BW, Hu WH, Zhu Y

Extravascular lung water and pulmonary arterial wedge pressure for fluid management in patients with acute respiratory distress syndrome

Multidiscip Respir Med 2014; 9(1): 3

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Goepfert M, Richter HP, Eulenburg CZ, Gruetzmacher J, Rafflenbeul E, Roeher K, Sandersleben AV, Diedrichs S, Reichensperner H, Goetz AE, Reuter DA

Individually Optimized Hemodynamic Therapy Reduces Complications and Length of Stay in the Intensive Care Unit: A Prospective, Randomized Controlled Trial

Anesthesiology 2013; 119(4): 824-36

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Optimized fluid management improves outcomes of pediatric burn patients

J Surg Res 2013; 181(1): 121-8

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Adler C, Reuter H, Seck C, Hellmich M, Zobel C

Fluid therapy and acute kidney injury in cardiogenic shock after cardiac arrest

Resuscitation 2013; 84(2): 194-9

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Lenkin AI, Kirov MY, Kuzkov VV, Paromov KV, Smetkin AA, Lie M, Bjertnaes LJ

Comparison of goal-directed hemodynamic optimization using pulmonary artery catheter and transpulmonary thermodilution in combined valve repair: a randomized clinical trial

Crit Care Res Pract 2012: 821218.

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Pino-Sanchez F, Lara-Rosales R, Guerrero-Lopez F, Chamorro-Marin V, Navarrete-Navarro P, Carazo-de la Fuente E, Fernandez-Mondejar E.

Influence of extravascular lung water determination in fluid and vasoactive therapy

J Trauma 2009; 67(6): 1220-4

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Performance of Bedside Transpulmonary Thermodilution Monitoring for Goal-Directed Hemodynamic Management After Subarachnoid Hemorrhage

Stroke 2009; 40(7): 2368 - 74

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Smetkin AA, Kirov M, Kuzkov VV, Lenkin AI, Eremeev AV, Slastilin VY, Borodin VV, Bjertnaes LJ.

Single transpulmonary thermodilution and continuous monitoring of central venous oxygen saturation during off-pump coronary surgery.

Acta Anaesthesiol Scand 2009; 53: 505-14

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Csontos C, Foldi V, Fischer T, Bogar L.

Arterial thermodilution in burn patients suggests a more rapid fluid administration during early resuscitation.

Acta Anaesthesiol Scand 2008; 52(6): 742-9

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Goal directed fluid management reduces vasopressor and catecholamine use in cardiac surgery patients

Intensive Care Medicine 2007; 33: 96-103

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Mitchell JP, Schuller D, Calandrino FS, Schuster DP.

Improved outcome based on fluid management in critically ill patients requiring pulmonary artery catheterization

Am Rev Respir Dis 1992; 145(5): 990-8

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4a PICCO PARAMETERS – METHODOLOGY

4a.1 FLOW (Cardiac Output)

Smith JA, Camporota L, Beale R

Monitoring arterial blood pressure and cardiac output using central or peripheral arterial pressure waveforms

Yearbook of Intensive and Emergency Medicine 2009; 285 - 296

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Segal E, Katzenelson R, Berkenstadt H, Perel A.

Transpulmonary thermodilution cardiac output measurement using the axillary artery in critically ill patients

J Clin Anesth 2002; 14(3): 210-3

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Sakka SG, Meier-Hellmann A.

Evaluation of cardiac output and cardiac preload

In: Vincent JL (Ed.), Yearbook of Intensive Care and Emergency Medicine 2000; 671-9

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4a.2 PRELOAD (Global End Diastolic Volume and Intrathoracic Blood Volume)

Hofer CK, Furrer L, Matter-Ensner S, Maloigne M, Klaghofer R, Genoni M, Zollinger A.

Volumetric preload measurement by thermodilution: a comparison with transoesophageal echocardiography

Br J Anaesth 2005; 94(6): 748-55

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Buhre W, Buhre K, Kazmaier S, Sonntag H, Weyland A.

Assessment of cardiac preload by indicator dilution and transoesophageal echocardiography

Eur J Anaesthesiol 2001; 18(10): 662-7

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McLuckie A, Bihari D.

Investigating the relationship between intrathoracic blood volume index and cardiac index

Intensive Care Med 2000; 26(9): 1376-8

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4a.3 CONTRACTILITY (Global Ejection Fraction, Cardiac Function Index and Left Ventricular Contractility)

Michard F, Perel A.

Management of circulatory and respiratory failure using less invasive hemodynamic monitoring

In: Vincent JL (Ed.), Yearbook of Intensive Care and Emergency Medicine 2003; 508-20

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Wisner-Euteneier AJ, Lichtwarck-Aschoff M, Zimmermann G, Bluemel G, Pfeiffer U.

Evaluation of the cardiac function index as a new bedside indicator of cardiac performance

Intensive Care Med 1994; 20(S2):21

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4a.4 VOLUME RESPONSIVENESS (Stroke Volume Variation and Pulse Pressure Variation)

Reuter DA, Goepfert MS, Goresch T, Schmoeckel M, Kilger E, Goetz AE.

Assessing fluid responsiveness during open chest conditions

Br J Anaesth 2005; 94(3): 318-23

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Rex S, Brose S, Metzelder S, Huneke R, Schalte G, Autschbach R, Rossaint R, Buhre W.

Prediction of fluid responsiveness in patients during cardiac surgery

Br J Anaesth 2004; 93(6): 782-8

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Reuter DA, Felbinger TW, Kilger E, Schmidt C, Lamm P, Goetz AE.

Optimizing fluid therapy in mechanically ventilated patients after cardiac surgery by on-line monitoring of left ventricular stroke volume variations. Comparison with aortic systolic pressure variations

Br J Anaesth 2002; 88(1): 124-6

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4a.5 PULMONARY OEDEMA (Extravascular Lung Water)

Phillips C, Chesnutt M, Smith M.

Extravascular lung water in sepsis-associated acute respiratory distress syndrome: indexing with predicted body weight improves correlation with severity of illness and survival

Crit Care Med, 2008; 36(1); 69-73

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Sakka SG, Klein M, Reinhart K, Meier-Hellmann A.

Prognostic value of extravascular lung water in critically ill patients

Chest 2002; 122(6): 2080-6

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4b PICCO PARAMETERS – VALIDATION

4b.1 FLOW (Cardiac Output)

Calbet JA and Boushel RC

Assessment of cardiac output with transpulmonary thermodilution during exercise in man

J Appl Physiol 2014 (1985): jap 00686 2014

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Petzoldt M, Riedel C, Braeunig J, Haas S, Goepfert MS, Treede H, Baldus S, Goetz AE, Reuter DA

Stroke volume determination using transcatheter pulmonary thermodilution and arterial pulse contour analysis in severe aortic valve disease

Intensive Care Med 2013; 39(4): 601-11

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Gruenewald M, Meybohm P, Renner J, Broch O, Caliebe A, Weiler N, Steinfath M, Scholz J, Bein B

Effect of norepinephrine dosage and calibration frequency on accuracy of pulse contour-derived cardiac output

Crit Care 2011; 15(1): R22.

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Friesecke S, Heinrich A, Abel P, Felix SB

Comparison of pulmonary artery and aortic transpulmonary thermodilution for monitoring of cardiac output in patients with severe heart failure: validation of a novel method

Crit Care Med 2009; 37(1): 119-23

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Lemson J, de Boode WP, Hopman JC, Singh SK, van der Hoeven JG

Validation of transpulmonary thermodilution cardiac output measurement in a pediatric animal model

Pediatr Crit Care Med 2008; 9(3): 313-9

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Felbinger TW, Reuter DA, Eltzschig HK, Bayerlein J, Goetz AE

Cardiac index measurements during rapid preload changes: a comparison of pulmonary artery thermodilution with arterial pulse contour analysis

J Clin Anesth 2005; 17(4):241-8

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Marx G, Schuerholz T, Sumpelmann R, Simon T, Leuwer M

Comparison of cardiac output measurements by arterial trans-catheter pulmonary and pulmonary arterial thermodilution with direct Fick in septic shock

Eur J Anaesthesiol 2005; 22(2):129-34

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Bein B, Worthmann F, Tonner PH, Paris A, Steinfath M, Hedderich J, Scholz J

Comparison of esophageal Doppler, pulse contour analysis, and real-time pulmonary artery thermodilution for the continuous measurement of cardiac output

J Cardiothorac Vasc Anesth 2004; 18(2):185-9

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Godje O, Hoke K, Goetz AE, Felbinger TW, Reuter DA, Reichart B, Friedl R, Hannekum A, Pfeiffer UJ
Reliability of a new algorithm for continuous cardiac output determination by pulse-contour analysis during hemodynamic instability
Crit Care Med 2002; 30(1):52-8

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4b.2 PRELOAD (Global Enddiastolic Volume and Intrathoracic Blood Volume)

Renner J, Gruenewald M, Brand P, Steinfath M, Scholz J, Lutter G, Bein B
Global End-Diastolic Volume as a Variable of Fluid Responsiveness During Acute Changing Loading Conditions
J Cardiothorac Vasc Anesth 2007; 21(5): 650-4

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Kozieras, J, Thuemer O, Sakka SG
Influence of an acute increase in systemic vascular resistance on transpulmonary thermodilution-derived parameters in critically ill patients
Intensive Care Med 2007; 33:1619-23

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Michard F, Alaya S, Zarka V, Bahloul M, Richard C, Teboul JL
Global end-diastolic volume as an indicator of cardiac preload in patients with septic shock
Chest 2003; 124(5):1900-8

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4b.3 CONTRACTILITY (Global Ejection Fraction, Cardiac Function Index and Left Ventricular Contractility)

Aguilar G, Belda FJ, Ferrando C, Jover JL
Assessing the left ventricular systolic function at the bedside: the role of transpulmonary thermodilution-derived indices
Anesthesiol Res Pract 2011: 927421

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Meybohm P, Gruenewald M, Renner J, Maracke M, Rossee S, Hocker J, Hagelsteins S, Zacharowski K, Bein B
Assessment of left ventricular systolic function during acute myocardial ischemia: A comparison of transpulmonary thermodilution and transesophageal echocardiography
Minerva Anesthesiol 2011; 77(2): 132-41

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Trepte CJ, Eichhorn V, Haas SA, Richter HP, Goepfert MS, Kubitz JC, Goetz AE, Reuter DA
Thermodilution-derived indices for assessment of left and right ventricular cardiac function in normal and impaired cardiac function
Crit Care Med 2011; 39(9): 2106-12

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Jabot J, Monnet X, Lamia B, Chemla D, Christian R, Teboul JL
Cardiac function index provided by transpulmonary thermodilution behaves as an indicator of left ventricular systolic function
Crit Care Med 2009; 37(11): 2913-8

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de Hert S, Robert D, Cromheecke S, Michard F, Nijs J, Rodrigues IE
Evaluation of Left Ventricular Function in Anesthetised Patients Using Femoral Artery dp/dtmax
J Cardio Thor Vasc Anes 2006; 20(3): 325-30

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Combes A, Berneau JB, Lut CE, Trouillet JL

Estimation of left ventricular systolic function by single transpulmonary thermodilution

Intensive Care Med 2004; 30(7): 1377-83

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4b.4 VOLUME RESPONSIVENESS (Stroke Volume Variation and Pulse Pressure Variation)

Kubitz JC, Annecke T, Forkl S, Kemming GI, Kronas N, Goetz AE, Reuter DA

Validation of pulse contour derived stroke volume variation during modifications of cardiac afterload

Br J Anaesth 2007; 98(5): 591-7

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Hofer CK, Muller SM, Furrer L, Klaghofer R, Genoni M, Zollinger A

Stroke volume and pulse pressure variation for prediction of fluid responsiveness in patients undergoing off-pump coronary artery bypass grafting

Chest 2005; 128(2):848-54

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Reuter DA, Kirchner A, Felbinger TW, Weis FC, Kilger E, Lamm P, Goetz AE

Usefulness of left ventricular stroke volume variation to assess fluid responsiveness in patients with reduced cardiac function

Crit Care Med 2003; 31(5):1399-404

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4b.5 PULMONARY OEDEMA (Extravascular Lung Water)

Nusmeier A, Cecchetti C, Blohm M, Lehman R, van der Hoeven J, Lemson J

Near-normal values of extravascular lung water in children

Pediatr Crit Care Med 2015; 16(2): e28-33

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Venkateswaran RV, Dronavalli V, Patchell V, Wilson I, Mascaro J, Thompson R, Coote J, Bonser RS

Measurement of extravascular lung water following human brain death; implications for lung donor assessment and transplantation

Eur J Cardiothorac Surg 2013; 43(6): 1227-32

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Tagami T, Kushimoto S, Yamamoto Y, Atsumi T, Tosa R, Matsuda K, Oyama R, Kawaguchi T, Masuno T, Hirama H, Yokota H

Validation of extravascular lung water measurement by single transpulmonary thermodilution: human autopsy study

Crit Care 2010; 14(5): R162

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Lemson J, Backx AP, van Oort AM, Bouw TP, van der Hoeven JG

Extravascular lung water measurement using transpulmonary thermodilution in children

Pediatr Crit Care Med 2009; 10(2): 227-33

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Monnet X, Anguel N, Osman D, Hamzaoui, Richard C, Teboul JL

Assessing pulmonary permeability by transpulmonary thermodilution allows differentiation of hydrostatic pulmonary edema from ALI / ARDS

Intensive Care Medicine 2007; 33(3):448-53

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Kirov MY, Kuzkov VV, Kuklin VN, Waerhaug K, Bjertnaes LJ

Extravascular lung water assessed by transpulmonary single thermodilution and postmortem gravimetry in sheep

Crit Care 2004; 8(6):R451-8

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Katzenelson R, Perel A, Berkenstadt H, Preisman S, Kogan S, Sternik L, Segal E

Accuracy of transpulmonary thermodilution versus gravimetric measurement of extravascular lung water

Crit Care Med 2004; 32(7):1550-4

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Sakka SG, Ruhl CC, Pfeiffer UJ, Beale R, McLuckie A, Reinhart K, Meier-Hellmann A

Assessment of cardiac preload and extravascular lung water by single transpulmonary thermodilution

Intensive Care Medicine 2000; 26 (2):180-7

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5. Fields of Application

5.1 ALI / ARDS

Jozwiak M, Teboul JL, Monnet X

Extravascular lung water in critical care: recent advances and clinical applications

Ann Intensive Care 2015; 5(1): 38

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Kor DJ, Warner DO, Carter RE, Meade LA, Wilson GA, Li M, Hamersma MJ, Hubmayr R, D, Mauermann WJ, Gajic O

Extravascular Lung Water and Pulmonary Vascular Permeability Index as Markers Predictive of Postoperative Acute Respiratory Distress Syndrome: A Prospective Cohort Investigation

Crit Care Med 2014; 43(3): 665 - 73

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Tagami T, Nakamura T, Kushimoto S, Tosa R, Watanabe A, Kaneko T, Fukushima H, Rinka H, et al.

Early-phase changes of extravascular lung water index as a prognostic indicator in acute respiratory distress syndrome patients

Annals of Intensive Care 2014; 4: 27

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Hu W, Lin CW, Liu BW, Hu WH, Zhu Y

Extravascular lung water and pulmonary arterial wedge pressure for fluid management in patients with acute respiratory distress syndrome

Multidiscip Respir Med 2014; 9(1): 3

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Brown LM, Calfee CS, Howard JP, Craig TR, Matthay MA, McAuley DF

Comparison of thermodilution measured extravascular lung water with chest radiographic assessment of pulmonary oedema in patients with acute lung injury

Ann Intensive Care 2013; 3(1): 25

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Kushimoto S, Endo T, Yamanouchi S, Sakamoto T, Ishikura H, Kitazawa Y et al.

Relationship between extravascular lung water and severity categories of acute respiratory distress syndrome by the Berlin definition

Crit Care 2013; 17(4): R132

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Tagami T, Sawabe M, Kushimoto S, Marik P, Mieno MN, Kawaguchi T, Kusakabe T, Tosa R, Yokota H, Fukuda M
Quantitative Diagnosis of Diffuse Alveolar Damage Using Extravascular Lung Water
Crit Care Med 2013; 41(9): 2144-50
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Jozwiak M, Silva S, Persichini R, Anguel N, Osman D, Richard C, Teboul JL, Monnet X
Extravascular lung water is an independent prognostic factor in patients with acute respiratory distress syndrome
Crit Care Med 2013; 41(2): 472-80
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Kushimoto S, Taira T, Taira, Y, Kitazawa Y, Okuchi K, Sakamoto T, Ishikura H, Endo T, Yamanouchi S et al.,
The clinical usefulness of extravascular lung water and pulmonary vascular permeability index to diagnose and characterize pulmonary edema: a prospective multicenter study on the quantitative differential diagnostic definition for acute lung injury/acute respiratory distress syndrome
Crit Care 2012; 16(6): R232
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Letourneau JL, Pinney J, Phillips C
Extravascular lung water predicts progression to acute lung injury in patients with increased risk
Crit Care Med 2012; 40(3): 947-54
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Craig TR, Duffy MJ, Shyamsundar M, McDowell C, McLaughlin B, Elborn JS, McAuley D
Extravascular lung water indexed to predicted body weight is a novel predictor of intensive care unit mortality in patients with acute lung injury
Crit Care Med 2010; 38(1): 114-20
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Berkowitz DM, Danai PA, Eaton S, Moss M, Martin G
Accurate characterization of extravascular lung water in acute respiratory distress syndrome
Crit Care Med 2008; 36(6): 1803-9
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Phillips C, Chesnutt M, Smith M
Extravascular lung water in sepsis-associated acute respiratory distress syndrome: indexing with predicted body weight improves correlation with severity of illness and survival
Crit Care Med, 2008; 36(1); 69-73
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Monnet X, Anguel N, Osman D, Hamzaoui, Richard C, Teboul JL
Assessing pulmonary permeability by transpulmonary thermodilution allows differentiation of hydrostatic pulmonary edema from ALI / ARDS
Intensive Care Medicine 2007; 33(3): 448-53
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Perkins GD, McAuley DF, Thickett DR, Gao F
The beta-agonist lung injury trial (BALTI): a randomized placebo-controlled clinical trial
Am J Respir Crit Care Med 2006; 173(3): 281-7
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5.2 Burns

Sanchez-Sanchez M, Garcia-de-Lorenzo A, Herrero E, Lopez T, Galvan B, Asensio MJ, Cachafeiro L, Casado C
A protocol for resuscitation of severe burn patients guided by transpulmonary thermodilution and lactate levels: A 3-year prospective cohort study

Crit Care 2013; 17(4): R176

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Branski LK, Herndon DN, Byrd JF, Kinsky MP, Lee JO, Fagan SP, Jeschke MG

Transpulmonary thermodilution for hemodynamic measurements in severely burned children

Crit Care 2011; 15(2): R118.

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Bognar Z, Foldi V, Rezman B, Bogar L, Csontos C

Extravascular lung water index as a sign of developing sepsis in burns

Burns 2010; 8: 1263-70

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Csontos C, Foldi V, Fischer T, Bogar L

Arterial thermodilution in burn patients suggests a more rapid fluid administration during early resuscitation

Acta Anaesthesiol Scand 2008; 52(6): 742-9

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Holm C, Mayr M, Horbrand F, Tegeler J, Henckel von Donnersmarck G, Muhlbauer W, Pfeiffer UJ

Reproducibility of transpulmonary thermodilution measurements in patients with burn shock and hypothermia

J Burn Care Rehabil 2005; 26(3):260-5

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Holm C, Melcer B, Horbrand F, Henckel von Donnersmarck G, Muhlbauer W.

Arterial thermodilution: an alternative to pulmonary artery catheter for cardiac output assessment in burn patients

Burns 2001; 27(2):161-6

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Holm C, Melcer B, Horbrand F, Worl H, von Donnersmarck GH, Muhlbauer W.

Intrathoracic blood volume as an end point in resuscitation of the severely burned: an observational study of 24 patients

J Trauma 2000; 48(4):728-34

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5.3 Cardiac Surgery

Goepfert M, Richter HP, Eulenburg CZ, Gruetzmacher J, Rafflenbeul E, Roehrer K, Sandersleben AV, Diedrichs S, Reichensperner H, Goetz AE, Reuter DA

Individually Optimized Hemodynamic Therapy Reduces Complications and Length of Stay in the Intensive Care Unit: A Prospective, Randomized Controlled Trial

Anesthesiology 2013; 119(4); 824-36

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Staier K, Wilhelm M, Wiesenack C, Thoma M, Keyl C

Pulmonary artery vs. transpulmonary thermodilution for the assessment of cardiac output in mitral regurgitation: a prospective method comparison study

Eur J Anaesthesiol 2012; 29(9): 431-7

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Smetkin AA, Kirov M, Kuzkov VV, Lenkin AI, Ereemeev AV, Slastilin VY, Borodin VV, Bjertnaes LJ
Single transpulmonary thermodilution and continuous monitoring of central venous oxygen saturation during off-pump coronary surgery.
Acta Anaesthesiol Scand 2009; 53: 505-14

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Goal directed fluid management reduces vasopressor and catecholamine use in cardiac surgery patients
Intensive Care Medicine 2007; 33: 96-103

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Wouters PF, Quaghebeur B, Sergeant P, Van Hemelrijck J, Vandermeersch E
Cardiac output monitoring using a brachial arterial catheter during off-pump coronary artery bypass grafting
J Cardiothorac Vasc Anesth 2005; 19: 160-4

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Bettex DA, Hinselmann V, Hellermann JP, Jenni R, Schmid ER
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