PULSION Medical Systems

LiMON-Technology Literature List

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●●● Very Highly Recommended
●● Highly Recommended
● Recommended

'This document is intended to provide information to an international audience outside of the USA'
1. **REVIEWS**

Halle BM, Poulsen TD, Pedersen HP
*Indocyanine green plasma disappearance rate as dynamic liver function test in critically ill patients*

Sakka SG.
*Assessing Liver Function*
Curr Opin Crit Care 2007; 13(2):207-14

Bauer M, Winning J, Kortgen A
*Liver Failure*
Curr Opin Anaest 2005; 18:111-6

Sakka SG, Meier-Hellmann A
*Non-invasive liver function monitoring by indocyanine green plasma disappearance rate in critically ill patients*

2. **BACKGROUND**

2.1 **Pathophysiology**

*Prospective assessment of hepatic function and mechanisms of dysfunction in the critically ill.*

Sander M, Krimphove M, Spies C
*Increasing Regional Blood Flow: The Splanchnic Region*

2.2 **Technology / Validation**

Purcell P, Kruger P, Jones M
*Indocyanine green elimination: a comparison of the LiMON and serial blood sampling methods*
ANZ J Surg 2006; 76: 75-7

Sakka SG, van Hout N
*Relation between indocyanine green (ICG) plasma disappearance rate and ICG blood clearance in critically ill patients.*

Sakka SG, Koeck H, Meier-Hellmann A
*Measurement of indocyanine green plasma disappearance rate by two different dosages*
Intensive Care Med 2004; 30(3):506-9

*Comparison of invasive and noninvasive measurement of plasma disappearance rate of indocyanine green in patients undergoing liver transplantation: a prospective investigator-blinded study*
Liver Transpl 2004; 10(8):1060-4
Sakka, SG, Reinhart K, Meier-Hellmann A
Comparison of invasive and noninvasive measurements of indocyanine green plasma disappearance rate in critically ill patients with mechanical ventilation and stable hemodynamics

2.3 Indocyanine Green
Leevy CM, Leevy CB, Howard MM
Indocyanine green and the liver
In: Davidson CS (Ed.), Problems in Liver Diseases, 1979, Georg Thieme Publishers Stuttgart-New York; 42-52

Paumgartner G, Probst P, Kraines R, Leevy CM
Kinetics of Indocyanine green removal from the blood
NY Acad Sci 1970; 170:134-47

3. FIELDS OF APPLICATION

3.1 Intensive Care Medicine

3.1.1 Cardiac Surgery
Indocyanine green clearance as an outcome prediction tool in cardiac surgery: A prospective study
J Crit Care 2014; 29(2): 224 – 9

Tomasa TM, Moreno JA, Just MS, Cubells C, Camara ML, Roca J, Fernandez-Llamazares J
Indocyanine green plasma disappearance rate predicts cardiac surgery stay
Experimental & Clinical Cardiology 2014; 20(7): 838-55

Sander M, Spies CD, Berger K, Schroder T, Grubitzsch H, Wernecke KD, von Heymann C
Perioperative indocyanine green clearance is predictive for prolonged intensive care unit stay after coronary artery bypass grafting - an observational study
Crit Care 2009; 13(5): R149

Sander M, Spies CD, Foer A, Syn DY, Grubitzsch H, Von Heymann C
Peri-operative plasma disappearance rate of indocyanine green after coronary artery bypass surgery

Sakka S, Hofmann D, Thuermer O, Schelenz C, Van Hout N
Increasing cardiac output by epinephrine after cardiac surgery: effects on indocyanine green plasma disappearance rate and splanchnic microcirculation
J Cardiothorac Vasc Anesth 2007; 21(3):351-6

Hofmann D, Thuermer O, Schelenz C, van Hout N, Sakka SG
Increasing cardiac output by fluid loading: effects on indocyanine green plasma disappearance rate and splanchnic microcirculation
3.1.2  **Sepsis And Septic Shock**

*Effects of dobutamine on systemic, regional and microcirculatory perfusion parameters in septic shock: a randomized, placebo-controlled, double-blind, crossover study*


*Relationship of systemic, hepatosplanchnic, and microcirculatory perfusion parameters with 6-hour lactate clearance in hyperdynamic septic shock patients: an acute, clinical-physiological, pilot study.*

Ann Intensive Care 2012; 2(1): 44

Memis D, Inal MT, Sut N

*The effects of levosimendan vs dobutamine added to dopamine on liver functions assessed with noninvasive liver function monitoring in patients with septic shock*

J Crit Care 2012;27(3): 318.e1-6

Inal MT, Memis D, Kargi M, Sut N

*Prognostic value of indocyanine green elimination assessed with LiMON in septic patients*

J Crit Care 2009; 24(3): 329-34


*Prospective assessment of hepatic function and mechanisms of dysfunction in the critically ill*


Poeze M, Solberg BC, Greve JW, Ramsay G

*Monitoring global volume-related hemodynamic or regional variables after initial resuscitation: What is a better predictor of outcome in critically ill septic patients?*


Sakka SG, Reinhart K, Meier-Hellmann A

*Prognostic value of the indocyanine green plasma disappearance rate in critically ill patients*

Chest 2002; 122(5):1715-20

3.1.3  **Surgical**

Eryilmaz HB, Memis D, Sezer A, Inal M

*The Effects of Different Insufflation Pressures on Liver Functions Assessed with LiMON on Patients Undergoing Laparoscopic Cholecystectomy*

Scientific World Journal 2012: 172575

Sakka SG

*Indocyanine green plasma disappearance rate as an indicator of hepatosplanchnic ischemia during abdominal compartment syndrome*

Anesth Analg 2007; 104(4):1003-4

Poeze M, Ramsay G, Buuman WA, Greve JW, Dentener M, Takala J

*Increased hepatosplanchnic inflammation precedes the development of organ dysfunction after elective high-risk surgery*

Shock 2002; 17:451-8
3.1.4 Medical

ICG-liver test versus new biomarkers as prognostic markers for prolonged length of stay in critically ill patients - a prospective study of accuracy for prediction of length of stay in the ICU
Ann Intensive Care 2014; 4: 19

Quintero J, Miserachs M, Ortega J, Bueno J, Dopazo C, Bilbao I, Castells L, Charco R
Indocyanine green plasma disappearance rate: a new tool for the classification of paediatric patients with acute liver failure
Liver Int 2014; 34(5): 689-94

The influence of continuous venovenous renal replacement therapy on the plasma disappearance rate of indocyanine green

Malbrain ML, Viaene D, Kortgen A, De Laet I, Dits H, Van Regenmortel N, Schoonheydt K, Bauer, M
Relationship between intra-abdominal pressure and indocyanine green plasma disappearance rate: hepatic perfusion may be impaired in critically ill patients with intra-abdominal hypertension
Ann Intensive Care 2012; 2 Suppl 1: S19

Steinvall I, Fredrikson M, Bak Z, Sjoberg J
Incidence of early burn-induced effects on liver function as reflected by the plasma disappearance rate of indocyanine green: A prospective descriptive cohort study
Burns 2012; 38(2): 214-24

Inal MT, Memis D, Sezer YA, Atalay M, Karakoc A, Sut N
Effects of intra-abdominal pressure on liver function assessed with the LiMON in critically ill patients

Seibel A, Muller M, Sakka S
Indocyanine green plasma disappearance rate for monitoring hepatosplanchnic blood flow
Intensive Care Med 2011; 37(2): 357-9

Sakka SG, Reinhart K, Meier-Hellmann A
Prognostic value of the indocyanine green plasma disappearance rate in critically ill patients
Chest 2002; 122(5):1715-20

3.2 Liver Transplantation

A rapid, reproducible, noninvasive predictor of liver graft survival

Vos JJ, Scheeren TW, Lukes DJ, de Boer MT, Hendriks HG, Wietasch JK
Intraoperative ICG plasma disappearance rate helps to predict absence of early postoperative complications after orthotopic liver transplantation
J Clin Monit Comput 2013; 27(5): 591-8
Levesque E, Hoti E, Azoulay D, Adam R, Samuel D, Castaing D, Saliba F
Non-invasive ICG-clearance: a useful tool for the management of hepatic artery thrombosis following liver transplantation
Clin Transplant 2011; 25(2): 297-301

Levesque E, Saliba F, Benhamida S, Ichai P, Azoulay D, Adam R, Castaing D, Samuel D
Plasma disappearance rate of indocyanine green: a tool to evaluate early graft outcome after liver transplantation
Liver Transpl 2009; 15(10): 1358-64

Early noninvasive measurement of the indocyanine green plasma disappearance rate accurately predicts early graft dysfunction and mortality after deceased donor liver transplantation

Parker BM, Cywinski JB, Alster JM, Irefin SA, Popovich M, Beven M, Fung JJ
Predicting immunosuppressant dosing in the early postoperative period with noninvasive indocyanine green elimination following orthotopic liver transplantation
Liver Transpl 2008; 14(1): 46-52

Scheingraber S, Richter S, Igna D, Girndt M, Flesch S, Kleinschmidt S, Schilling MK
Indocyanine green elimination but not bilirubin indicates improvement of graft function during MARS therapy
Clin Transplant 2007; 21(6): p. 689-95

K(ICG) value, a reliable real-time estimator of graft function, accurately predicts outcomes in adult living-donor liver transplantation
Liver Transpl 2006; 12: 605-13

Comparison of invasive and noninvasive measurement of plasma disappearance rate of indocyanine green in patients undergoing liver transplantation: a prospective investigator-blinded study
Liver Transpl 2004; 10(8):1060-4

Perioperative monitoring of indocyanine green clearance and plasma disappearance rate in patients undergoing liver transplantation
Anaesthesist 2002; 51(5):359-66

Mandell MS, Wachs M, Niemann CU, Henthorn TK
Elimination of indocyanine green in the perioperative evaluation of donor liver function
Anesth Analg 2002; 95(5):1182-4

Niemann CU, Roberts JP, Ascher NL, Yost CS
Intraoperative hemodynamics and liver function in adult-to-adult living liver donors
Liver Transpl 2002; 8(12):1126-32
Krenn CG, Schafer B, Berlakovich GA, Steininger R, Steltzer H, Spiss CK  
Detection of graft nonfunction after liver transplantation by assessment of indocyanine green kinetics  
Anesth Analg 1998 Jul;87(1):34-6

Wesslau C, Krüger R, May G  
Clinical investigations using indocyanine green clearance for evaluation of liver function in organ donors  
Transplantology 1994; 5(1):7-9

3.3 Liver Surgery / Resection

Thomas MN, Weninger E, Angele M, Bosch F, Pratschke S, Andrassy J, Rentsch M, Stangl M, Hartwig W, Werner J, Guba M  
Intraoperative simulation of remnant liver function during anatomic liver resection with indocyanine green clearance (LiMON) measurements  
HPB (Oxford) 2015; 17(6): 471 - 6

Tralhao JG, Hoti E, Oliveiros B, Botelho MF, Sousa FC  
Study of perioperative liver function by dynamic monitoring of ICG-clearance  
Hepatogastroenterology 2012; 59(116): 1179-83

de Liguori Carino N, O'Reilly DA, Dajani K, Ghaneh P, Poston GJ, Wu AV  
Perioperative use of the LiMON method of indocyanine green elimination measurement for the prediction and early detection of post-hepatectomy liver failure  

Szijarto A, Hargitai B, Fischer S, Darvas K, Kupcsulik P  
Two-staged procedure of portal ligation and hepatectomy monitored by ICG clearance  

Scheingraber S, Richter S, Igna D, Flesch S, Kopp B, Schilling MK  
Indocyanine green disappearance rate is the most useful marker for liver resection  
Hepatogastroenterology 2008; 55(85): 1394-9


Kinetics of indocyanine green removal from blood can be used to predict the size of the area removed by radiofrequency ablation of hepatic nodules  
J Gastroenterol Hepatol 2006; 21:1714-9

Imamura H, Sano K, Sugawara Y, Kokudo N, Makuuchi M  
Assessment of hepatic reserve for indication of hepatic resection: decision tree incorporating indocyanine green test  
Lee SG, Hwang S
How I do it: assessment of hepatic functional reserve for indication of hepatic resection
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Imamura H, Seyama Y, Kokudo N, Maema A, Sugawara Y, Sano K, Takayama T, Makuuchi M
One thousand fifty-six hepatectomies without mortality in 8 years
Arch Surg 2003; 138: 1198-1206
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Thasler WE, Bein T, Jauch KW
Perioperative effects of hepatic resection surgery on hemodynamics, pulmonary fluid balance, and indocyanine green clearance
Langenbecks Arch Surg 2002; 387: 271-5
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Ishikawa M, Yogita S, Miyake H, Fukuda Y, Harada M, Wada D, Tashiro S
Clarification of risk factors for hepatectomy in patients with hepatocellular carcinoma
Hepatogastroenterology 2002; 49: 1625-31
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Presence of active hepatitis associated with liver cirrhosis is a risk factor for mortality caused by posthepatectomy liver failure
Dig Dis Sci 2000; 45: 1383-8
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Hsia CY, Lui WY, Chau GY, King KL, Loong CC, Wu CW
Perioperative safety and prognosis in hepatocellular carcinoma patients with impaired liver function
J Am Coll Surg 2000; 190: 574-9
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Survival and recurrence after hepatic resection of 386 consecutive patients with hepatocellular carcinoma
J Am Coll Surg 2000; 191: 381-8
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3.4  Hepatology / Gastroenterology

Incorporating indocyanin green clearance into the Model for End Stage Liver Disease (MELD-ICG) improves prognostic accuracy in intermediate to advanced cirrhosis
Gut 2010; 59(7): 963-8
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Merle U, Sieg O, Stremmel W, Encke J, Eisenbach C
Sensitivity and specificity of plasma disappearance rate of indocyanine green as a prognostic indicator in acute liver failure
BMC Gastroenterol 2009; 9: 91
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Herold C, Heinz R, Radespiel-Tröger M, Schneider HT, Schuppan D, Hahn EG
Quantitative testing of liver function in patients with cirrhosis due to chronic hepatitis C to assess disease severity.
Liver. 2001; 21(1):26-30
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3.5 Hypovolemic Shock

Kisch H, Leucht S, Lichtwarck-Aschoff M, Pfeiffer UJ
Accuracy and reproducibility of the measurement of actively circulating blood volume with an integrated fiberoptic monitoring system.
Crit Care Med. 1995; 23(5):885-93

4 MONITORING THERAPEUTIC EFFECTS

4.1 Drug Therapies

4.1.1 Septic Shock

Bicakcioglu M, Aydogan MS, Sayan H, Toprak HL, Isik B, Yilmaz S, Yologlu S
Effects of different positive end-expiratory pressure values on liver function and indocyanine green clearance test in liver transplantation donors: a prospective, randomized, double-blind study

Sayan H, Aydogan MS, Bicakcioglu M, Toprak HL, Isik B, Yilmaz S
Effects of Thoracic Epidural Anesthesia on Liver Blood Flow and Indocyanine Green Clearance Test in Living-Donor Liver Transplantation: A Prospective, Randomized, Double-Blind Study

Lehmann C, Taymoorian K, Wauer H, Krausch D, Birnbaum J, Kox WJ
Effects of the stable prostacyclin analogue iloprost on the plasma disappearance rate of indocyanine green in human septic shock

Meier-Hellmann A, Bredle DL, Specht M, Hannemann L, Reinhart K
Dopexamine increases splanchnic blood flow but decreases gastric mucosal pH in severe septic patients treated with dobutamine
Crit Care Med 1999; 27: 2166-71

Joly LM, Monchi M, Cariou A, Chiche JD, Bellenfant F, Brunet F, Dhainaut JF
Effects of dobutamine on gastric mucosal perfusion and hepatic metabolism in patients with septic shock
Am J Respir Crit Care Med 1999: 160; 1983-6

4.1.2 Liver Surgery / Dysfunction

Sheng QS, Lang R, He Q, Yang YJ, Zhao DF, Chen DZ
Indocyanine green clearance test and model for end-stage liver disease score of patients with liver cirrhosis.
Hepatobiliary Pancreat Dis Int 2009; 8(1): 46-9

Br J Anaesth. 2000; 85(3):389-95

Devlin J, Ellis AE, McPeake J, Heaton N, Wendon JA, Williams R
N-acetylcysteine improves indocyanine green extraction and oxygen transport during hepatic dysfunction.
Crit Care Med. 1997; 25(2):236-42
4.1.3 Adjuvant Therapies

Memis D, Inal MT, Sut N
The effects of levosimendan vs dobutamine added to dopamine on liver functions assessed with noninvasive liver function monitoring in patients with septic shock
J Crit Care 2012; 27(3): 318.e1-6

Simvastatin Lowers Portal Pressure in Patients with Cirrhosis and Portal Hypertension: a Randomized Controlled Trial.
Gastroenterology 2009; 136(5): 1651-8

Link A, Girndt M, Selejan S, Mathes A, Bohm M, Rensing H
Argatroban for anticoagulation in continuous renal replacement therapy.

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