Monitorização de hemoglobina não-invasiva

Pitfalls e confiabilidade

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Conflicts of interest / disclaimer

No conflict with this presentation.

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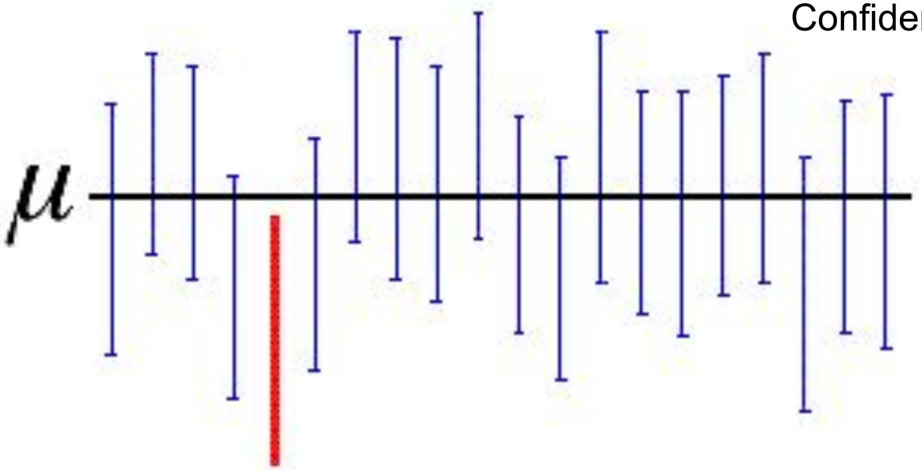
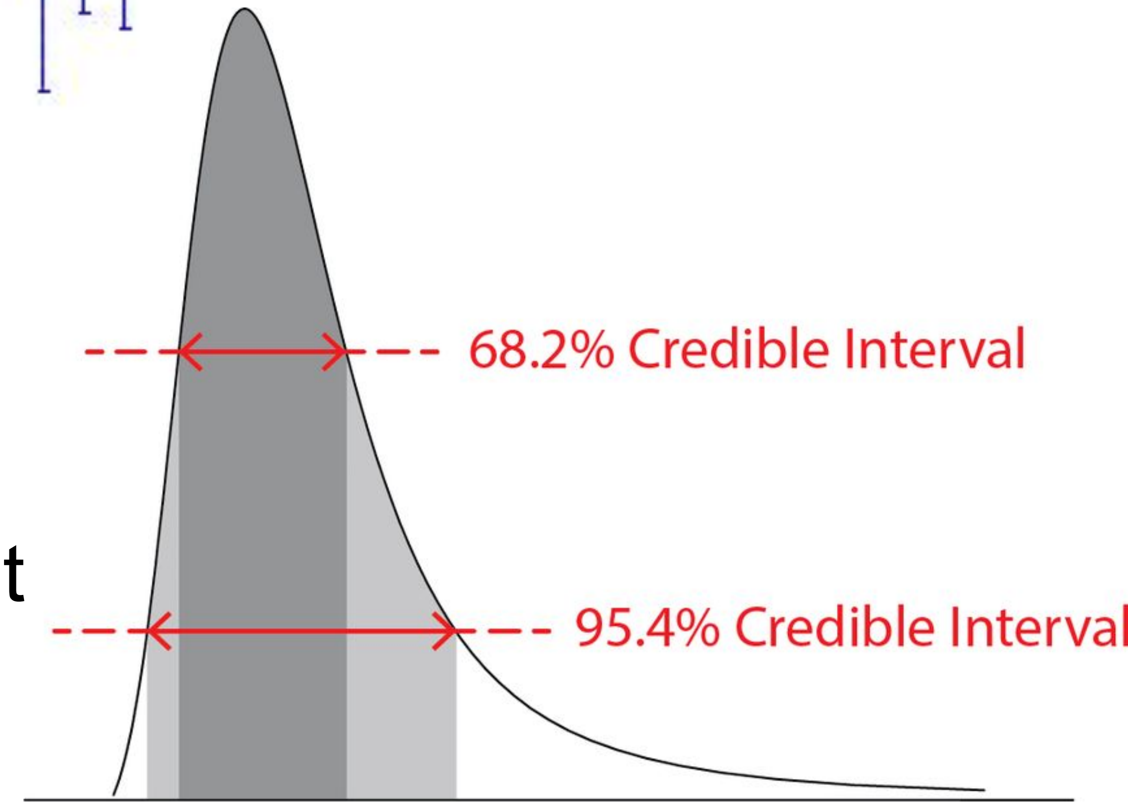
Confidence intervals



LOA
Limits of agreement
1.96 sd



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Be aware:

Mean bias must be near 0 (central tendency)

LOA overestimates precision

Be aware:

Correlation must be very high for good clinical precision! Do not use classical definitons..

Monitor specific

- Massimo Radical 7;
- Pronto-7;
- NBM-200 and NBM-200MP

Special situations

- Healthy volunteers / hemodilution;
- Intense bleeding/severe trauma;
- Newborns;
- Major surgery.

International Journal of Laboratory Hematology
The Official journal of the International Society for Laboratory Hematology
ORIGINAL ARTICLE
INTERNATIONAL JOURNAL OF LABORATORY HEMATOLOGY

Accuracy of noninvasive hemoglobin and invasive point-of-care hemoglobin testing compared with a laboratory analyzer

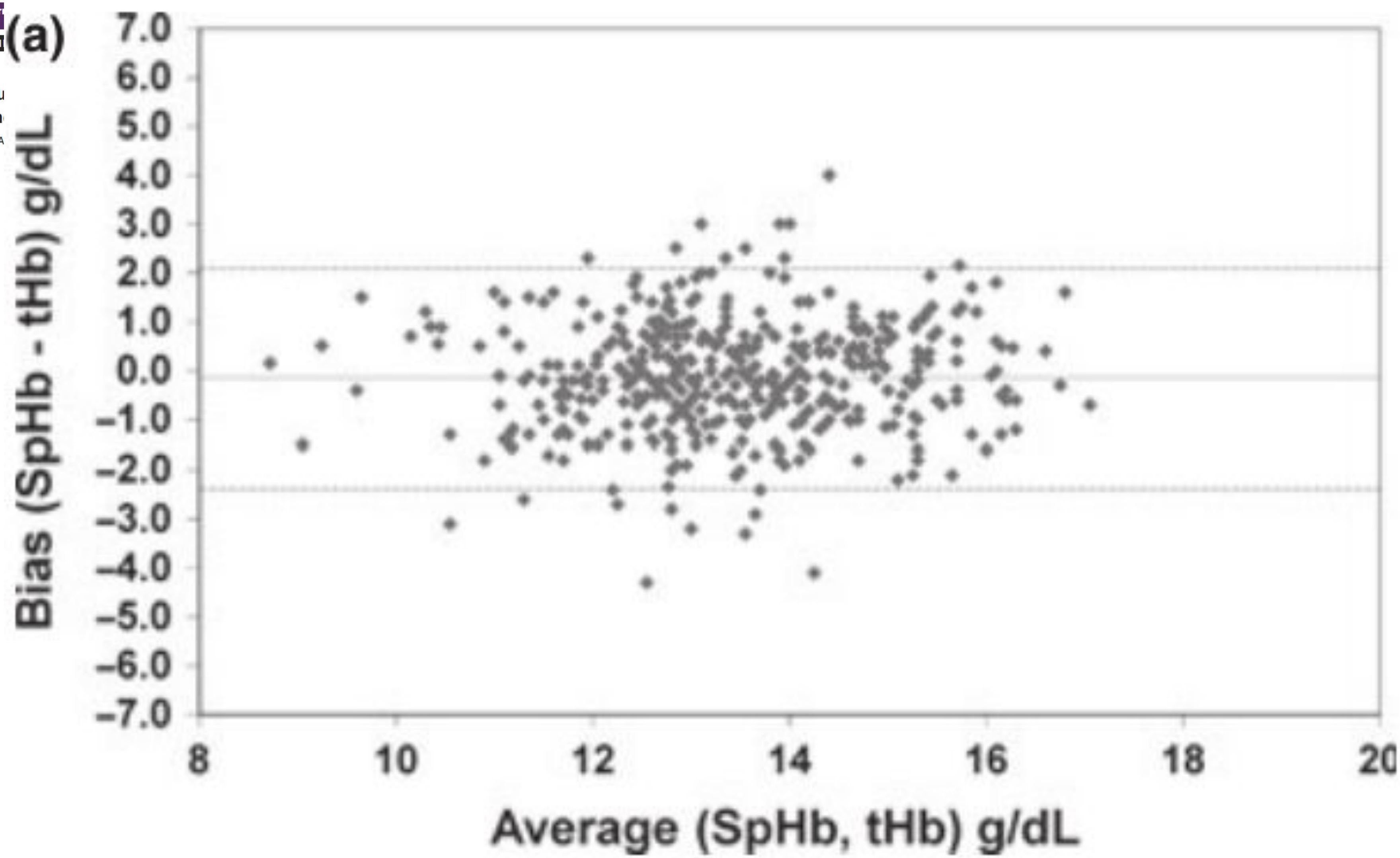
N. SHAH*, E. A. OSEA[†], G. J. MARTINEZ[‡]

Inter
ORIGI
Accu
hem
N. SHA

Table 2. Agreement of Pronto-7 SpHb and HemoCue to venous laboratory reference values (Hb)

	Pronto-7 Bias±SD, g/dL	HemoCue Bias±SD, g/dL
All subjects	−0.14 ± 1.1	−0.11 ± 1.6
Smokers	0.03 ± 1.1	−0.10 ± 1.9
Nonsmokers	−0.17 ± 1.2	−0.11 ± 1.5
Comorbidities	−0.02 ± 1.2	0.01 ± 1.4
Healthy	−0.23 ± 1.1	−0.19 ± 1.7
Light pigmentation	−0.23 ± 1.1	−0.11 ± 1.6
Med dark pigmentation	0.34 ± 1.2	−0.10 ± 1.4

Intern
ORIGI
Accu
hem
N. SHA



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LOA -2 to +2

Insignificant bias by smoking status, skin color, comorbidity

SHOCK, Vol. 44, Supplement 1, pp. 45–49, 2015

TRENDING, ACCURACY, AND PRECISION OF NONINVASIVE HEMOGLOBIN MONITORING DURING HUMAN HEMORRHAGE AND FIXED CRYSTALLOID BOLUS

Nicole Ribeiro Marques,* George C. Kramer,* Richard Benjamin Voigt,*† Michael G. Salter,* and Michael P. Kinsky*

**Department of Anesthesiology, University of Texas Medical Branch, Galveston, Texas; and †Department of Electrical and Systems Engineering, University of Pennsylvania, Philadelphia, Pennsylvania*

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Massimo Radical 7 vs Sysmex (blood sampler)

Healthy volunteers

Predefined hemorrhage and fixed crystalloid infusion

SHOCK, Vol. 44, Supplement 1, pp. 45–49, 2015

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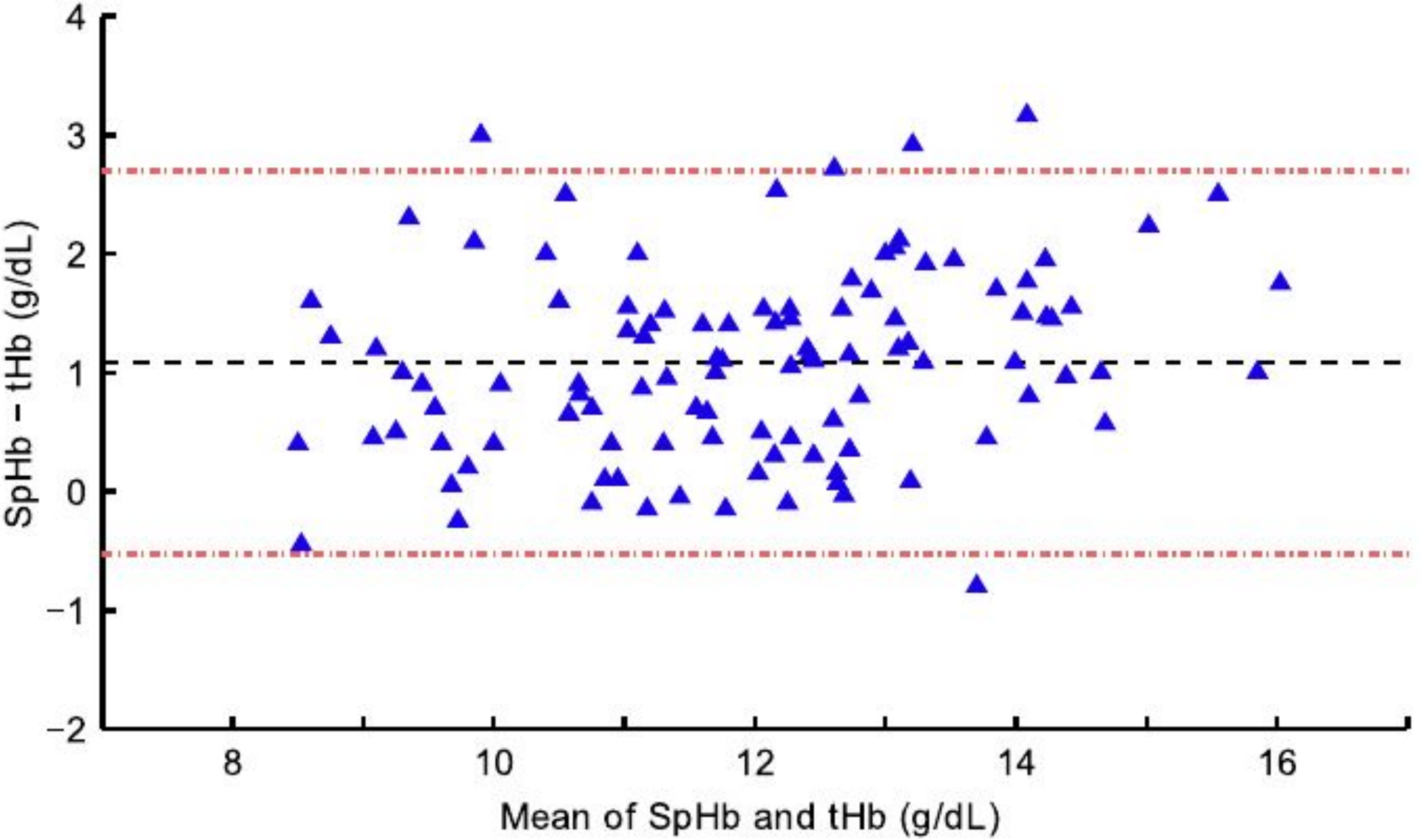
TABLE 4. **Distribution of the differences between tHb and SpHb**

tHb range, g/dL	n (%)
<0.5	28 (26)
0.5 – 1.0	26 (24)
1.1 – 1.5	27 (25)
1.6 – 2.0	14 (14)
>2.0	11 (11)

tHb indicates total hemoglobin.

SHOCK, Vol. 44, Supplement 1, pp. 45–49, 2015

TRENDING, ACCURACY, AND PRECISION OF NONINVASIVE HEMOGLOBIN MONITORING DURING HUMAN HEMORRHAGE AND FIXED



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SHOCK, Vol. 44, Supplement 1, pp. 45–49, 2015

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Nicole Ribeiro Marques,* George C. Kramer,*
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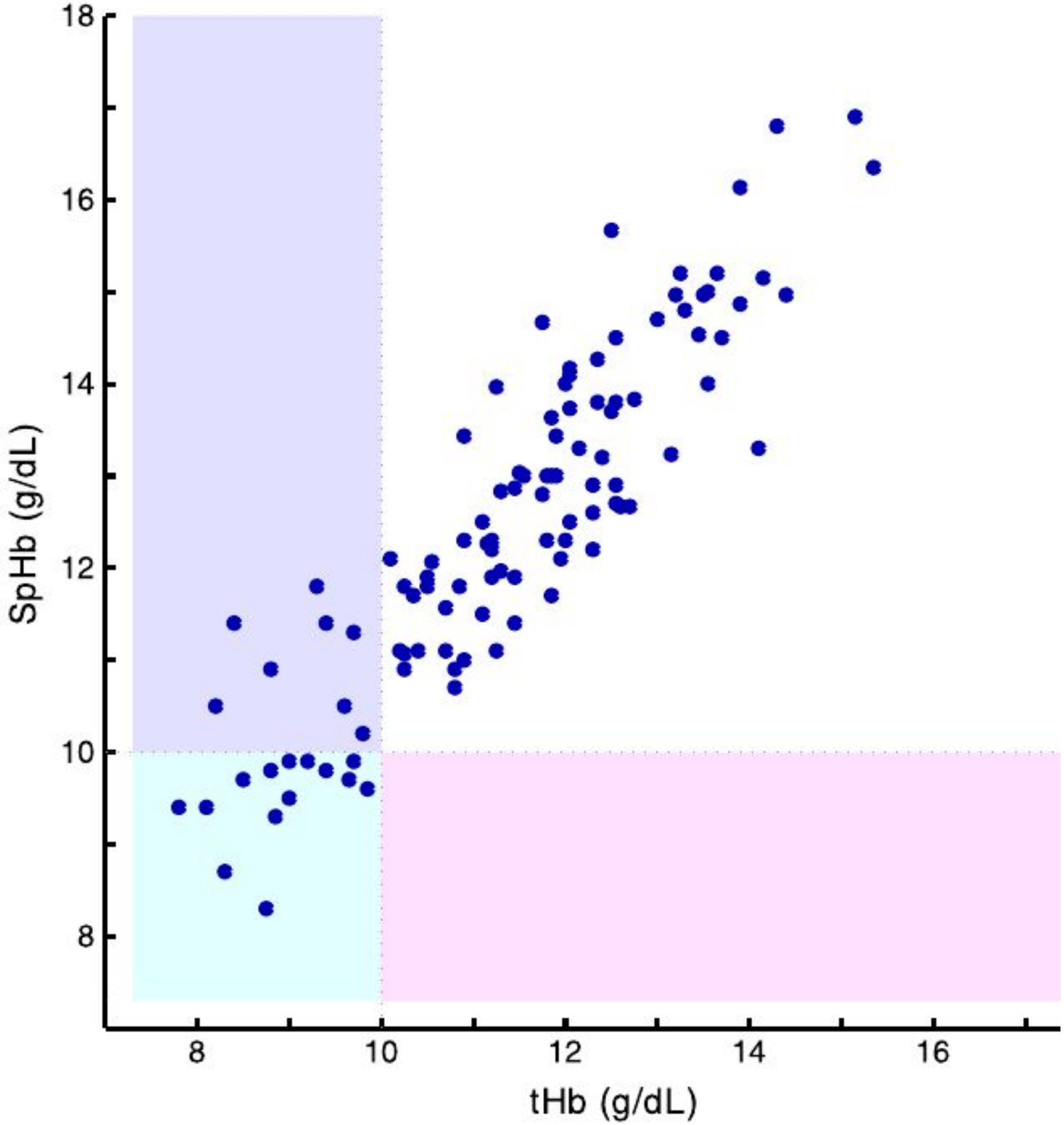
Electrical and Systems Engineering, University of Pennsyl



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LOA -3 to +1

Tendency to overestimate

J Clin Monit Comput (2017) 31:177–185
DOI 10.1007/s10877-015-9816-2

CrossMark

ORIGINAL RESEARCH

Accuracy of non-invasive continuous total hemoglobin measurement by Pulse CO-Oximetry in severe traumatized and surgical bleeding patients

Werner Baulig[1] · Burkhardt Seifert[2] · Donat R. Spahn[3] · Oliver M. Theusinger[3]

Institute of Anaesthesiology, University and University Hospital Zurich, Zurich, Switzerland

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Massimo Radical 7 VS ABL 800

TRAUMA / Bleeding;

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CrossMark

ORIGINAL RESEARCH

Accu
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and

Werne

Table 3 Agreement of SpHb and AdSpHb with CoOxHb at the different time points

Time points	n	SpHb (g/dl) Bias (LOA)	AdSpHb (g/dl) Bias (LOA)
1	34	−0.4 (−3.1; +2.3)	0.00
2	34	−0.6 (−3.3; +2.0)	−0.1 (−1.8; +1.5)
3	33	−0.7 (−3.2; +1.8)	−0.2 (−2.0; +1.6)
4	21	−0.6 (−2.9; +1.8)	−0.0 (−1.6; +1.6)
5	11	−0.4 (−2.3; +1.4)	−0.2 (−2.2; +1.9)
6	7	−0.5 (−3.3; +2.3)	−0.4 (−4.1; +3.3)
7	1	–	–

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J Clin Monit Comput (2017) 31:177–185
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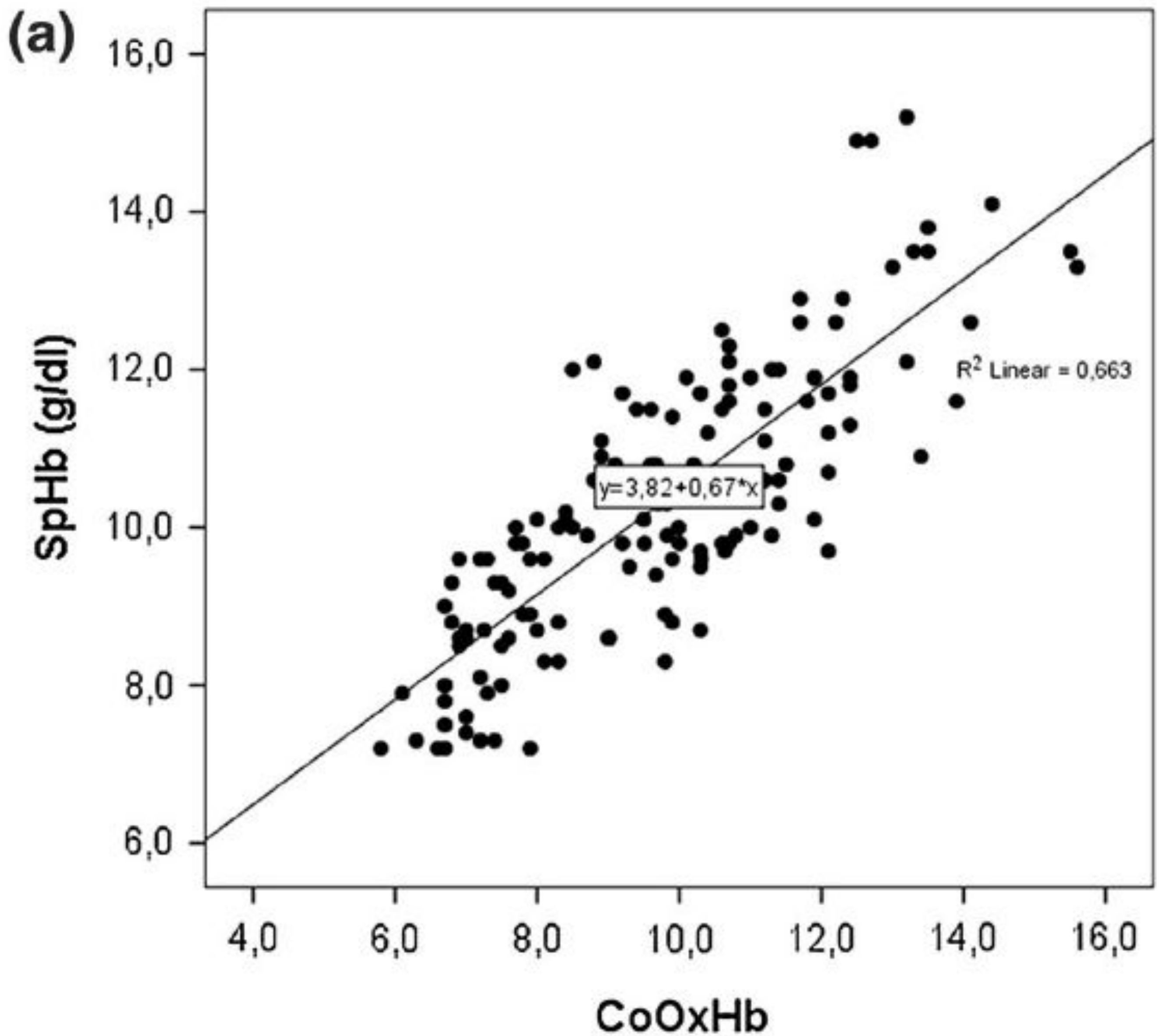
ORIGINAL RESEARCH

Accuracy of non-invas
measurement by Pulse
and surgical bleeding

Werner Baulig[1] · Burkhardt Seifert



CONGRESSO PAULISTA DE ANESTESIOLOGIA
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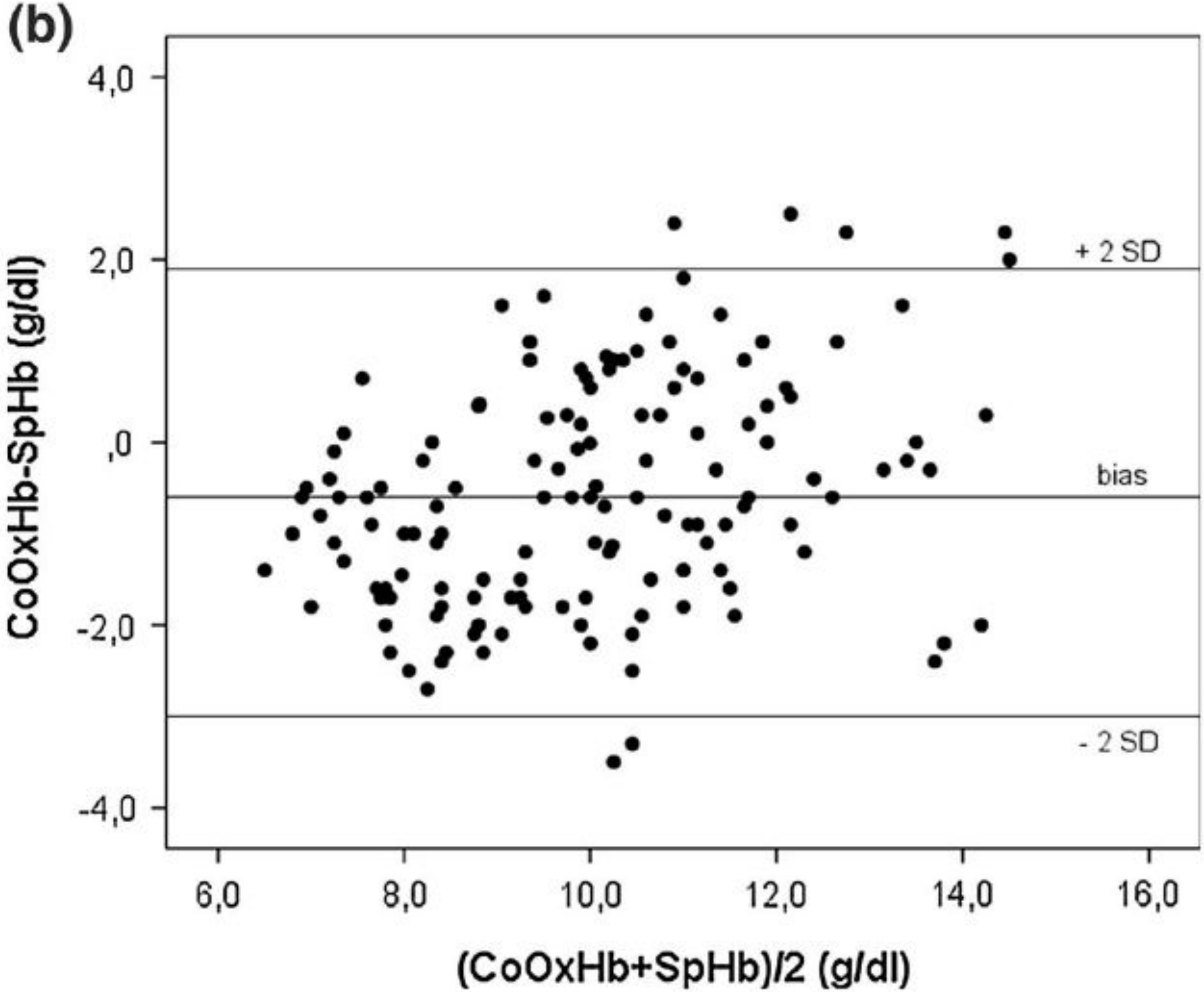
J Clin Monit Comput (2017)
DOI 10.1007/s10877-015-98

ORIGINAL RESEAR

**Accuracy of no
measurement l
and surgical bl**

Werner Baulig[1] · Burk



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Accuracy of non-invasive continuous total hemoglobin measurement by Pulse CO-Oximetry in severe traumatized and surgical bleeding patients

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Moderate / high correlation but..

Moderate-low precision: LOA -3 to +1.9

A bit reliable to detect changes only if changes <1g/dl excluded!

PPV 0.49 NPV 0.69

Journal of Perinatology (2015), 1–4

www.nature.com/jp

ORIGINAL ARTICLE

Validation of noninvasive hemoglobin measurement by pulse co-oximeter in newborn infants

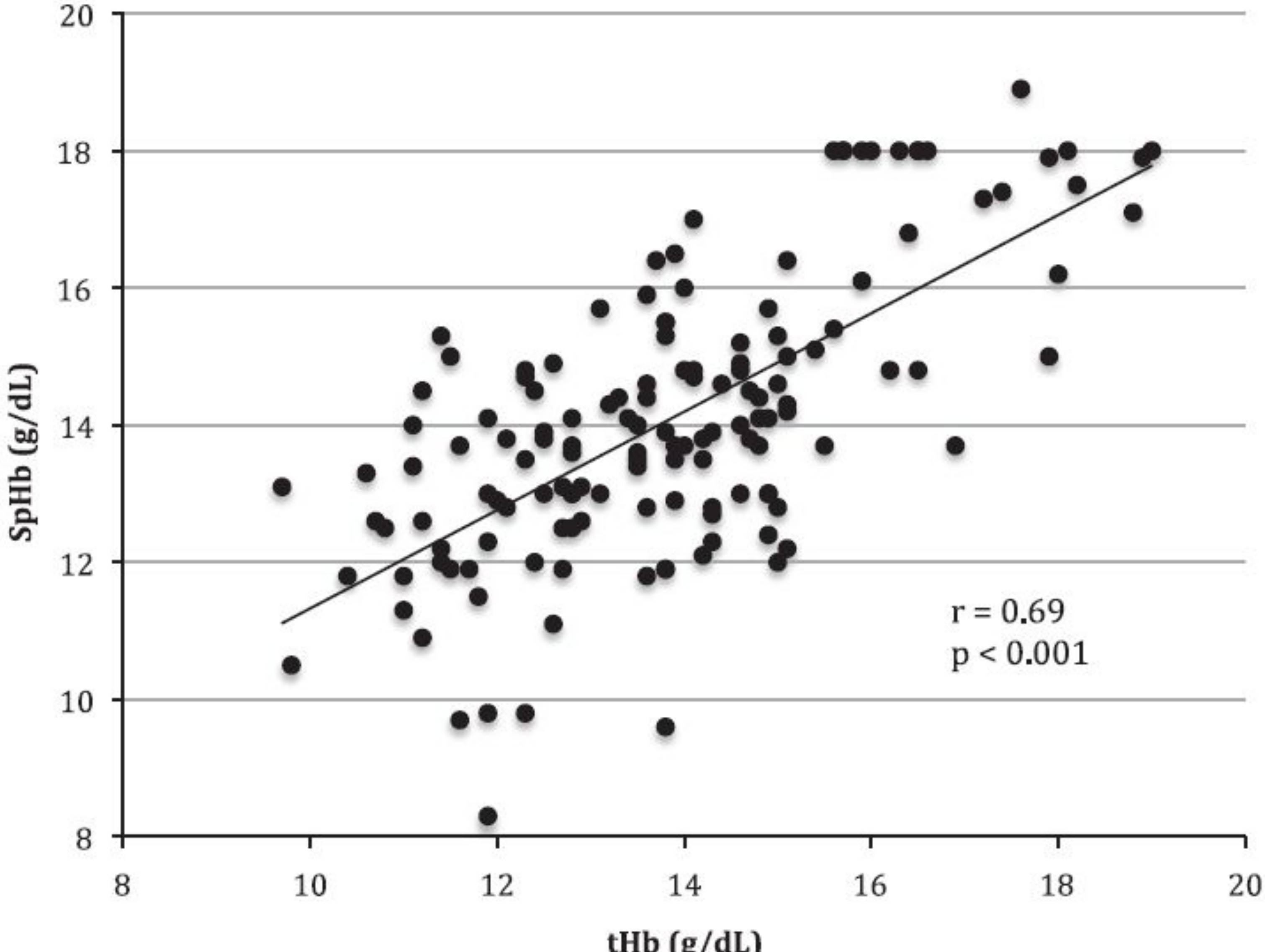
C Nicholas[1,2], R George[2], S Sardesai[1], M Durand[1], R Ramanathan[1,2] and R Cayabyab[1]

Journal of Perinatology (2015), 1–4

ORIGINAL ARTICLE

Validation of
co-oximeter i

C Nicholas[1,2], R George[2], S Sa



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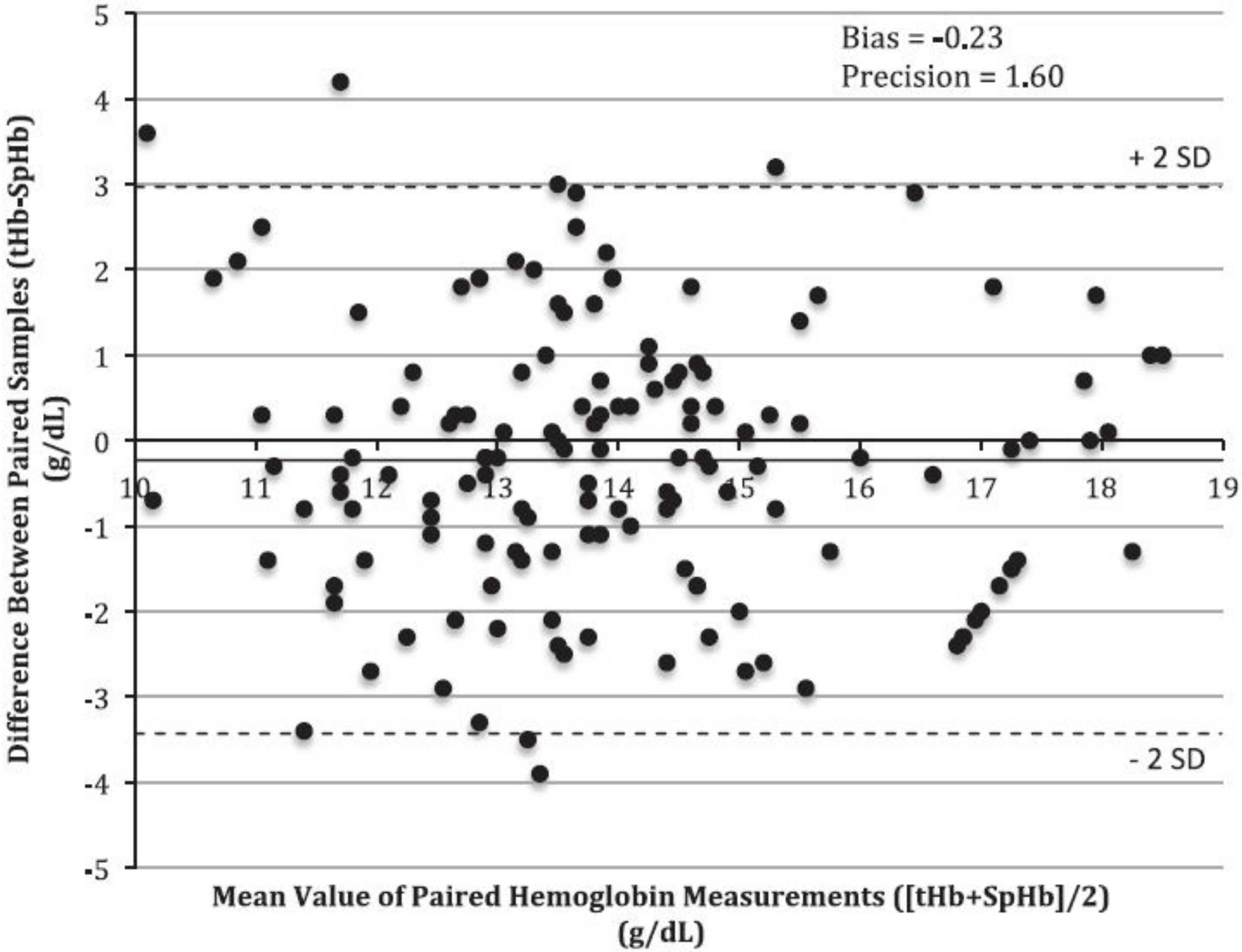

Bias = -0.23
Precision = 1.60

+- 2dp = +- 3g/dl

British Journal of Anaesthesia **109** (4): 522–8 (2012)
Advance Access publication 20 July 2012 · doi:10.1093/bja/aes234

BJA

Accuracy of non-invasive measurement of haemoglobin concentration by pulse co-oximetry during steady-state and dynamic conditions in liver surgery

J. J. Vos[1*], A. F. Kalmar[1], M. M. R. F. Struys[1], R. J. Porte[2], J. K. G. Wietasch[1], T. W. L. Scheeren[1] and H. G. D. Hendriks[1]

[1] Department of Anesthesiology and [2] Division of Liver Transplantation and HPB, Department of Surgery, The University of Groningen, University Medical Center Groningen, Groningen, The Netherlands

* Corresponding author. E-mail: j.j.vos@umcg.nl

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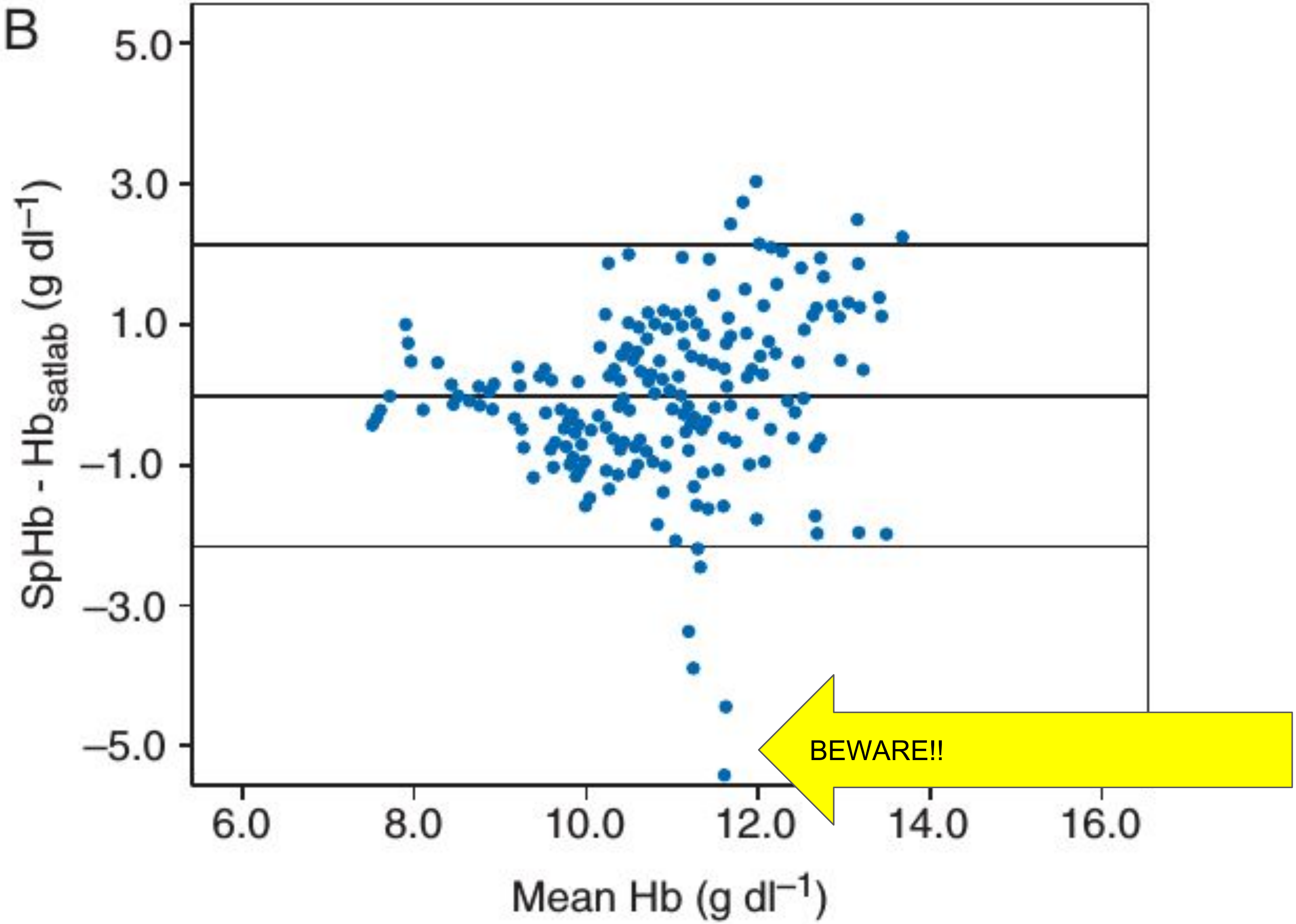
* Corresponding author. E-mail: j.j.vos@umcg.nl

Massimo Radical 7 vs ABL 800

Major hepatic resection


B
5.0
3.0
1.0
−1.0
−3.0
−5.0
6.0
8.0
10.0
12.0
14.0
16.0
SpHb - Hb$_{satlab}$ (g dl^{-1})
Mean Hb (g dl^{-1})
BEWARE!!

British Journal of Anaesthesia 109 (4)
Advance Access publication 20 July 2

Accuracy of non
concentration by
and dynamic co

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and H. G. D. Hendriks[1]
[1] Department of Anesthesiology and
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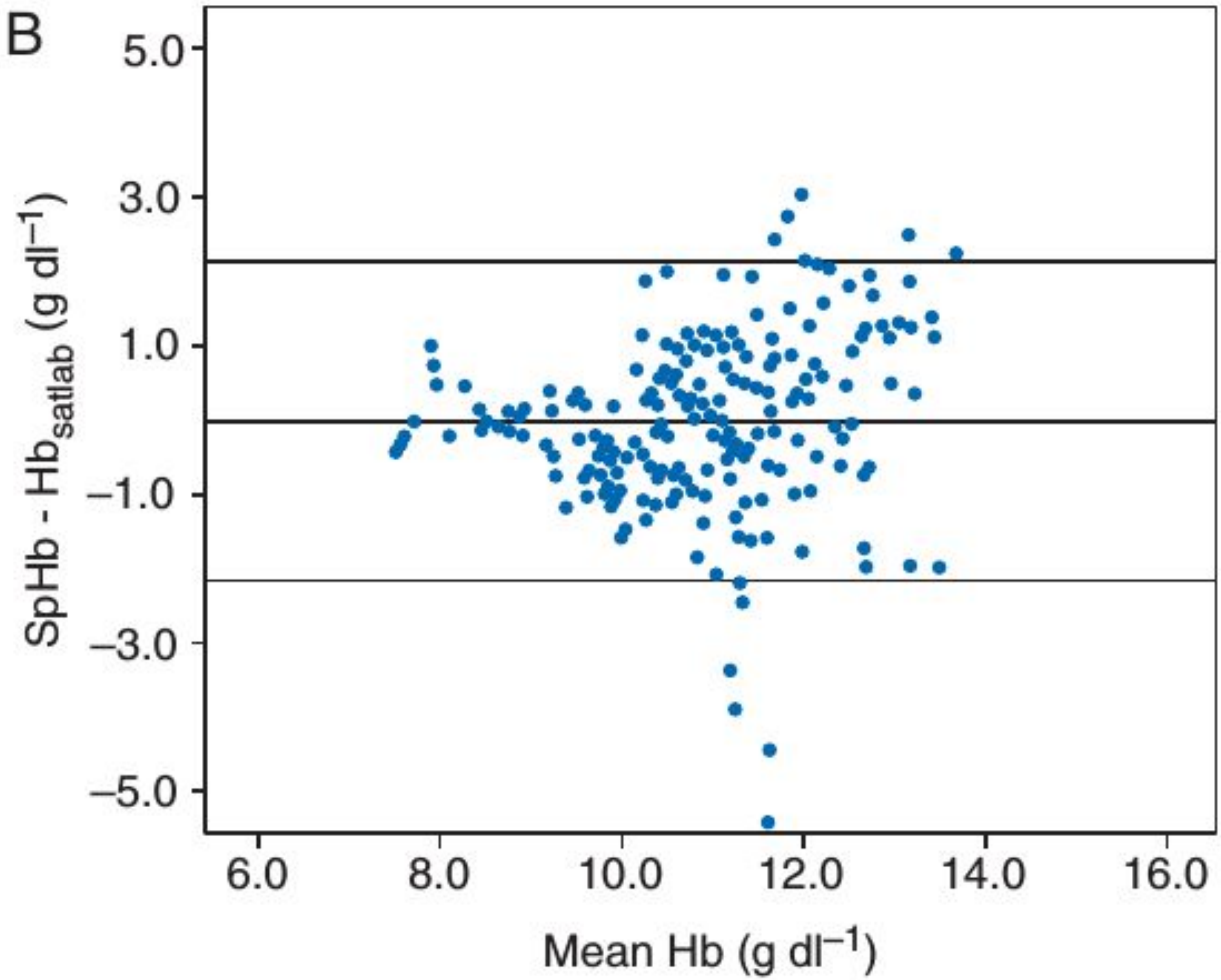
* Corresponding author. E-mail: j.j.v

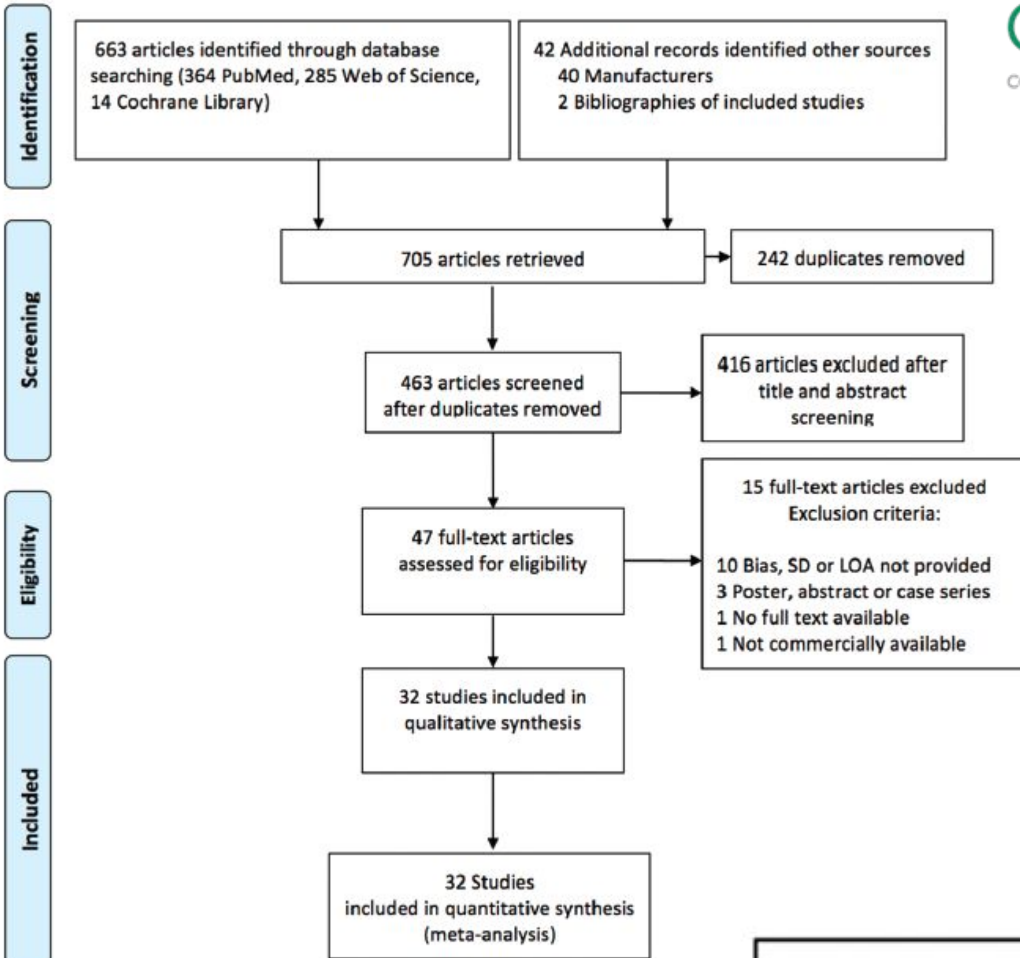


Accuracy of Continuous Noninvasive Hemoglobin Monitoring: A Systematic Review and Meta-Analysis

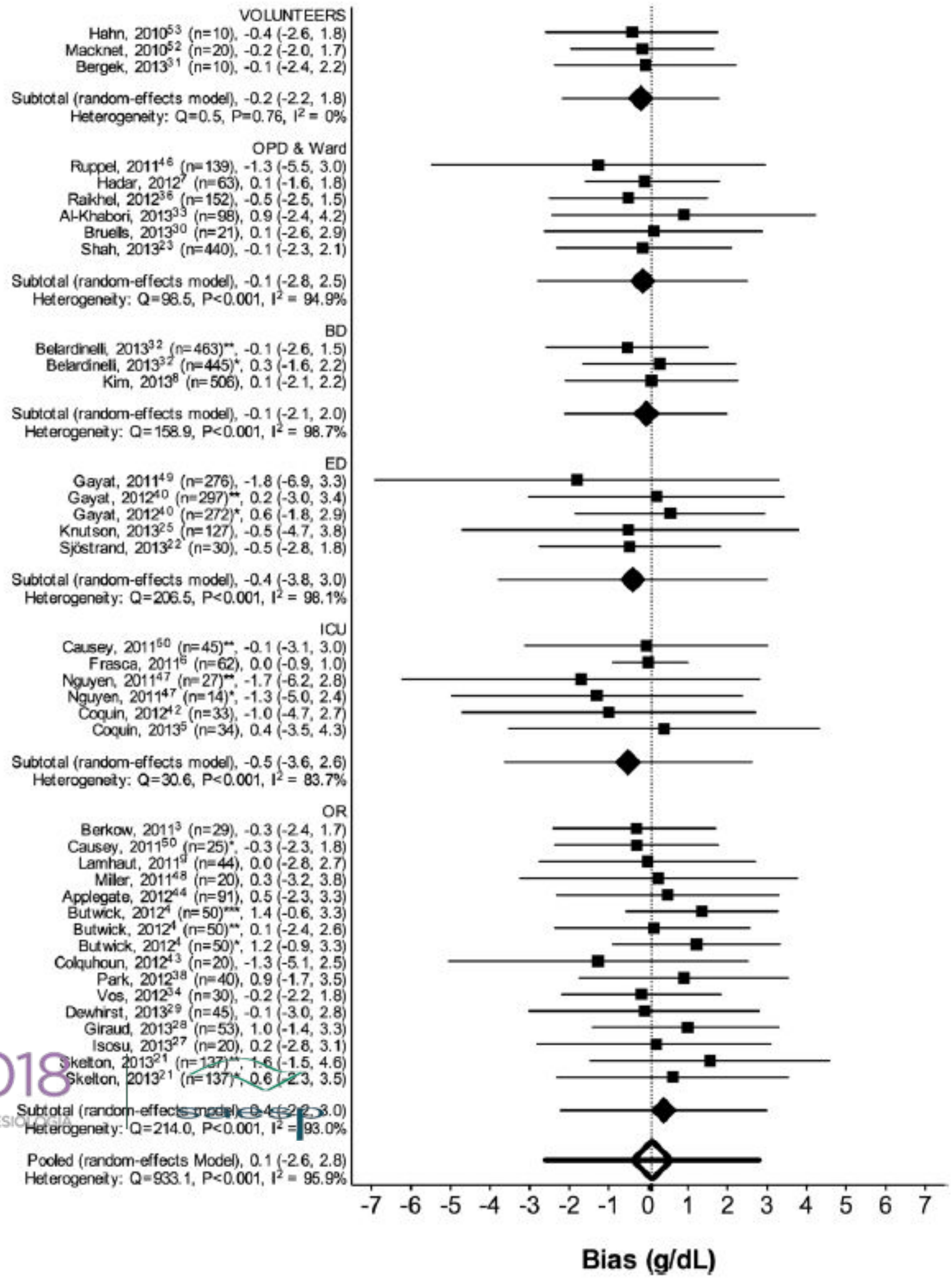
Sang-Hyun Kim, MD, PhD,* Marc Lilot, MD,* Linda Suk-Ling Murphy, MLIS,† Kulraj S. Sidhu, MD,*
Zhaoxia Yu, PhD,‡ Joseph Rinehart, MD,* and Maxime Cannesson, MD, PhD

www.anesthesia-analgesia.org

August 2014 • Volume 119 • Number 2



32 Studies
included in quantitative synthesis
(meta-analysis)



VOLUNTEERS
Hahn, 2010[53] (n=10), -0.4 (-2.6, 1.8)
Macknet, 2010[52] (n=20), -0.2 (-2.0, 1.7)
Bergek, 2013[31] (n=10), -0.1 (-2.4, 2.2)
Subtotal (random-effects model), -0.2 (-2.2, 1.8)
Heterogeneity: Q=0.5, P=0.76, I2 = 0%
OPD & Ward
Ruppel, 2011[46] (n=139), -1.3 (-5.5, 3.0)
Hadar, 2012[7] (n=63), 0.1 (-1.6, 1.8)
Raikhel, 2012[36] (n=152), -0.5 (-2.5, 1.5)
Al-Khabori, 2013[33] (n=98), 0.9 (-2.4, 4.2)
Bruells, 2013[30] (n=21), 0.1 (-2.6, 2.9)
Shah, 2013[23] (n=440), -0.1 (-2.3, 2.1)
Subtotal (random-effects model), -0.1 (-2.8, 2.5)
Heterogeneity: Q=96.5, P<0.001, I2 = 94.9%
BD
Belardinelli, 2013[32] (n=463)**, -0.1 (-2.6, 1.5)
Belardinelli, 2013[32] (n=445)*, 0.3 (-1.6, 2.2)
Kim, 2013[8] (n=506), 0.1 (-2.1, 2.2)
Subtotal (random-effects model), -0.1 (-2.1, 2.0)
Heterogeneity: Q=158.9, P<0.001, I2 = 98.7%
ED
Gayat, 2011[49] (n=276), -1.8 (-6.9, 3.3)
Gayat, 2012[40] (n=297)**, 0.2 (-3.0, 3.4)
Gayat, 2012[40] (n=272)*, 0.6 (-1.8, 2.9)
Knutson, 2013[25] (n=127), -0.5 (-4.7, 3.8)
Sjöstrand, 2013[22] (n=30), -0.5 (-2.8, 1.8)
Subtotal (random-effects model), -0.4 (-3.8, 3.0)
Heterogeneity: Q=206.5, P<0.001, I2 = 98.1%
ICU
Causey, 2011[50] (n=45)**, -0.1 (-3.1, 3.0)
Frasca, 2011[6] (n=62), 0.0 (-0.9, 1.0)
Nguyen, 2011[47] (n=27)**, -1.7 (-6.2, 2.8)
Nguyen, 2011[47] (n=14)*, -1.3 (-5.0, 2.4)
Coquin, 2012[42] (n=33), -1.0 (-4.7, 2.7)
Coquin, 2013[5] (n=34), 0.4 (-3.5, 4.3)
Subtotal (random-effects model), -0.5 (-3.6, 2.6)
Heterogeneity: Q=30.6, P<0.001, I2 = 83.7%
OR
Berkow, 2011[3] (n=29), -0.3 (-2.4, 1.7)
Causey, 2011[50] (n=25)*, -0.3 (-2.3, 1.8)
Lamhaut, 2011[9] (n=44), 0.0 (-2.8, 2.7)
Miller, 2011[48] (n=20), 0.3 (-3.2, 3.8)
Applegate, 2012[44] (n=91), 0.5 (-2.3, 3.3)
Butwick, 2012[4] (n=50)***, 1.4 (-0.6, 3.3)
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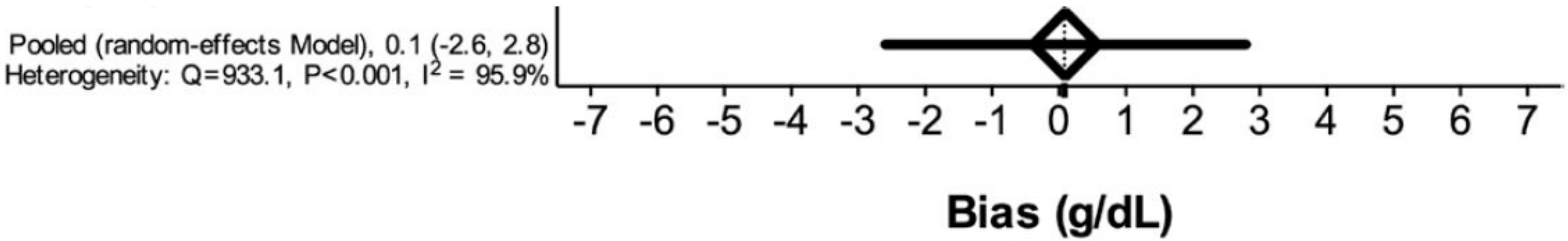
Isosu, 2013[27] (n=20), 0.2 (-2.8, 3.1)
Skelton, 2013[21] (n=137)**, 1.6 (-1.5, 4.6)
Skelton, 2013[21] (n=137)*, 0.6 (-2.3, 3.5)
Subtotal (random-effects model), 0.4 (-2.2, 3.0)
Heterogeneity: Q=214.0, P<0.001, I2 = 93.0%
Pooled (random-effects Model), 0.1 (-2.6, 2.8)
Heterogeneity: Q=933.1, P<0.001, I2 = 95.9%
-7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7
Bias (g/dL)



0.10 ± 1.37 g/dL (–2.59 to 2.80 g/dL)

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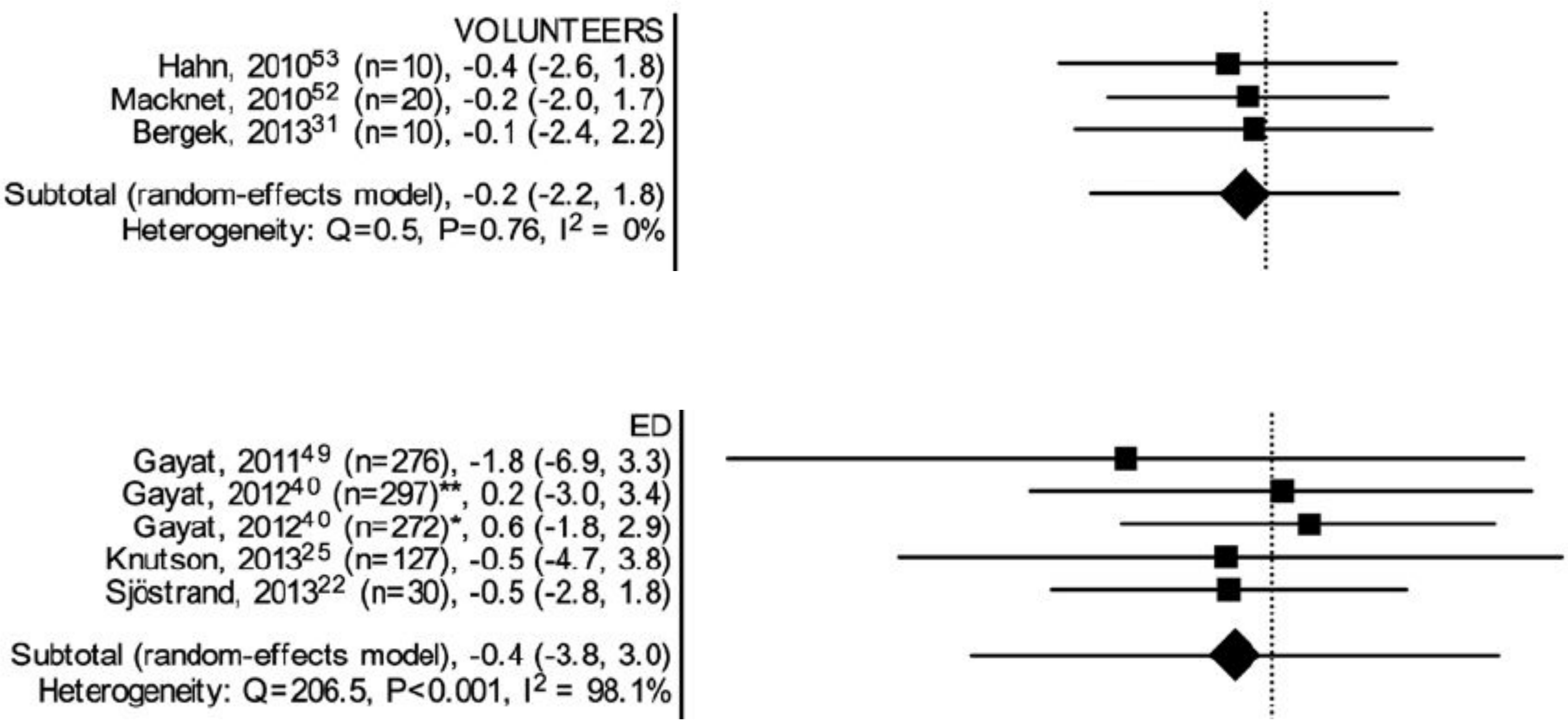

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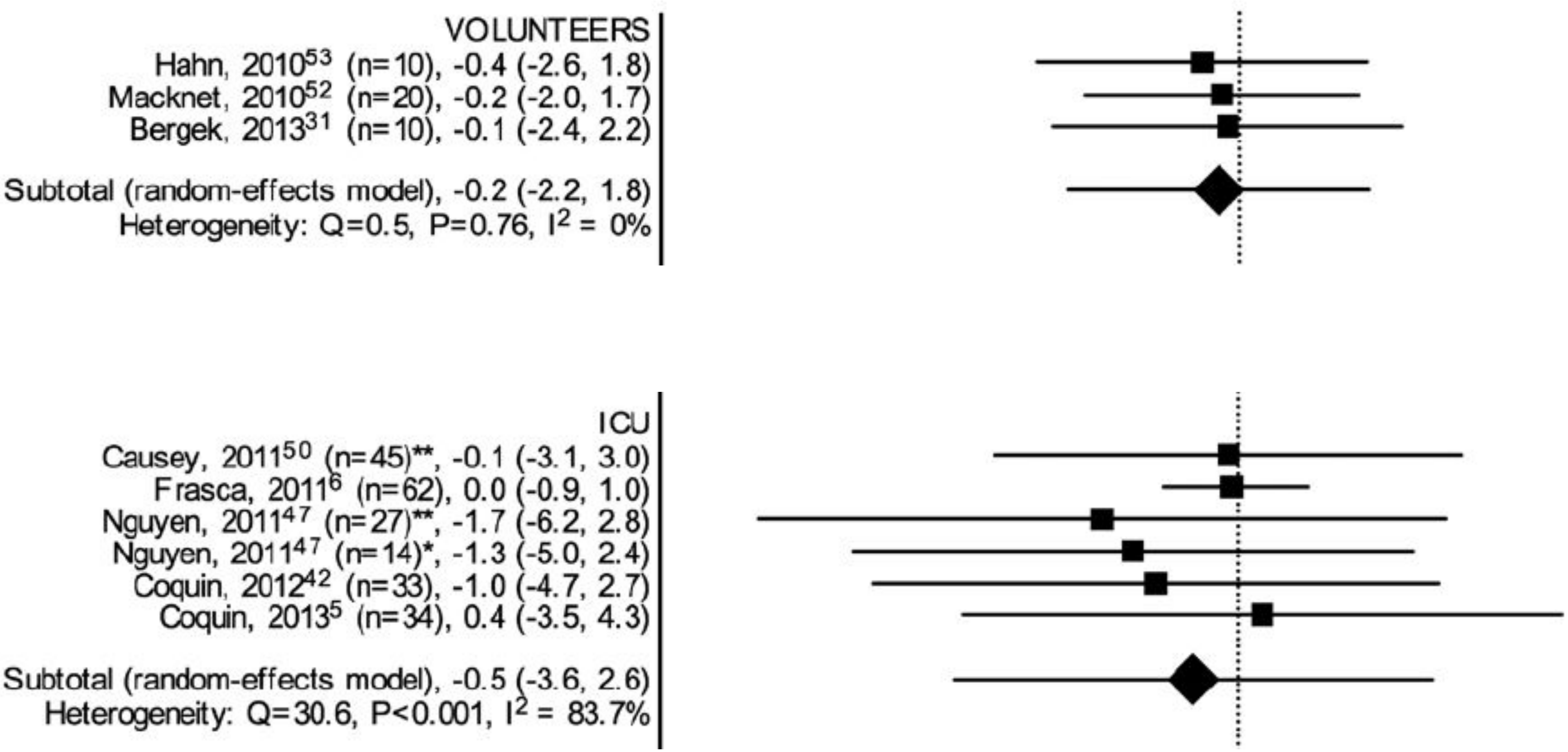
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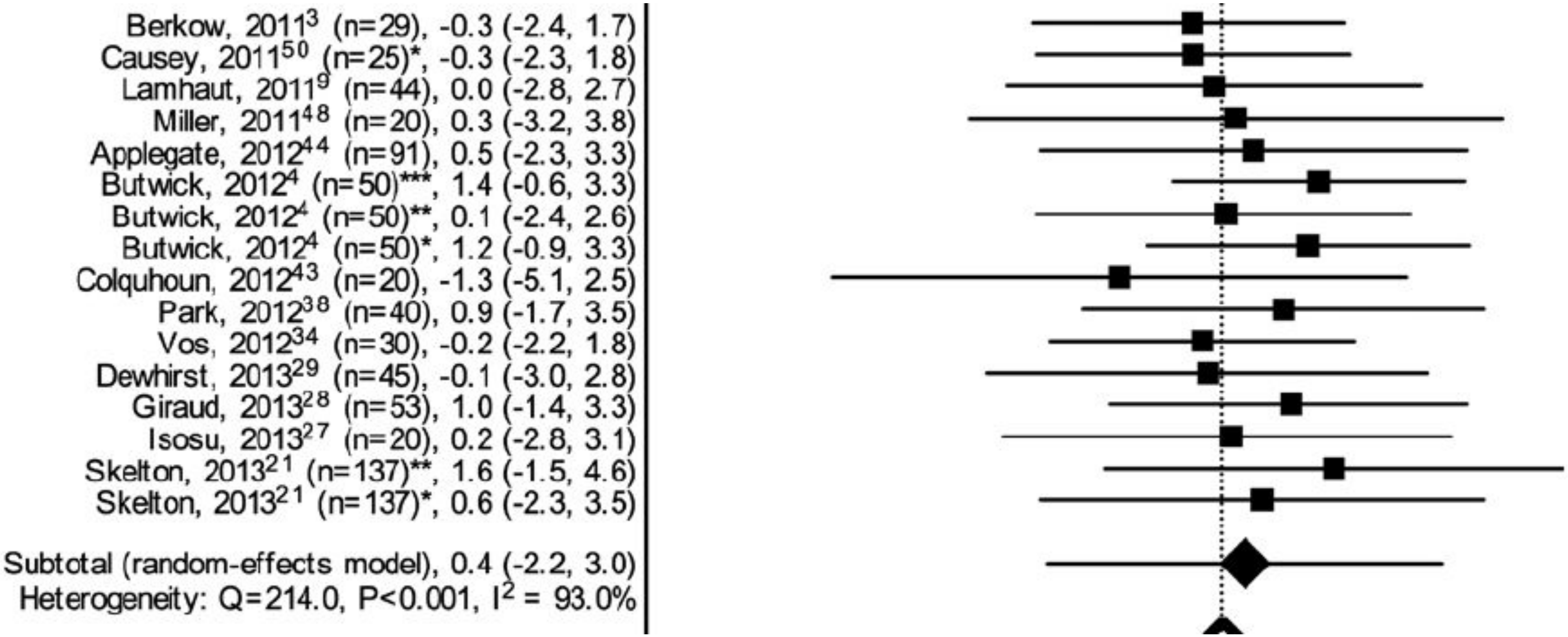
Heterogeneity: Q=30.6, P<0.001, I2 = 83.7%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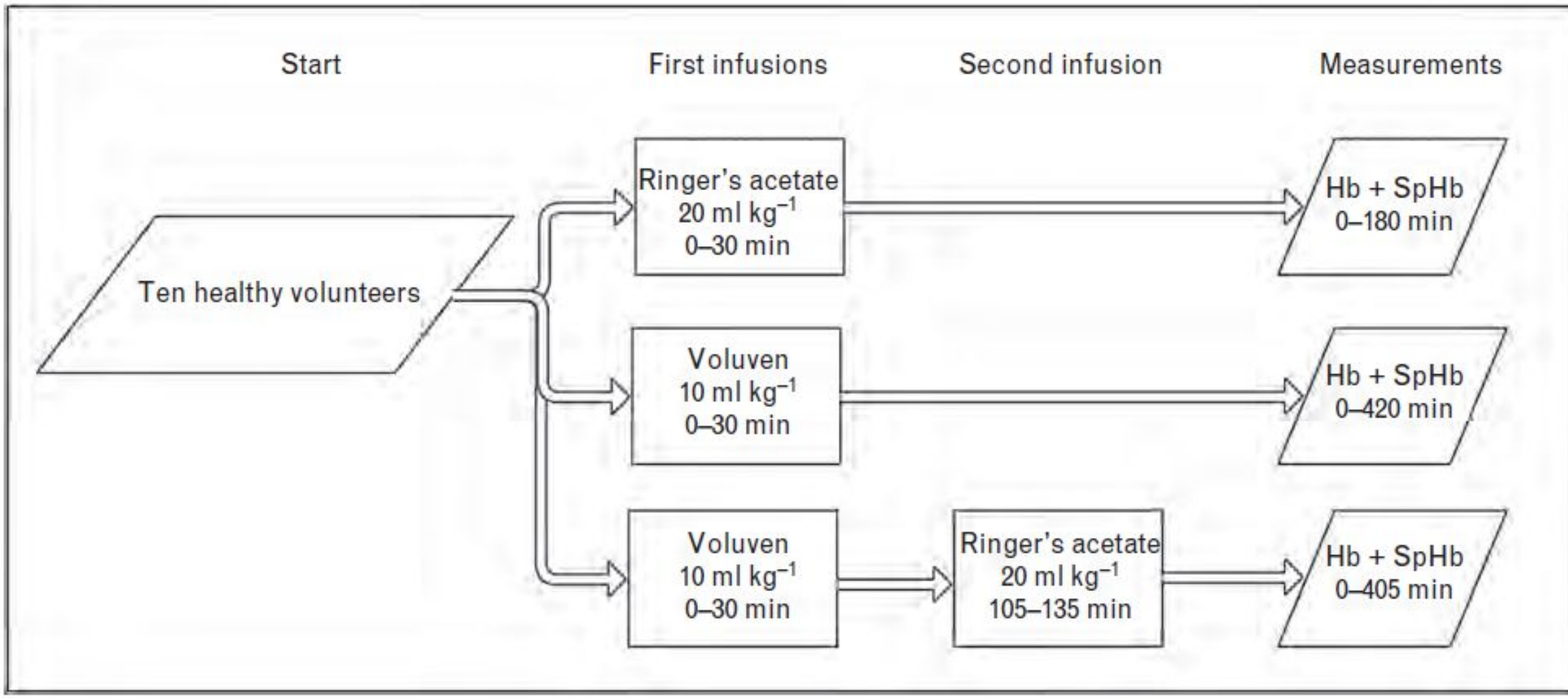
Skelton, 2013[21] (n=137)*, 0.6 (-2.3, 3.5)
Subtotal (random-effects model), 0.4 (-2.2, 3.0)
Heterogeneity: Q=214.0, P<0.001, I2 = 93.0%

Table 2. Subgroup Analysis by Device

	Sample size	No. studies	Pooled random-effects estimates		
			Bias	SD	95% LOA
Radical-7[3,4,6,9,21,22,25,27–29,31,3	1495	22	−0.02	1.42	−2.81 to 2.76
Pronto-7[23,30,32,33,36,40]	1446	6[a]	0.05	1.23	−2.35 to 2.46
NBM-200 and NBM-200MP[5	1345	5[b]	0.18	1.15	−2.08 to 2.45

Accuracy of noninvasive haemoglobin measurement by pulse oximetry depends on the type of infusion fluid

Christian Bergek, Joachim H. Zdolsek and Robert G. Hahn



Accuracy of noninvasive haemoglobin measurement by pulse oximetry depe

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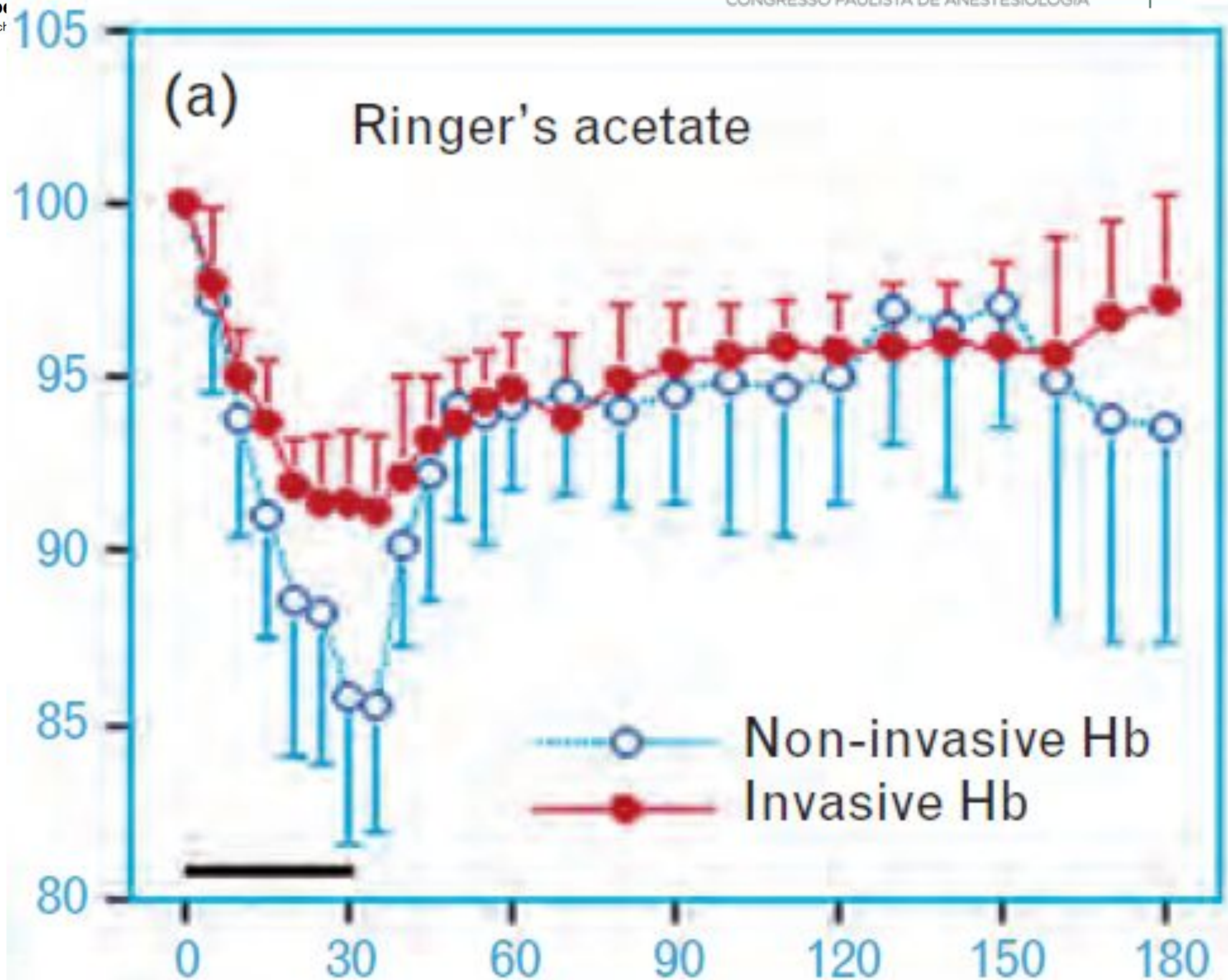

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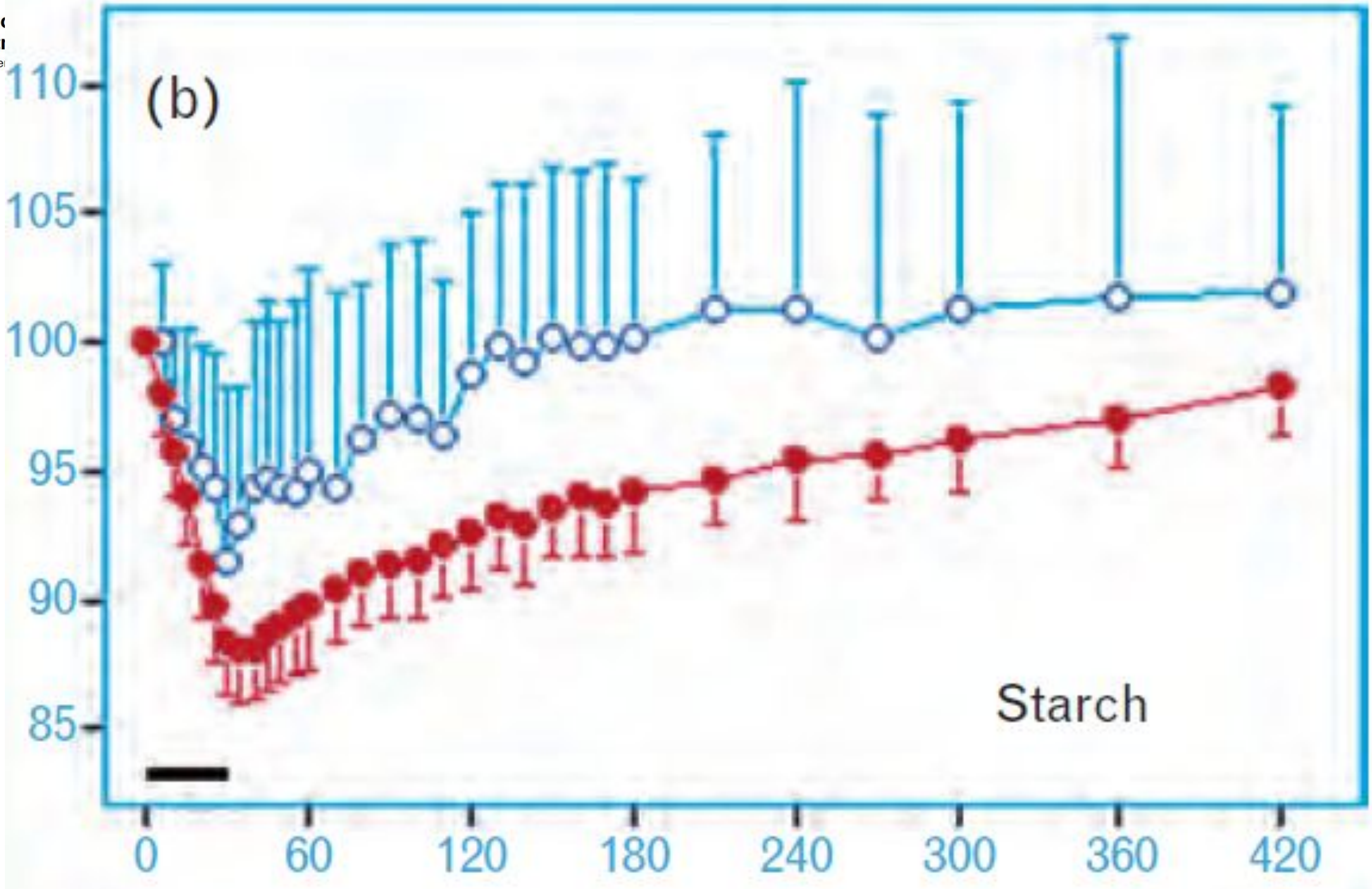

ORIGINAL ARTICLE

Accuracy of noninvasive haemoglobin measurement by pulse oximetry depends on

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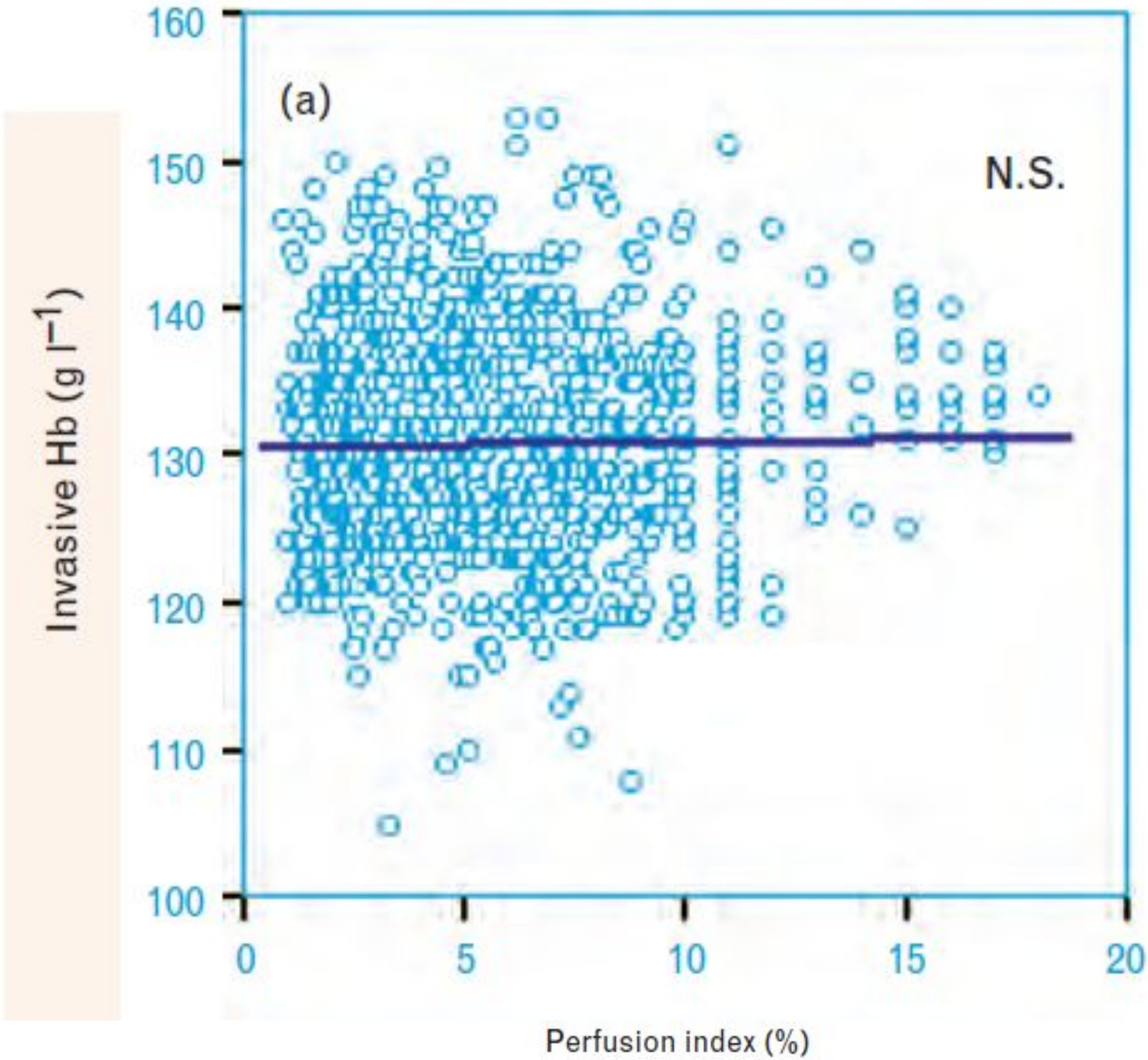

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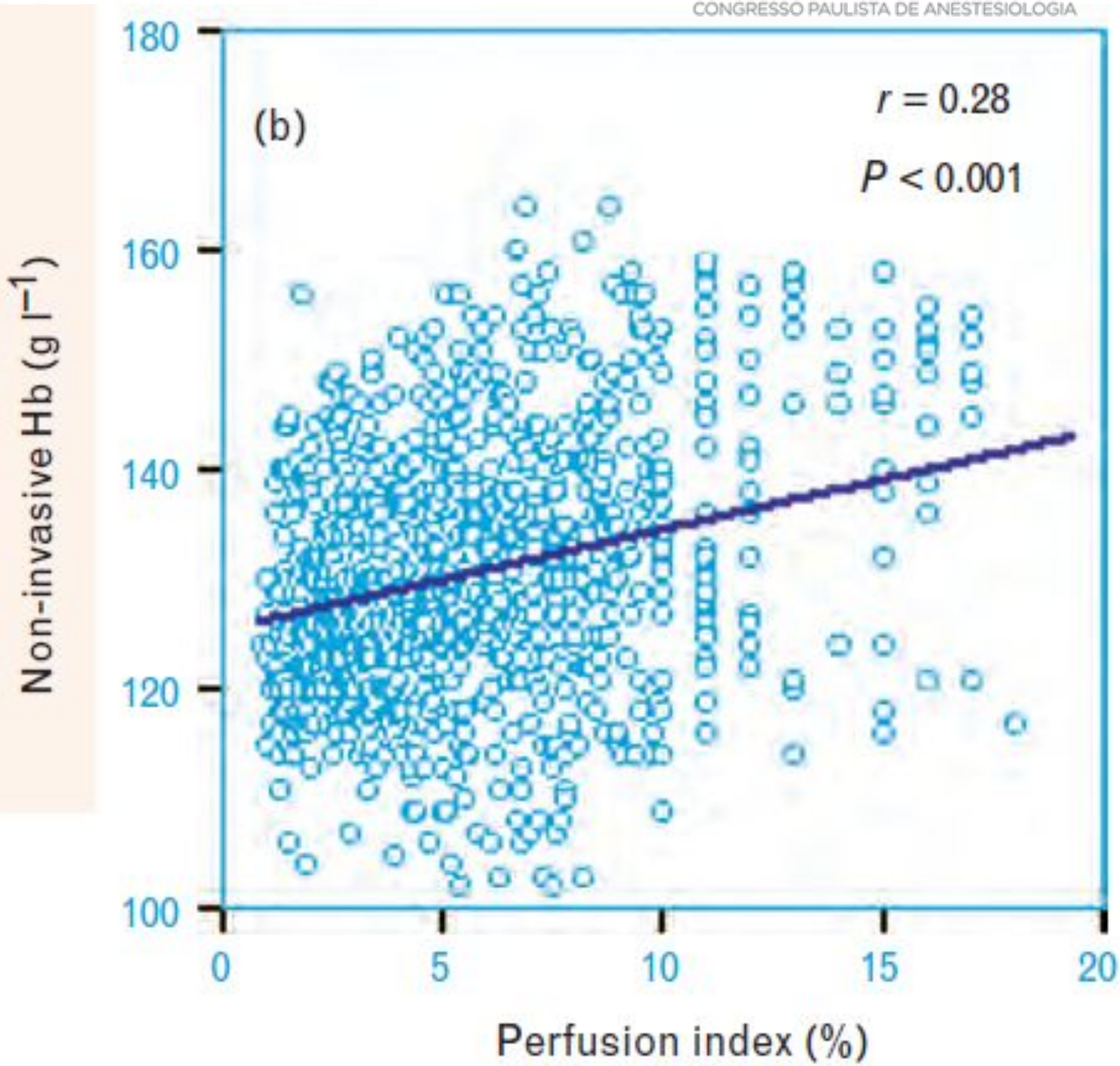
Christian Bergek, Joachim H. Z



ORIGINAL ARTICLE

Accuracy of noninvasive haemoglobin measurement by pulse oximetry depends on the type of infusion fluid
Christian Bergek, Joachim H. Zdolsek and Robert G. Hahn

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Underestimates when ringer acetate used

Overestimates when starch used

Biased by perfusion index changes

http://dx.doi.org/10.5755/j01.eee.19.7.5165

Statistically Biased Calibration Method for the Real-time Adjustment of Noninvasive Haemoglobin Measurements in a Semi-automated Infusion System

http://dx.doi.org/10.5755/j0

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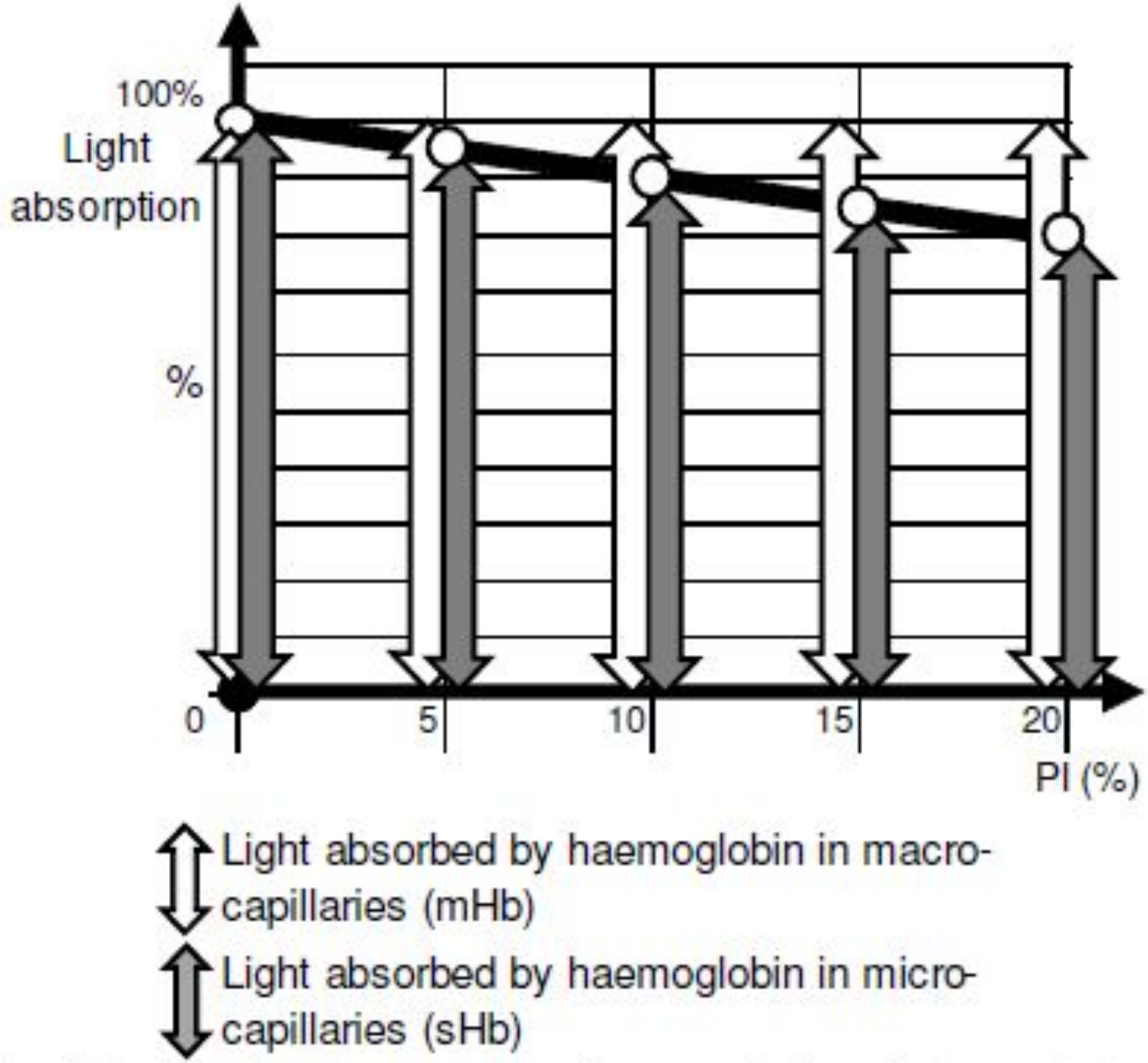

Fig. 5. Relationship between the tissue perfusion index and the light absorption in micro- and macro-capillaries. PI – perfusion index.

http://dx.doi.org/10.5755/j01.eee.19.7.5165 ELEKTRONIKA IR ELEKTROTECHNIKA, ISSN 1392-1215, VOL. 19, NO. 7, 2013

Statistically Biased Calibration Method for the Real-time Adjustment of Noninvasive Haemoglobin Measurements in a Semi-automated Infusion System

absorption. The SpHb is usually reliable in predicting the invasive arterial and venous Hb in relatively stable physiological conditions such as screening the pre-donation Hb and anemia [10]. However, SpHb can lack accuracy and especially precision in predicting invasively measured Hb in physiologically unstable conditions such as intravenous fluid infusion [11], major surgery and haemorrhage [7]–[9].

Take home message

- Underestimates after crystalloids.
- Overestimates after colloids;
- Ignore changes <1g/dl;
- Biased by PI:
  - High LOA in trauma / major surgery;
  - Even higher LOA in newborns;
- Radical 7, Pronto 7, NBM 200: similar precision.

Take home message

- Consider overall LOA -3 to +3
- Do not transfuse based only on SpHb!

Take home message

Thank you, welcome to COPA 2018

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