

# CLINICAL CHEMISTRY AND LABORATORY MEDICINE

Published in Association with the European Federation of Clinical Chemistry and Laboratory Medicine (EFLM)

**EFLM**  
EUROPEAN FEDERATION OF CLINICAL CHEMISTRY  
AND LABORATORY MEDICINE



*CCLM* is the official journal of the Association of Clinical Biochemists in Ireland (ACBI), the Austrian Society of Laboratory Medicine and Clinical Chemistry (ÖGLMKC), the German Society for Clinical Chemistry and Laboratory Medicine (DGKL), the Hungarian Society of Laboratory Medicine (MLDT), the Royal Belgian Society of Laboratory Medicine (RBSLM), the Italian Society of Clinical Biochemistry and Clinical Molecular Biology (SIBioC), the Portuguese Society of Clinical Chemistry, Genetics and Laboratory Medicine (SPML), the Slovenian Association for Clinical Chemistry and Laboratory Medicine (SZKLM) and the Spanish Society of Laboratory Medicine (SEQC). *CCLM* is affiliated with the Australasian Association of Clinical Biochemists (AACB) and Société Française de Biologie Clinique (SFBC).

## EDITOR-IN-CHIEF

**Mario Plebani**  
Padova, Italy

## ASSOCIATE EDITORS

**Giuseppe Lippi**  
Reviews Editor  
Verona, Italy  
**Philippe Gillery**  
Reims, France  
**Ronda Greaves**  
Melbourne, Australia  
**Karl J. Lackner**  
Mainz, Germany  
**Bohuslav Melichar**  
Olomouc, Czech Republic  
**Peter Schlattmann**  
Jena, Germany  
**Pan Shiyang**  
Nanjing, P.R. China

## EDITORIAL BOARD

**Ivan Brandslund**  
Odense, Denmark  
**Christoph Buchta**  
Vienna, Austria  
**Janne Cadamuro**  
Salzburg, Austria

**DE GRUYTER**

**Etienne Cavalier**  
Liege, Belgium  
**Abdurrahman Coskun**  
Istanbul, Türkiye  
**Wei Cui**  
Beijing, P.R. China  
**Vincent De Guire**  
Montreal, Canada  
**Vincent Delatour**  
Paris, France  
**Emmanuel Favaloro**  
Westmead, Australia  
**Julien Favresse**  
Brussels, Belgium  
**Pilar Fernandez-Calle**  
Madrid, Spain  
**João Tiago Guimarães**  
Porto, Portugal  
**Liam Heaney**  
Loughborough, UK  
**Brandon M. Henry**  
Cincinnati, OH, USA  
**Markus Herrmann**  
Graz, Austria  
**Martin Hersberger**  
Zurich, Switzerland  
**Chung Shun Ho**  
Shatin, Hong Kong  
**Johannes J.M.L. Hoffmann**  
Nuenen, Netherlands

**Evgenija Homšak**  
Maribor, Croatia  
**Zhi-De Hu**  
Hohhot, P.R. China  
**Aamir Ijaz**  
Mirpur, Pakistan  
**Berend Isermann**  
Leipzig, Germany  
**Joannes F.M. Jacobs**  
Nijmegen, Netherlands  
**Petr Jarolim**  
Boston, MA, USA  
**Graham Jones**  
Darlinghurst, NSW, Australia  
**János Kappelmayer**  
Debrecen, Hungary  
**Peter Kavsak**  
Toronto, Canada  
**Magdalena Krintus**  
Bydgoszcz, Poland  
**Vathany Kulasingam**  
Toronto, ON, Canada  
**Leslie Charles Lai**  
Kuala Lumpur, Malaysia  
**Ivana Lapić**  
Zagreb, Croatia  
**Michael Laposata**  
Galveston, TX, USA  
**Nicholas E. Larkey**  
Charlottesville, VA, USA  
**Tze Ping Lo**  
Singapore

**Tran Thi Chi Mai**  
Hanoi, Vietnam  
**Konstantinos Makris**  
Athens, Greece  
**Yesim Ozarda**  
Bursa, Turkey  
**Tomris Özben**  
Antalya, Turkey  
**Andrea Padoan**  
Padova, Italy  
**Geraldo Picheth**  
Curitiba, Brazil  
**Ted E. Schutzbank**  
San Diego, CA, USA  
**Swarup A.V. Shah**  
Mumbai, India  
**Cord Spreckelsen**  
Jena, Germany  
**Michael Vogeser**  
Munich, Germany  
**Maria Alice V. Willrich**  
Rochester, MN, USA  
**Annalise E. Zemlin**  
Cape Town, South Africa  
**Tomáš Zima**  
Prague, Czech Republic

## MANAGING EDITOR

**Heike Jahnke**  
Berlin, Germany

**ABSTRACTED/INDEXED IN** Analytical Abstracts · Baidu Scholar · Cabells Journalytics · CABI (over 50 subsections) · Chemical Abstracts Service (CAS): CAPlus; SciFinder · CNKI Scholar (China National Knowledge Infrastructure) · CNPIEC: cnpLINKer · Dimensions · EBSCO (relevant databases) · EBSCO Discovery Service · EMBASE · Genamics JournalSeek · Google Scholar · ICAP Alcohol Information Databases · Japan Science and Technology Agency (JST) · J-Gate · Journal Citation Reports/Science Edition · JournalGuide · Medline · MyScienceWork · Naver Academic · Naviga (Softweco) · Norwegian Register for Scientific Journals, Series and Publishers · Pathway Studio · Primo Central (ExLibris) · ProQuest (relevant databases) · Publons · PubMed · PubsHub · QOAM (Quality Open Access Market) · ReadCube · Reaxys · ScienceON (Korea Institute of Science and Technology Information) · Scilit · SCImago (SJR) · SCOPUS · Semantic Scholar · Sherpa/RoMEO · Summon (ProQuest) · TDNet · TEMA Technik und Management · Text Mining · Ulrich's Periodicals Directory/ulrichsweb · WanFang Data · Web of Science: Biological Abstracts; BIOSIS Previews; Current Contents/Life Sciences; Prous Science Integrity; Science Citation Index; Science Citation Index Expanded · WorldCat (OCLC) · X-MOL · Yewno Discover

*CCLM* is the official journal of the Association of Clinical Biochemists in Ireland (ACBI), the Austrian Society of Laboratory Medicine and Clinical Chemistry (ÖGLMKC), the German Society for Clinical Chemistry and Laboratory Medicine (DGKL), the Hungarian Society of Laboratory Medicine (MLDT), the Royal Belgian Society of Laboratory Medicine (RBSLM), the Italian Society of Clinical Biochemistry and Clinical Molecular Biology (SIBioC), the Portuguese Society of Clinical Chemistry, Genetics and Laboratory Medicine (SPML), the Slovenian Association for Clinical Chemistry and Laboratory Medicine (SZKKLM) and the Spanish Society of Laboratory Medicine (SEQC). *CCLM* is affiliated with the Australasian Association of Clinical Biochemists (AACB) and Société Française de Biologie Clinique (SFBC).

The publisher, together with the authors and editors, has taken great pains to ensure that all information presented in this work (programs, applications, amounts, dosages, etc.) reflects the standard of knowledge at the time of publication. Despite careful manuscript preparation and proof correction, errors can nevertheless occur. Authors, editors and publisher disclaim all responsibility for any errors or omissions or liability for the results obtained from use of the information, or parts thereof, contained in this work.

The citation of registered names, trade names, trademarks, etc. in this work does not imply, even in the absence of a specific statement, that such names are exempt from laws and regulations protecting trademarks etc. and therefore free for general use.

ISSN 1434-6621 · e-ISSN 1437-4331 · CODEN CCLMFV

All information regarding notes for contributors, subscriptions, Open access, back volumes and orders is available online at [www.degruyter.com/cclm](http://www.degruyter.com/cclm).

**RESPONSIBLE EDITOR(S)** Prof. Dr. Mario Plebani, Università di Padova, Dipartimento di Medicina di Laboratorio, Azienda Ospedaliera di Padova, Via Nicolò Giustiniani 2, 35131 Padova, Italy. Tel.: +390 (0)49 821 2792, Fax: +390 (0)49 663 240, e-mail: [mario.plebani@unipd.it](mailto:mario.plebani@unipd.it)

**PUBLISHER** Walter de Gruyter GmbH, Berlin/Boston, Genthiner Str. 13, 10785 Berlin, Germany

**JOURNAL COORDINATOR** Heike Jahnke, De Gruyter, Genthiner Str. 13, 10785 Berlin, Germany, Tel.: +49 (0)30 260 05 – 220, Fax: +49 (0)30 260 05 – 325, e-mail: [heike.jahnke@degruyter.com](mailto:heike.jahnke@degruyter.com)

**ADVERTISEMENTS** e-mail: [anzeigen@degruyter.com](mailto:anzeigen@degruyter.com)

© 2024 Walter de Gruyter GmbH, Berlin/Boston, Germany

**TYPESETTING** TNQ Tech Private Limited, Chennai, India

**PRINTING** Franz X. Stückle Druck und Verlag e.K., Ettenheim

**COVER ILLUSTRATION** Research lab © Eisenhans. Permission to use the image on the cover granted by Fotolia LLC.



## Contents

### Editorial

Ronda F. Greaves

**LC-MS/MS random access automation – a game changer for the 24/7 clinical laboratory — 1249**

Refers to articles on pp 1288, 1301, 1314, 1327, 1339

### Reviews

Sherif Bayoumy, Inge M.W. Verberk, Lisa Vermunt, Eline Willemse, Ben den Dulk, Ans T. van der Ploeg, Dasja Pajkrt, Elisa Nitz, Johanna M.P. van den Hout, Julie van der Post, Nicole I. Wolf, Shanice Beerepoot, Ewout J.N. Groen, Victoria Tüngler and Charlotte E. Teunissen

**Neurofilament light protein as a biomarker for spinal muscular atrophy: a review and reference ranges — 1252**

Li Du, Ning Wei, Rakhi Maiwall and Yuhu Song

**Differential diagnosis of ascites: etiologies, ascitic fluid analysis, diagnostic algorithm — 1266**

### Opinion Papers

Emilio Flores, Laura Martínez-Racaj, Ruth Torreblanca, Alvaro Blasco, Maite Lopez-Garrigós, Irene Gutiérrez and Maria Salinas

**Clinical Decision Support System in laboratory medicine — 1277**

Federico Pennestrì, Rossella Tomaiuolo, Giuseppe Banfi and Alberto Dolci

**Blood over-testing: impact, ethical issues and mitigating actions — 1283**

### General Clinical Chemistry and Laboratory Medicine

Tobias Schierscher, Linda Salzmann, Neeraj Singh, Janik Wild, Vanessa Fischer, Friederike Bauland, Andrea Geistanger, Lorenz Risch, Christian Geletneky, Christoph Seger and Judith Taibon

**An isotope dilution-liquid chromatography-tandem mass spectrometry (ID-LC-MS/MS)-based candidate reference measurement procedure for the quantification of zonisamide in human serum and plasma — 1288**

Tobias Schierscher, Linda Salzmann, Neeraj Singh, Martina Bachmann, Friederike Bauland, Andrea Geistanger, Lorenz Risch, Christian Geletneky, Christoph Seger and Judith Taibon

**An isotope dilution-liquid chromatography-tandem mass spectrometry (ID-LC-MS/MS)-based candidate reference measurement procedure for the quantification of carbamazepine in human serum and plasma — 1301**

Tobias Schierscher, Linda Salzmann, Neeraj Singh, Martina Bachmann, Anja Kobel, Janik Wild, Friederike Bauland, Andrea Geistanger, Lorenz Risch, Christian Geletneky, Christoph Seger and Judith Taibon

**An isotope dilution-liquid chromatography-tandem mass spectrometry (ID-LC-MS/MS)-based candidate reference measurement procedure (RMP) for the quantification of phenobarbital in human serum and plasma — 1314**

Tobias Schierscher, Linda Salzmann, Neeraj Singh, Vanessa Fischer, Anja Kobel, Friederike Bauland, Andrea Geistanger, Lorenz Risch, Christian Geletneky, Christoph Seger and Judith Taibon

**An isotope dilution-liquid chromatography-tandem mass spectrometry (ID-LC-MS/MS)-based candidate reference measurement procedure (RMP) for the quantification of primidone in human serum and plasma — 1327**

Tobias Schierscher, Neeraj Singh, Anja Kobel, Janik Wild, Friederike Bauland, Andrea Geistanger, Lorenz Risch, Christian Geletneky, Christoph Seger and Judith Taibon

**An isotope dilution-liquid chromatography-tandem mass spectrometry (ID-LC-MS/MS)-based candidate reference measurement procedure for the quantification of carbamazepine-10,11-epoxide in human serum and plasma — 1339**

Niek F. Dirks, Wendy P.J. den Elzen, Jacquelin J. Hillebrand, Heleen I. Jansen, Edwin ten Boekel, Jacqueline Brinkman, Madelon M. Buijs, Ayse Y. Demir, Ineke M. Dijkstra, Silvia C. Endenburg, Paula Engbers, Jeannette Gootjes, Marcel J.W. Janssen, Wilhelmina H.A. Kniest-de Jong, Maarten B. Kok, Stephan Kamphuis, Adrian Kruit, Etienne Michielsen, Albert Wolthuis, Anita Boelen and Annemieke C. Heijboer

**Should we depend on reference intervals from manufacturer package inserts? Comparing TSH and FT4 reference intervals from four manufacturers with results**

**from modern indirect methods and the direct method — 1352**

Sedat Abusoglu, Muhittin Serdar, Ali Unlu and Gulsum Abusoglu

**Comparison of three chatbots as an assistant for problem-solving in clinical laboratory — 1362**

Maria Schmidt, Daniel Steinbach, Martin Federbusch, Anke Tönjes, Berend Isermann, Thorsten Kaiser and Felix Eckelt  
**Evidence-based cutoffs for total and adjusted calcium: a major factor in detecting severe hypo- and hypercalcemia — 1367**

Vincenzo G. Menditto, Marco Moretti, Lucia Babini, Annalisa Mattioli, Andres Ramon Giuliani, Marina Fratini, Fabienne Yvonne Pallua, Elisa Andreoli, Cinzia Nitti, Susanna Contucci, Armando Gabrielli, Marco Bruno Luigi Rocchi and Giovanni Pomponio  
**Minor head injury in anticoagulated patients: performance of biomarkers S100B, NSE, GFAP, UCH-L1 and Alinity TBI in the detection of intracranial injury. A prospective observational study — 1376**

Sirikwan Laksap, Suphisara Suanboon, Manoo Punyamung, Chedtapak Ruengdit and Sakorn Pornprasert  
**A comparative evaluation of the analytical performances of premier resolution-high-performance liquid chromatography (PR-HPLC) with capillary zone electrophoresis (CZE) assays for the detection of hemoglobin variants and the quantitation of HbA<sub>0</sub>, A<sub>2</sub>, E, and F — 1383**

Attila Ádám Szabó, Enikő Edit Enyedi, István Tibor Altorjay, Péter Hajnal, Tamás Bence Pintér, Ivetta Siket Mányiné, Csongor Váradi, Emese Bányai, Attila Tóth, Zoltán Papp and Miklós Fagyas  
**Get reliable laboratory findings – how to recognize the deceptive effects of angiotensin-converting enzyme inhibitor therapy in the laboratory diagnostics of sarcoidosis? — 1393**

**Reference Values and Biological Variations**

Sieglinde Zelzer, Andreas Meinitzer, Dietmar Enko, Konstantinos Markis, Symeon Tournis, Ioulia Trifonidi, Efsthios Chronopoulos, Loukia Spanou, Nerea Alonso, Martin Keppel and Markus Herrmann  
**Vitamin D and vitamin K status in postmenopausal women with normal and low bone mineral density — 1402**

**Hematology and Coagulation**

MinYang Zhang, YaLi Zhang, JingWen Zhang, JiaLi Zhang, SiYuan Gao, ZeChao Li, KangPei Tao, XiaoDan Liang, JianHua Pan and Min Zhu

**An automatic analysis and quality assurance method for lymphocyte subset identification — 1411****Cancer Diagnostics**

Hyeon Seok Seok, Yuna Choi, Shinae Yu, Kyung-Hwa Shin, Sollip Kim and Hangsik Shin  
**Machine learning-based delta check method for detecting misidentification errors in tumor marker tests — 1421**

**Cardiovascular Diseases**

Giuseppe Lippi, Laura Pighi, Elisa Paviati, Davide Demonte, Simone De Nitto, Matteo Gelati, Martina Montagnana, Giorgio Gandini, Brandon M. Henry and Gian Luca Salvagno  
**Analytical evaluation of the novel Mindray high sensitivity cardiac troponin I immunoassay on CL-1200i — 1433**

**Infectious Diseases**

Christian Gosset, Jacques Foguene, Mickaël Simul, Nathalie Layios, Paul B. Massion, Pierre Damas and André Gothot  
**A reactive monocyte subset characterized by low expression of CD91 is expanded during sterile and septic inflammation — 1438**

**Online Only Content**

<https://www.degruyter.com/view/j/cclm.2024.62.issue-7/issue-files/cclm.2024.62.issue-7.xml>

**Letters to the Editor**

Raffick A.R. Bowen and Leighton H. Daigh  
**Inadvertent omission of a specimen integrity comment – an overlooked post-analytical error — e145**

Jing Jin, Tingting Liu, Zhongyan Shan, Weiping Teng, Jing Li and Xiaochun Teng  
**Falsely elevated T<sub>3</sub> due to interference of anti-T<sub>3</sub> autoantibodies: a case report — e148**

Eliane F.E. Wenstedt, Bertrand D. van Zelst,  
Nohamir R.A. Paula and Sjoerd A.A. van den Berg

**Validation of the Siemens Atellica cortisol immunoassay compared to liquid chromatography mass spectrometry in adrenal venous sampling for primary hyperaldosteronism — e151**

Anneke C. Muller Kobold, Jacco J. de Haan,  
Reinoud P.H. Bokkers, Simeon J.S. Ruiten,  
Marius C. van den Heuvel, Eef G.W.M. Lentjes, Daan J. Touw and  
Koert P. de Jong

**Lessons learned from site-specific sampling and biological half-life of IGFII and IIE(68-88) peptide: a case study — e155**

Alice Brochier, Mattias Hofmans, Stijn Lambrecht,  
Pauline Breughe, Barbara Denys, Sander De Bruyne,  
Malicorne Buysse, Anna Vantilborgh and Carolien Bonroy

**The added value of automated HPC count: detecting clinically important interferences on the flow cytometric CD34+ cell count — e160**

Jacob F. Hess, Michaela Kotrová, Birgit Fricke, Simona Songia,  
Silvia Rigamonti, Roberta Cavagna, Manuela Tosi, Nils Paust,  
Anton W. Langerak, Orietta Spinelli, Giovanni Cazzaniga,  
Monika Brüggemann and Tobias Hutzenlaub, on behalf of the  
EuroClonality-NGS Working Group

**Clinical pilot study on microfluidic automation of IGH-VJ library preparation for next generation sequencing — e164**

Serena Lillo, Trine Rennebod Larsen, Leif Pennerup,  
Kirsten Ohm Kyvik, Jens Søndergaard and Steen Antonsen  
**Long-term effects of interventions applied to optimize the use of 25-OH vitamin D tests in primary health care — e168**