

University of Groningen

## A New Instrument for Microbial Epidemiology

Berends, Matthijs

DOI:  
[10.33612/diss.177417131](https://doi.org/10.33612/diss.177417131)

**IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.**

*Document Version*  
Publisher's PDF, also known as Version of record

*Publication date:*  
2021

[Link to publication in University of Groningen/UMCG research database](#)

*Citation for published version (APA):*  
Berends, M. (2021). *A New Instrument for Microbial Epidemiology: Empowering Antimicrobial Resistance Data Analysis*. University of Groningen. <https://doi.org/10.33612/diss.177417131>

### Copyright

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

The publication may also be distributed here under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license. More information can be found on the University of Groningen website: <https://www.rug.nl/library/open-access/self-archiving-pure/taverne-amendment>.

### Take-down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

**A**  
**NEW INSTRUMENT**  
**FOR**  
**MICROBIAL**  
**EPIDEMIOLOGY**

*Empowering  
Antimicrobial Resistance  
Data Analysis*

**Matthijs S. Berends**

## COLOPHON

Cover design: Matthijs Berends (images used with permission)  
Layout: Matthijs Berends  
Printing: Gildeprint – [www.gildeprint.nl](http://www.gildeprint.nl)

The work described within this thesis was supported by (1) the Certe Medical Diagnostics and Advice Foundation, (2) the INTERREG V A (202085) funded project EurHealth-1Health (<http://www.eurhealth1health.eu>), part of a Dutch-German cross-border network supported by the European Commission, the Dutch Ministry of Health, Welfare and Sport, the Ministry of Economy, Innovation, Digitalisation and Energy of the German Federal State of North Rhine-Westphalia, and the Ministry for National and European Affairs and Regional Development of the German Federal State of Lower Saxony, (3) the European Union's Horizon 2020 Research and Innovation Programme under the Marie Skłodowska-Curie Grant Agreement 713660 (MSCA-COFUND-2015-DP "Pronkjewail"), and (4) the European Society for Clinical Microbiology and Infectious Diseases (ESCMID) through the ESCMID Study Group for Antimicrobial Stewardship (ESGAP).

Printing of this thesis was financially supported by the Certe Medical Diagnostics and Advice Foundation. This support is greatly appreciated.

**Copyright © 2021 by Matthias Simeon Berends.** All rights reserved. Any unauthorised reprint or use of this material is prohibited. No parts of this thesis may be reproduced, stored, or transmitted in any form or by any means, without written permission of the author or, when appropriate, the publishers of the publications.



rijksuniversiteit  
 groningen

# **A New Instrument for Microbial Epidemiology**

## *Empowering Antimicrobial Resistance Data Analysis*

Proefschrift

ter verkrijging van de graad van doctor  
aan de Rijksuniversiteit Groningen op gezag van  
de rector magnificus prof. dr. C. Wijmenga  
en volgens besluit van het College voor Promoties.

De openbare verdediging zal plaatsvinden op  
woensdag 25 augustus om 11:00 uur

door

**Matthias Simeon Berends**

geboren op 27 november 1985

te Harderwijk

**Promotor**

Prof. dr. Alex W. Friedrich

**Copromotores**

Dr. Corinna Glasner

Dr. Gunnar I. Andriessse, MBA

**Beoordelingscommissie**

Prof. dr. Christian G. Giske

Prof. dr. Maarten J. Postma

Prof. dr. Andreas Voss

**Paranimfen**

Heine Bosma

Christian F. Luz

# CONTENTS

## SECTION I

WHERE WE WERE, WHERE WE ARE, WHERE WE CAN GO

- 1. General Introduction** **9**
- 2. Diagnostic Stewardship: Sense or Nonsense?!** **31**  
Berends MS\*, Luz CF\*, Wouthuyzen-Bakker M, Märtson AG, Alffenaar JW,  
Dik JWH, Glasner C, Sinha BNM  
*Dutch Journal of Clinical Microbiology (2018) 26;3*
- 3. Introducing a New, Free, and Independent Method for Standardised, Reproducible and Reliable Analyses of Antimicrobial Resistance Data** **45**  
Berends MS, Luz CF, Sinha BNM, Glasner C<sup>‡</sup>, Friedrich AW<sup>‡</sup>  
*In preparation*

## SECTION II

A NEW INSTRUMENT FOR APPLYING STANDARDISED AND REPRODUCIBLE ANTIMICROBIAL RESISTANCE DATA ANALYSIS

- 4. AMR - An R Package for Working with Antimicrobial Resistance Data** **57**  
Berends MS\*, Luz CF\*, Friedrich AW, Sinha BNM, Albers CJ, Glasner C  
*Journal of Statistical Software (2021), ahead of print*
- 5. Rapid Analysis of Diagnostic and Antimicrobial Patterns in R (RadaR): Interactive Open-Source Software App for Infection Management and Antimicrobial Stewardship** **93**  
Luz CF, Berends MS, Dik JWH, Lokate M, Pulcini C, Glasner C, Sinha BNM  
*Journal of Medical Internet Research (2019) 21;6, e12843*
- 6. Better Antimicrobial Resistance Data Analysis and Reporting in Less Time** **113**  
Berends MS\*, Luz CF\*, Zhou X, Friedrich AW, Lokate ML, Sinha BNM<sup>‡</sup>, Glasner C<sup>‡</sup>  
*medRxiv [preprint] (2021), 21257599*

\* Equal contribution

‡ Equal contribution

### SECTION III

#### EVALUATION OF PHENOTYPIC ANTIMICROBIAL RESISTANCE IN THE NORTHERN DUTCH-GERMAN CROSS-BORDER REGION

7. **Trends in Occurrence and Phenotypic Resistance of Coagulase-Negative Staphylococci (CoNS) Found in Blood in the Northern Netherlands between 2013 and 2019** 137  
Berends MS, Luz CF, Ott A, Andriessse GI, Becker K, Glasner C<sup>†</sup>, Friedrich AW<sup>‡</sup>  
*In preparation*
8. **Defining Multidrug Resistance of Gram-Negative Bacteria in the Dutch-German Border Region-Impact of National Guidelines** 161  
Köck R, Siemer P, Esser J, Kampmeier S, Berends MS, Glasner C, Arends JP, Becker K, Friedrich AW  
*Microorganisms (2018) 6;1*
9. **Changing Epidemiology of Methicillin-Resistant *Staphylococcus aureus* in 42 Hospitals in the Dutch-German Border Region, 2012 to 2016: Results of the Search-and-Follow-Policy** 175  
Jurke A, Daniels-Haardt I, Silvis W, Berends MS, Glasner C, Becker K, Köck R, Friedrich AW  
*Eurosurveillance (2019) 24;15*
10. **A Prospective Multicentre MDRO Screening Study on ICUs in the Dutch-German Cross-Border Region (2017-2018): The Importance of Healthcare Structures** 195  
Berends MS\*, Glasner C\*, Becker K, Esser J, Gieffers J, Jurke A, Kampinga G, Kampmeier S, Klont R, Köck R, Al Naemi N, Ott A, Ruis G, Saris K, Tami A, Van Zeijl J, Von Müller L, Voss A, Waar K, Friedrich AW  
*Eurosurveillance (2021), ahead of print*

### SECTION V

11. **Summary and Future Perspectives** 219
- Gearfetting yn Frysk 239  
Samenvatting in het Nederlands 249  
Zusammenfassung auf Deutsch 261  
Alphabetical list of published work 273  
Alphabetical list of related presentations 275  
Acknowledgements / Tankwurd / Dankwoord / Danksagung 279  
Curriculum Vitae 287





# Section I

*Where We Were,  
Where We Are,  
Where We Can Go*

