

NAME: Luciana Tricai Cavalini

POSITION TITLE: Associate Professor and Adjunct Professor

EDUCATION/TRAINING:

INSTITUTION AND LOCATION	DEGREE (if applicable)	Completion Date MM/YYYY	FIELD OF STUDY
Paraná Federal University	M.D.	01/1995	Medicine
São Paulo University	Residency	02/1997	Social and Preventive Medicine
Oswaldo Cruz Foundation	M.Sc.	06/1999	Public Health
Rio de Janeiro State University	Ph.D.	06/2005	Public Health
Karolinska Institutet	Postdoctoral	02/2008	Social Medicine

A. Personal Statement

My professional experience shows that I have the proper qualifications to perform my role in this project. Over my career, I have achieved a significant experience in the field of Epidemiology, Biostatistics and Health Informatics, and participated in several national and international research projects that dealt with major health information systems. My background as a physician gives me the necessary knowledge of the specific features of biological and pathophysiological processes in humans, as well as access to the jargon of the various medical specialties. My background as an epidemiologist is quite complete, starting in my MSc, by conducting the design, execution and analysis of a case-control study, in which I had experience with some of the more complex concepts of classical epidemiology. For example, in my MSc research project, there was a concern to prevent or control recall bias in dementia patients and reporting bias from paper records in addition to the discovery of an interaction effect between age and the outcome, which resulted in a higher level complexity of the analysis.

Between MSc and PhD, I took part in a number of national-scale Brazilian research projects such as the World Bank funded Brazilian Burden of Disease Project and two projects funded by United Nations Development Program, one to evaluate the efficiency of Brazilian social programs and the other to assess the incorporation of fixed capital in the Brazilian hospital system. All of these projects used the large national databases from the Ministry of Health information systems; so today they would be considered as Big Data projects.

However, having worked in these projects, I became concerned about the fact that data quality is determinant of the quality of the outcomes of any project of this scale. And certainly, the validity and reliability of the data we were using were pressing issues. All these projects have adopted some data quality improvement strategy, but all the methods adopted were applied *a posteriori*. However, the data was collected at the point-of-care; so I became interested in resolving the data quality problem at the time the health event is taking place.

This became stronger to me when I went to work in the Emergency Room (ER) of the largest hospital in Latin America, being responsible for biosafety area and the reporting of epidemic diseases. Basically, patients were at risk of life because information about their cases were not circulating from the primary care units to the ER, and even internally in the hospital. This is the moment when I started to develop interest for clinical decision support systems projects.

During this period, I started my PhD with one of the most prominent statisticians in Brazil. I have learned already that the health events are hierarchical, from the individual level to higher levels of aggregation. But there was, at that time, few studies performing knowledge discovery using fixed and random effects models to assess risk of death and disease on a national scale in Brazil, in addition to the data quality issue, still demanding solutions. These were the research problems I faced and solved in my doctoral dissertation and articles derived therefrom.

In the second year of my PhD, I was approved by public contest to fill a tenured position at the Department of Epidemiology and Biostatistics of the Institute of Community Health at the Fluminense Federal University, located in the Metropolitan Area of Rio de Janeiro, Brazil. There, I could design and execute several teaching, research and community service projects related to the use and development of health information systems in

Public Health. In 2007, I was awarded with a grant from the Brazilian Ministry of Education to stay at the Department of Social Medicine at the Karolinska Institutet, in Sweden, as a postdoctorate researcher. I worked there with my former PhD supervisor and his colleagues in projects related to use of Brazilian and Swedish health information systems to analyze health inequalities.

When I was in Sweden, I went to the Open Source Healthcare Alliance Conference in Kuala Lumpur, Malaysia, where I met Tim Cook, currently my co-PI in the present project. Back there, he was a member of the Architecture Review Board for the *openEHR* Foundation, and I was already working on a project to develop a decision support system for syndromic surveillance of acute jaundice-hemorrhagic fever. We decided to develop this project together according to the *openEHR* specifications, and started our collaboration since then. Later in the year, I could invite him as a visiting technician in Sweden and later in Brazil as a visiting researcher, to leverage our projects in common.

After my year in Sweden, I came back to the Fluminense Federal University and I was elected the Director of the Institute of Community Health. Usually, those administrative tasks completely absorb us and stay in the middle of our academic activities, but I was fortunate to be able to reconcile administrative and intellectual work. Our research group had been already invited to join the National Institute of Science and Technology – Medicine Assisted by Scientific Computing, a nationwide research network on health informatics funded by the Brazilian Ministry of Science and Technology, and coordinated by the National Laboratory of Scientific Computing. This project allowed our group to perform an in-depth study of all the healthcare informatics standards available, and combine the best features of them, adding a great deal of innovation, in the Multilevel Healthcare Information Modeling (MLHIM) specifications. This project was a success in academic aspects, producing several journal and conference papers, PhD and MSc thesis.

Almost at the end of my term as the Director of the Institute of Community Health, in 2012, I was approved by public contest to fill another tenured position at the Department of Health Information Technology of the Medical Sciences College at the Rio de Janeiro State University. That was not only an upgrade in my academic career, but most importantly, allowed me to focus exclusively on the development of teaching, research and community service projects in Medical Informatics. In two years, our research laboratory was upgraded to Technological Development Unit by the University's Innovation Agency, and awarded with several internal grants, and we also have four projects funded by the Rio de Janeiro State Foundation for Research Support, in which we could mature the MLHIM specifications, develop various proofs of concept of the achievement of semantic interoperability with MLHIM, and finally evolve the specifications to its next generation, the Shareable Structured Semantic Model (S3Model).

I am known as a fair and flexible team leader, with ability to delegate tasks and responsibilities, also taking my own share of them. Usually my alumni want to stay working with me after their projects are finished. My taste for innovation is also very welcome by the more advanced and progressive sectors of the Universities I work for. Having reached quite early a very high level in my academic career, I am confident of the potentialities of the S3Model and its implementation in Mian Sanon, which motivated our present application.

1. Cavalini LT, Cook TW. Use of XML Schema Definition for the development of semantically interoperable healthcare applications. In: Jeremy Gibbons; Wendy McCaull. (Org.). Lecture Notes in Computer Science. Springer Berlin Heidelberg 2014; 8315: 125-45.
2. Cavalini LT, Cook TW. Semantic interoperability of controlled vocabularies in medicine: A case study of the International Statistical Classification of Diseases "Tuberculosis" subset. *Comput Ind*2015; 69: 30-4.
3. Cook TW, Cavalini LT. Clinical decision support systems and advanced diagnostic imaging. *JAMA* 2015; 314: 1518.
4. Menezes PM, Cook TW, Cavalini LT. Convergence of Health Level Seven Version 2 messages to Semantic Web technologies for software-intensive systems in telemedicine trauma care. *Healthc Inform Res* 2016; 22; 22-9.

B. Positions and Honors

Positions and Employment

1999-2002

Research Assistant, Oswaldo Cruz Foundation, RJ, Brazil

2000-2001

Public Health Physician, Souza Aguiar Municipality Hospital, RJ, Brazil

2000-2002	MSc Teacher, Barra Mansa University Center, RJ, Brazil
2000-2003	Research Consultant, Institute of Applied Economics Research, RJ, Brazil
2001-2003	Public Health Physician, Rio de Janeiro State Health Office, RJ, Brazil
2003-	Associate Professor, Fluminense Federal University, RJ, Brazil
2012-	Adjunct Professor, Rio de Janeiro State University, RJ, Brazil
2013	Consultant, World Bank, DC
2013-	Distance Learning Teacher, Oswaldo Cruz Foundation, RJ, Brazil

Other Experience and Professional Memberships

2012	Peer Review Committee, Brazilian Ministry of Health, Science and Technology Award
2012-	Mgt. Board Member, SIG on Computing Applied to Health, Brazilian Computing Society
2012-	Editorial Board Member, Brazilian Journal of Telehealth
2013	Peer Review Committee, Brazilian Ministry of Health, SUS Research Program
2013-2014	Member, IEEE Communications Society
2013-2015	Editorial Board Member, World Journal of Meta-Analysis
2014	Peer Review Committee, Intel Challenge
2014-2015	Member, Association for Computing Machinery
2014-	Editorial Board Member, Global Journal of Epidemiology and Public Health
2015	Peer Review Committee, 100 Open Startup Challenge

Honors

2000	Prof. Dr. Bussamara Leme Award, Latin-American Perinatology Association
2000	Second Jury Award, International Association on Health Policy
2003	Honorable Mention, VII Brazilian Congress in Public Health
2014	Second Place, Rio Startup Challenge
2015	Sérgio Missiaggia Science Initiation Award, Rio de Janeiro State University

C. Contribution to Science

1. In the beginning of my academic career, I had a specific concern on the use of the national healthcare information systems to evaluate the healthcare system and to analyze health inequalities. Living in an extremely unequal country, this is a common concern among the forward-minded intellectuals. The epidemiological method and the biostatistical algorithms provide a very valuable tool to address those research questions from the perspective of quantitative science. However, the concern with data quality was always present in my investigations, since I am convinced that the use of invalid and/or unreliable data will only produce invalid and unreliable results. In this sense, I have developed in my PhD an algorithm to correct under-reporting of death certificates (a persistent problem in the poorer areas of Brazil) and to non-proportionally redistribute the ill defined causes of death and hospital admissions. Lately, the results produced by my original article matched the results of the field work promoted by the Brazilian Ministry of Health, and my algorithm is starting to be adopted to correct the national healthcare databases.

- a) Cavalini LT, Ponce de Leon ACM. Correction approach for underreporting of deaths and hospital admissions due to ill-defined causes. *Revista de Saúde Pública* 2007; 41: 85-93.
- b) Cavalini LT, Ponce de Leon ACM. Morbidity and mortality in Brazilian municipalities: a multilevel study of the association between socioeconomic and healthcare indicators. *International Journal of Epidemiology* 2008; 37: 775-83.
- c) Laflamme L, Hasselberg M, Reimers AM, Cavalini LT, Ponce de Leon ACM. Social determinants of child and adolescent traffic-related and intentional injuries: A multilevel study in Stockholm County. *Social Science & Medicine* 2009; 68: 1826-34.
- d) Luz CC, Junger WL, Cavalini LT. Analysis of prehospital care for stroke and acute myocardial infarction in the elderly population of Minas Gerais, Brazil. *Revista da Associação Médica Brasileira* 2010; 56: 452-7.

2. After this beginning, my academic career was completely devoted to the health informatics field, specifically to find a real solution for semantic interoperability, since I discovered in the transition between the previous and the current research that there is no real data quality without semantic interoperability. This research has dominated the last 12 years of my work life, with almost exclusive dedication. After an in-depth study and application development using all the existing healthcare information standards, we came to the conclusion that there is a fundamental problem in the current paradigm of computer science that was causing the “anomaly” (according to Thomas Kuhn's concept) in which semantic interoperability can not be achieved, regardless of the amount of funding applied and manpower engaged on it. Since 2009, we started to break the old paradigm and create a new one, in an effort that I feel analogous to the switch between the geocentric and the heliocentric cosmological systems. Now we finally have a mature and fully developed implementation of the information infrastructure for this new paradigm, which started with the MLHIM specifications and evolved to the S3Model. This groundbreaking technology is ready to be put in production scale and create a new industry in healthcare information technology.

- a) Cavalini LT, Cook TW. Knowledge engineering of healthcare applications based on minimalist multilevel models. In: 14th IEEE International Conference on e-Health Networking, Applications and Services (HealthCom 2012), 2012, Beijing, p. 431-434.
- b) Cook TW, Cavalini LT. A multilevel-model driven social network for healthcare information exchange. In: LinkQS 2014: Linking the Quantified Self Workshop - 25th ACM Hypertext and Social Media Conference (Hypertext 2014), 2014, Santiago. Available at: http://ceur-ws.org/Vol-1210/LQS_03.pdf.
- c) Cook TW, Nogueira JRM, Cavalini LT. Knowledge management of controlled vocabularies in medicine and the semantic interoperability challenge. In: Alfonso Perez Gama. (Org.). Knowledge engineering: principles, methods and applications. 1ed. New York: Nova Publishers, 2015, p. 57-78.
- d) Luz MP, Nogueira JRM, Cavalini LT, Cook TW. Providing full semantic interoperability for the Fast Healthcare Interoperability Resources Schemas with Resource Description Framework. In: IEEE 2015 International Conference on Healthcare Informatics (ICHI), 2015, Dallas, p. 463-466.

Link to My Bibliography:

<http://www.ncbi.nlm.nih.gov/sites/myncbi/luciana.cavalini.1/bibliography/49569036/public/?sort=date&direction=ascending>

D. Research Support

Ongoing Research Support

FAPERJ 18/2014	Cavalini (PI)	09/01/14-08/31/16
FAPERJ 06/2015	Cavalini (PI)	01/01/15-12/31/17

Analysis of the performance of the multilevel model driven approach on healthcare data management
 The goal of this project is to compare software performance of the MLHIM specifications and the other multilevel model driven technologies, the openEHR specifications and the ISO 13606 family of standards.
 Role: PI

FAPERJ 41/2013	Cavalini (PI)	07/01/14-06/30/16
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Emergent Group for Research and Innovation on Health Information Technologies
 The goal of this project is to develop and mature the MLHIM specifications, producing proofs of concept of the achievement of semantic interoperability using this technology.
 Role: PI

UERJ UDT/2014	Cavalini (PI)	10/01/14-09/30/16
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Technological development unit in Multilevel Healthcare Information Modeling

The goal of this project is to produce innovative software applications based on the MLHIM specifications that can evolve to an industry scale production.

Role: PI

Completed Research Support

FAPERJ 06/2013

Saade (PI)

01/01/14-12/31/15

Research on decision and diagnostic support systems to aging related diseases

The goal of this project was to develop a decision support system for the early detection of dementia, based on the MLHIM specifications.

Role: Co-Investigator

CNPq 15/2008

Feijóo (PI)

09/01/08-08/31/14

National Institute of Science and Technology – Medicine Assisted by Scientific Computing

The goal of this research network was to develop nationwide projects on medicine assisted by scientific computing. The Multilevel Healthcare Information Modeling (MLHIM) Laboratory was a member of this network, with the goal of studying and testing the existing healthcare informatics standards and develop the MLHIM specifications.

Role: Associated Laboratory Coordinator