

Andrew A. Lover

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MAIN RESEARCH INTERESTS

Focus areas: Infectious disease epidemiology, disease surveillance, malariology, vector borne-disease.

Methodologies: Design, implementation and quantitative analyses of complex epidemiological studies, including substantial analyses of cross-sectional, longitudinal, geospatial, complex survey sampling, and cohort (survival) datasets in studies related to malaria, dengue, Zika virus, HIV/TB, and nosocomial infections.

EDUCATION

2014 - 2018	University of California, San Francisco		Research fellow
2011 - 2015	National University of Singapore	PhD	Epidemiology
2009 - 2011	National University of Singapore	MPH	Global Health & Epidemiology
2001 - 2003	University of California, Santa Barbara	MS	Organic Chemistry
1993 - 1997	Earlham College	BA	Chemistry

PRINCIPAL POSITIONS HELD

2018 - current	University of Massachusetts, Amherst	Assistant Professor, Epidemiology	School of Public Health and Health Sciences
2014 - 2018	University of California, San Francisco	Research fellow; Epidemiology and Research Coordinator, SE Asia	Malaria Elimination Initiative, Global Health Group
2011 - 2014	National University of Singapore	Epidemiologist	School of Public Health
2011 - 2014 (concurrent)	Regional Epidemic and Disease Intervention (REDI) Centre, Singapore	Field Epidemiology/ Training Coordinator	Epidemiology section
2007 - 2009	Gilead Sciences, Seattle, WA	Associate Scientist	Medicinal Chemistry
2004 - 2007	ICOS Corporation, Bothell, WA	Research Associate	Medicinal Chemistry

2001 - 2003	University of California, Santa Barbara	Graduate Researcher	Chemistry
2000 - 2001	Colorado State University	Research Assistant	Chemistry
1999 - 2000	Hauser Research Inc., Boulder, CO	Research Associate	Drug Development
1998 - 1999	Albany Molecular Research, Albany NY	Research Associate	Drug Discovery

KEY SKILLS AND EXPERTISE

- Design, implementation and quantitative analysis of complex clinical and field epidemiological studies, including community-randomized trials, and studies in resource-limited settings.
- Global health policy and implementation, including national-scale health programming for malaria elimination.
- Drug discovery and drug development.

PROFESSIONAL EXPERIENCE

I. Professional experience: Public Health

(Sept. 2018) – **Assistant Professor, Epidemiology**

current Department of Biostatistics and Epidemiology, School of Public Health and Health Sciences, University of Massachusetts- Amherst

- Principle investigator for epidemiological studies of infectious disease, and vector-borne diseases, including malaria, and tick-borne diseases.

2014 – **Regional Research and Epidemiology Coordinator (Vietnam/Lao PDR)-**

(Aug. 2018) Malaria Elimination Initiative, Global Health Group, University of California, San Francisco

- In-country (2014-2016) and US-based (2016-2018) project research and epidemiology coordinator and local lead for a 4-year Bill and Melinda Gates Foundation-funded project, *Preparing for Malaria Elimination in the Greater Mekong Subregion*.
- Key responsibilities are design, field implementation/monitoring and analysis of diverse epidemiological studies to generate an evidence-based program to support the elimination of *Plasmodium falciparum* malaria in Vietnam and Lao PDR.
- Direct supervision of project staff, and all field activities.
- Co-PI for a split-plot village-randomized trial; completed August 2019.

- Other responsibilities include daily project oversight and management, progress reporting, and liaising with both in-country partners, (NMCPs, PSI, CHAI, and others) and US-based partners.

2014
(2 months) **Team Leader-** Mid-term evaluation of the PMI/USAID Control and Prevention of Malaria (CAP-M) Project

- Comprehensive desk and field evaluation of a \$24 million USD project aimed at reducing morbidity and mortality from malaria and containment of artemisinin-resistant malaria in Cambodia, Myanmar (Burma) and Thailand.
- Led all field work, analysis, and head writer of final report.

2011 – 2014 **Epidemiologist-** Center for Infectious Disease Epidemiology Research (CIDER), Saw Swee Hock School of Public Health, The National University of Singapore (Singapore)

- Key responsibilities included data analysis, project technical support, and comprehensive reporting for a range of infectious disease surveillance and research projects, including design and implementation of syndromic surveillance platforms.

2011-2014 **Field epidemiology associate/ Organizer, lecturer, and facilitator,** Regional Epidemic and Disease Intervention (REDI) Centre, Singapore / National University of Singapore (Singapore)

- Planning, facilitation, and lecturing for a range of technical training courses in basic GIS, biostatistics, and data analysis for health staff throughout SE Asia with support from diverse partners.
- Technical and implementation support for regional outbreak and surveillance programs in Southeast Asia.

2010 **Co-investigator** – Timor-Leste Integrated Health Assistance (Timor-Leste)

- (2 months)
- Field investigation of patterns and barriers to the usage of long-lasting insecticide treated bednets in Timor-Leste.
 - Conceived, planned, and organized a qualitative method research study (focus groups) that examined barriers to ITN usage in rural and peri-urban areas of Timor-Leste.

II. Professional experience: Chemistry

2007 – 2009 **Associate Scientist I-** Gilead Sciences (Seattle, WA)

- Medicinal chemistry research into novel therapeutics for respiratory disease, including cystic fibrosis, asthma, and COPD.
- Responsible for independent research design, execution, and characterization of a wide variety of analogues for *in vivo* and *in vitro* evaluation.

- 2004 – 2007 **Research Associate II/III-** ICOS Corporation (Bellevue, WA)
- Drug discovery research (lead development and optimization) in diverse therapeutic areas including novel antibiotics, inflammation, and oncology.
- 2001 - 2004 **Graduate Researcher-** University of California, Santa Barbara
- Research in modern organic/organometallic methodologies in Bruce H. Lipshutz' laboratories, directed towards the total synthesis of the biaryl, antimalarial natural product korupensamine A.
- 2000 – 2001 **Graduate Researcher-** Colorado State University (Ft. Collins, CO)
- Research in Robert M. Williams' laboratories directed towards the asymmetric synthesis of unnatural cyclopropane-containing amino acids.
- 1999 – 2000 **Research Associate II-** Hauser Research Inc. (Boulder, CO)
- Involved in the synthesis, purification and characterization of advanced pharmaceutical intermediates for custom synthesis clients, including derivatization of Taxol® analogues for biological evaluation.
- 1998 - 1999 **Research Associate-** Albany Molecular Research Inc. (Albany, NY)
- Involved in the combinatorial synthesis and purification of directed pharmacophore libraries.
 - Also performed the synthesis and characterization of starting materials and substrates for chemical library generation.

GRANTS

Current

<u>Foundation for Innovative Novel Diagnostics</u> (PI)	1/15/2020-
Collaborative agreement	4/15/2020
“Assessing novel serological rapid tests for <i>Plasmodium vivax</i> ”	\$5,500 USD
<u>The Global Fund for TB, Malaria and HIV</u> (key personnel)	1/1/2018-
Regional Artemisinin-Resistance Initiative-2	1/1/2021
“Malaria Elimination Realized through Community-focused Interventions (MERCi)- Vietnam, Laos, and Cambodia”	\$6.8 million total to consortium;
Consortium grant with Health Poverty Action (HPA)	\$950,000 to UCSF
(member grant writing team)	

Past

<u>Asia-Pacific Malaria Elimination Network</u> (co-PI)	1/31/2018-
APMEN Research Granting Program	1/1/2019
“Community and facility assessment to determine populations at risk of malaria and primaquine-induced hemolysis, Southern Lao PDR”	\$50,000 USD
(sole grant writer)	(declined)

9/15/2017 -

<u>US Naval Health Research Center-Asia (NHRC-A)</u> (co-PI) Broad Agency Announcement (BAA) "Zooprophylaxis aided ivermectin-based vector elimination for malaria control, Central Vietnam (ZAIVE)" (lead writer)	5/14/2019 \$125,000 total
<u>The Bill and Melinda Gates Foundation</u> (key personnel) Global Health and Malaria Program "Preparing the Greater Mekong for Malaria Elimination" (member grant writing team)	11/1/2015 - 11/1/2019 \$4.2 million total
<u>US Naval Health Research Center-Asia (NHRC-A)</u> (co-investigator) Broad Agency Announcement (BAA) "Evaluation of Spatial Repellent (SR) Products Under Semi-field Conditions in Hanoi, Vietnam" (co-writer)	1/01/2015 - 6/01/2017 \$129,000 total
<u>Communicable Disease Division; Ministry of Health, Singapore</u> (co-investigator) Infectious Diseases Competitive research grant "One Health, Zoonotic Diseases and Pandemic Planning: Creating a Bioethics Framework in Singapore" (technical input)	11/01/2014 - 12/01/2015 \$140,000 total
<u>NUS Initiative to Improve Health in Asia / Duke-NUS</u> (co-investigator) Health in Southeast Asia Call "Development of a spatial ecohealth framework to identify indicators associated with emerging infectious disease risk in Singapore" (co-writer)	05/01/2012 - 01/01/2014 \$170,000 total
<u>Sanofi-Pasteur</u> (co-investigator) Block research grant "Improving the clinical case management and strengthening surveillance of dengue in Cambodia" (co-writer)	09/01/2011 - 01/01/2013 \$250,000 total

PUBLICATIONS

Google scholar profile: <https://goo.gl/SB3bqY>

In preparation

- Albsheer M^{*}, Lover AA^{*}, Saad N, Muneer MS, Altinae L, Hamid MA. "Prevalence, molecular characterization and risk factors for glucose-6-phosphate dehydrogenase (G6PD) deficiency within two *Plasmodium vivax* endemic areas, Sudan" (joint first author)
- Cramer E, Quang NX, Hertz J, Quang HH, Mendenhall I, Lover AA., "Ivermectin-treatment in cattle reduces survival in two malaria vector species *Anopheles dirus* and *An. epiroticus* under semi-field conditions, Central Viet Nam." (senior author)
- Roh M, Jongsakul K, Lausatianragit K, Sudathip P, Chaitaveep N, Feldman M, Martin NJ, Gosling R, Fukuda M, Lover AA "Civilian and military cooperation is needed to eliminate malaria in Greater Mekong Subregion: Lessons learned from the Sisaket Outbreak" (senior author)

Under review

- Lover AA, Sutherland I, Bryce G, Ellis B, Mendenhall I. "Comparative field evaluation of the BG Sentinel, CDC-light, and Mosquito Magnet traps for routine surveillance of vector and nuisance mosquito species in Singapore." (co-I and lead analyst)

Peer reviewed

22. Hossain FA, Lover AA, Corey G, Reich N, Rahman T. "Flusense: a contactless syndromic surveillance platform for influenza-like illness in hospital waiting areas." *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies*. 4(1):28, 2020. (co-PI)
21. Martin NJ, Nam VS, Lover AA, Phuong TV, Tu TC, Mendenhall IH. "The impact of transfluthrin on the spatial repellency of the primary malaria mosquito vectors in Vietnam: *Anopheles dirus* and *Anopheles minimus*" *Malaria Journal* 19(1) 1-9, 2020. (lead analyst)
20. Lover AA, Dantzer E, Hocini S, Estera R, Rerolle R, Smith JL, Hwang J, Gosling J, Yukich J, Greenhouse J, Jacobson J, Phetsouvanh R, Hongvanthong B, Bennett A. "Study protocol for a cluster-randomized trial to assess the effectiveness of targeted malaria parasite detection among high-risk populations in Southern Lao PDR (the Acme-Lao study)" *Gates Open Research*, 3(1730), 1730, 2019.
19. Lover AA, Baird JK, Gosling R, Price RN. "Malaria elimination: time to target all species." *American Journal of Tropical Medicine and Hygiene*, 99(1), 17–23, 2018.
18. Lover AA, Dantzer E, Hongvanthong B, Chindavong K, Welty S, Reza T, Khim N, Menard D, Bennett A. "Prevalence and risk factors for asymptomatic malaria and genotyping of glucose-6-phosphate dehydrogenase (G6PD) deficiencies in a vivax-predominant setting, Lao PDR: Implications for sub-national elimination goals" *Malaria Journal*, 17(1), 218, 2018.

17. Kattenberg JH, Erhart A, Truong MH, Rovira-Vallbona E, Vu KAD, Nguyen THN, Nguyen VH, Bannister-Tyrrell M, Theisen M, Bennet A, Lover AA, Tran TD, Nguyen XX, Rosanas-Urgell A. "Characterization of *Plasmodium falciparum* and *Plasmodium vivax* recent exposure in an area of significantly decreased transmission intensity in Central Vietnam" *Malaria Journal*, 17(1), 180, 2018.
16. Chen I, Thanh HNT, Lover AA, Thao PT, Luu TV, Than NH, Thang ND, Neukom J, Bennett, A. "Malaria risk factors and care-seeking behaviour within the private sector among high-risk populations in Vietnam: a qualitative study" *Malaria Journal*, 16(4), 515, 2017.
15. Lover AA, Harvard KE, Lindawson AE, Gueye CS, Shrett R, Gosling R, Feachem RA. "Regional initiatives for malaria elimination: Building and maintaining partnerships" *PLOS Medicine* 14(10): e1002401. <https://doi.org/10.1371/journal.pmed.1002401>, 2017
14. Lover AA, Gosling RG, Feachem RA, Tulloch J. "Eliminate now: seven critical actions required to accelerate elimination of *Plasmodium falciparum* malaria in the Greater Mekong Subregion" *Malaria Journal* 15(1), 518; doi: 10.1186/s12936-016-1564-3, 2016.
13. Cavailler P, Tarantola A, Leo YS, Lover AA, Rachline A, Duch M, Huy R, Quake AL, Kdan Y, Duong V, Brett JL, Buchy P. "Early diagnosis of dengue disease severity in a resource-limited Asian country" *BMC Infectious Diseases*. 16; doi:10.1186/s12879-016-1849-8, 2016.
12. Lover AA. "Considerations for comprehensive analyses of sporozoite-based controlled human malaria infection studies" *American Journal of Tropical Medicine and Hygiene* 93(6): 1130-1133, 2015.
11. Capps B, Bailey MM, Bickford D, Coker R, Lederman Z, Lover AA, Lysaght T and Tambyah P. "Introducing One Health to the ethical debate about zoonotic diseases in Southeast Asia" *Bioethics* 29(8): 588-596, 2015.
10. Lover AA, and Coker RJ. "Do mixed infections matter? Assessing virulence of mixed-clone infections in experimental human and murine malaria" *Infection, Genetics and Evolution* 36: 82-91, 2015.
9. Lover AA, Zhao X, Gao Z, Coker RJ, Cook AC. "The distribution of incubation and relapse times in experimental infections with the malaria parasite *Plasmodium vivax*" *BMC Infectious Diseases* 14(1), 539, 2014.
8. Thida A, Tun STT, Zaw SKK, Lover AA, Cavailler P, Chunn J, Aye MM, Par P, Naing WK, Zan KN, Shwe M, Kyaw TT, Waing ZH, Clevenbergh P. "Retention and risk factors for attrition in a large public health ART program in Myanmar: a retrospective cohort analysis" *PLOS ONE* 9(9): 108615, 2014.
7. Lover AA, Buchy P, Rachline A, Moniboth D, Huy R, Meng CY, Leo YS, Yuvatha K, Sophal U, Ngan C, Bunthin Y, Duong V, Goyet S, Brett J, Tarantola A and Cavailler P. "Spatial epidemiology

and climatic predictors of pediatric dengue infections captured via sentinel site surveillance, Phnom Penh Cambodia 2011-2012" *BMC Public Health* 14(1): 658, 2014.

6. Lover AA, and Coker, RJ. "Re-assessing the relationship between sporozoite dose and incubation period in *Plasmodium vivax* malaria: a systematic re-analysis" *Parasitology* 141(6): 859-868, 2014.
5. Lover AA, Hartman M, Chia KS, Heymann DL. "Demographic and spatial predictors of anemia in women of reproductive age in Timor-Leste: implications for health program prioritization" *PLOS ONE* 9(3): 91252, 2014.
4. Balm MN, Lover AA, Salmon S, Tambyah PA, Fisher DA. "Progression from new methicillin-resistant *Staphylococcus aureus* colonisation to infection: an observational study in a hospital cohort" *BMC Infectious Diseases* 13: 491, 2013.
3. Lover AA, and Coker, RJ. "Quantifying effect of geographic location on epidemiology of *Plasmodium vivax* malaria" *Emerging Infectious Diseases* 19(7):1058-1065, 2013.
2. Lover AA, Sutton BA, Asy AJ, Wilder-Smith A. "An exploratory study of treated-bed nets in Timor-Leste: patterns of intended and alternative usage" *Malaria Journal* 10: e199, 2011.
1. Lipshutz BH, Servesko JM, Petersen TB, Lover AA. "Asymmetric 1,4-Reductions of Hindered β -Substituted Cycloalkenones Using Catalytic SEGPHOS-Ligated CuH" *Organic Letters* 6(8): 1273-1275, 2004.

Review Article

1. Lover, AA. "Malaria" entry for *The International Encyclopedia of Primatology* Wiley-Blackwell, (DOI: 10.1002/9781119179313), June 2017.

Other Publications

VIII. Lover, AA and McAndrew T. "Sentinel event surveillance to estimate total SARS-CoV-2 infections, United States" preprint at <https://works.bepress.com/andrew-lover/28/>, 2020.

VII. Lover, AA. "Zika virus and microcephaly" *The Lancet Infectious Diseases* 16 (12): 1331-1332, 2016.

VI. Lover AA. "Serological evidence for localized and persistent antibody response in Zika virus-positive neonates with microcephaly (Brazil, 2015)- a secondary analysis" bioRxiv, <http://biorxiv.org/content/early/2016/05>

V. Lover, AA. "Study Variability in Recent Human Challenge Experiments with *Plasmodium falciparum* Sporozoites (PfSPZ Challenge)." *arXiv:1505.01316 [q-Bio, Stat]*, May 2015. <http://arxiv.org/abs/1505.01316>.

IV. Lover AA. "Note on the origin of the Madagascar strain of *Plasmodium vivax*" *American Journal of Tropical Medicine and Hygiene* 91(6): 1283, 2014.

III. Lover AA, and Kelley, JF. "Mid-term performance evaluation: control and prevention of malaria (CAP-Malaria) in Burma, Cambodia and Thailand." Report prepared for USAID Regional Development Mission for Asia (RDMA); May 2014.

II. Lover AA, and Coker RJ. "The challenges of malaria elimination" *The Lancet* 382(9906): 1699-1700, 2013.

I. Wilder-Smith A, Lover A, Kittayapong P, Burnham G. "Hypothesis: Impregnated school uniforms reduce the incidence of dengue infections in school children" *Medical Hypotheses* 76(6): 861-862, 2011.

Patent Issued

1. Dudler T, Farouz F, Fowler K, Hawthorn N, Huang D, Jin B, Kim M, Lover A, Odingo J, Oliver A, Reed M, Ruan F, and Thorsett E. "Substituted Phenyl Acetic Acids as DP2 Antagonists"; (ICOS Corporation), WO/2007/146838 (PCT/US2007/070805), 2007

UNIVERSITY AND PUBLIC SERVICE

Departmental Service

AY 2018-'19	Department of Epidemiology, School of Public Health and Health Sciences UMass	Member of curriculum committee
AY 2019-'20	Department of Epidemiology, School of Public Health and Health Sciences UMass	Member of graduate admissions committee
AY 2018-'19	Department of Epidemiology, School of Public Health and Health Sciences UMass	Member of graduate admissions committee
2014	Saw Swee Hock School of Public Health, National University of Singapore	Member of advising committee to solicit feedback for research employees within the School of Public Health.
AY 2013 - '14	Saw Swee Hock School of Public Health, National University of Singapore	Reviewer for MPH global health capstone projects.
AY 2011 – '14	Saw Swee Hock School of Public Health, National University of Singapore	Ad hoc interviewer/reviewer for research faculty candidates (4 reviews submitted).

TEACHING AND MENTORING

Short Courses

2015	Regional training course on malaria elimination in the Greater Mekong Subregion (SEARO and WPRO) <ul style="list-style-type: none">Chiang Mai, Thailand; funding: BMGF and WHO	Lecturer and facilitator
2014	Disease Transmission and Outbreak Investigation <ul style="list-style-type: none">Singapore; funding: Singapore Ministry of Defense	Organizer and Lecturer
2014	Asia-Pacific Malaria Elimination Network Surveillance & Response Training Program <ul style="list-style-type: none">Wuxi, PR China; funding: Asia-Pacific Malaria Elimination Network	Lecturer and facilitator
2013	Outbreak Investigation and Acute Response <ul style="list-style-type: none">Ho Chi Minh City, Vietnam; funding: Institut Pasteur; French Embassy- Regional Cooperation Department	Lecturer
2014	Disease Transmission and Outbreak Investigation <ul style="list-style-type: none">Singapore; funding: Singapore Ministry of Defense	Organizer and Lecturer
2012	Epidemiological Methods for Health Research <ul style="list-style-type: none">Ho Chi Minh City, Vietnam; funding: Institut Pasteur	Organizer, Facilitator and Lecturer
2012	HIV Cohort Data Analysis <ul style="list-style-type: none">Mandalay, Myanmar (Burma); funding: The Union Against Tuberculosis and Lung Disease	Organizer, Facilitator, Lecturer, and Program Evaluator
2011	HIV Program Monitoring and Data Analysis <ul style="list-style-type: none">Siem Reap, Cambodia; funding: FHI 360 and USAID	Organizer, Facilitator, Lecturer, and Program Evaluator
2011	Data Management with EpiData <ul style="list-style-type: none">Bali, Indonesia; funding: US CDC; TEPHINET- Training Programs in Epidemiology and Public Health Interventions Network	Organizer, Facilitator and Lecturer
2011	Public Health Surveillance and Introduction to GIS <ul style="list-style-type: none">Phnom Penh, Cambodia; funding: French Ministry of Foreign Affairs; Institut Pasteur	Organizer, Facilitator and Lecturer
2011	EpiData for Data Management and Basic Statistics <ul style="list-style-type: none">Vientiane, Lao PDR; funding: French Ministry of Foreign Affairs; Institut Pasteur; Institut de la Francophonie pour la Médecine Tropicale	Organizer, Facilitator and Lecturer

Academic lecturing

AY 2019 – '20 (Fall & Spring)	MICROBIO597Z: Medical Zoology-Parasitology and Epidemiology Literature review	Co-instructor (Graduate elective)
2020 (Spring)	PH390Z: Pathogens, People and Politics <ul style="list-style-type: none">School of Public Health and Health Sciences, University of Massachusetts, Amherst	Developer and Lead course instructor (Undergraduate elective)
2019 (Spring)	MICROBIO597Z: Medical Zoology-Parasitology and Epidemiology Literature review	Co-instructor (Graduate elective)
2019 (Spring)	EPI633: Communicable Disease Epidemiology <ul style="list-style-type: none">School of Public Health and Health Sciences, University of Massachusetts, Amherst	Developer and Lead course instructor (Graduate elective)
2017 (Spring)	PH492: Senior Capstone <ul style="list-style-type: none">School of Public Health and Health Sciences, University of Massachusetts, Amherst	Lead course instructor (Undergraduate required)
2013	CO5103: Quantitative Epidemiological Methods <ul style="list-style-type: none">Saw Swee Hock School of Public Health, National University of Singapore	Teaching assistant- computer lab sectionals
2013	CO5221: Introduction to Global Health <ul style="list-style-type: none">Saw Swee Hock School of Public Health, National University of Singapore	Guest lecturer: "Malaria Control for Global Health"
2012-2013	CO5201: Control of Communicable Diseases <ul style="list-style-type: none">Saw Swee Hock School of Public Health, National University of Singapore	Guest lecturer: "Malaria"
2001-2003	CHEM 6CH: Organic Chemistry Laboratory <ul style="list-style-type: none">Department of Chemistry, University of California, Santa Barbara	Teaching assistant- laboratory sections

PROFESSIONAL ACTIVITIES

Memberships

1993 - 2010	American Chemical Society
2014 - current	American Society of Tropical Medicine and Hygiene
2018 - current	Society for Epidemiological Research

Service to Professional Publications

- 2011 - current Ad hoc referee for: *Malaria Journal*, *American Journal of Epidemiology*, *Trends in Parasitology*, *Journal of Clinical Virology*, *Emerging Themes in Epidemiology*, *Parasitology*, *Health Policy and Planning*, *Scientific Reports (Nature)*
- 2014 Ad hoc invited grant reviewer for Human Frontier Science Program (Strasbourg, France).

Continuing Education Courses Attended

- 2018 Medical-Veterinary Acarology Short Course (Tick Week), Ohio State University, Columbus, Ohio USA
- 2012 Global Malaria Elimination Short Course, Karolinska Institute, Stockholm, Sweden
- 2010 Outbreak Investigation International Short Course, Singapore