

Regina E. Kitsoulis
Grants Management Officer
NATIONAL INSTITUTE OF ALLERGY AND INFECTIOUS DISEASES

Additional information follows

SECTION I – AWARD DATA – 1U01AI151797-01 REVISED**Award Calculation (U.S. Dollars)**

Salaries and Wages	\$272,938
Fringe Benefits	\$96,627
Personnel Costs (Subtotal)	\$369,565
Consultant Services	\$15,000
Materials & Supplies	\$7,918
Travel	\$72,225
Other	\$27,000
Subawards/Consortium/Contractual Costs	\$857,689

Federal Direct Costs	\$1,349,397
Federal F&A Costs	\$197,347
Approved Budget	\$1,546,744
Total Amount of Federal Funds Obligated (Federal Share)	\$1,546,744
TOTAL FEDERAL AWARD AMOUNT	\$1,546,744

AMOUNT OF THIS ACTION (FEDERAL SHARE) \$0

SUMMARY TOTALS FOR ALL YEARS		
YR	THIS AWARD	CUMULATIVE TOTALS
1	\$1,546,744	\$1,546,744
2	\$1,505,568	\$1,505,568
3	\$1,504,400	\$1,504,400
4	\$1,503,220	\$1,503,220
5	\$1,502,037	\$1,502,037

Recommended future year total cost support, subject to the availability of funds and satisfactory progress of the project

Fiscal Information:

CFDA Name: Allergy and Infectious Diseases Research
CFDA Number: 93.855
EIN: 1311726494A1
Document Number: UAI151797A
PMS Account Type: P (Subaccount)
Fiscal Year: 2020

IC	CAN	2020	2021	2022	2023	2024
AI	8472315	\$1,546,744	\$1,505,568	\$1,504,400	\$1,503,220	\$1,502,037

Recommended future year total cost support, subject to the availability of funds and satisfactory progress of the project

NIH Administrative Data:

PCC: M32F B / **OC:** 41026 / **Released:** (b) (6) 08/28/2020
Award Processed: 08/29/2020 12:01:42 AM

SECTION II – PAYMENT/HOTLINE INFORMATION – 1U01AI151797-01 REVISED

For payment and HHS Office of Inspector General Hotline information, see the NIH Home Page at <http://grants.nih.gov/grants/policy/awardconditions.htm>

SECTION III – TERMS AND CONDITIONS – 1U01AI151797-01 REVISED

This award is based on the application submitted to, and as approved by, NIH on the above-titled project and is subject to the terms and conditions incorporated either directly or by reference in the following:

- The grant program legislation and program regulation cited in this Notice of Award.
- Conditions on activities and expenditure of funds in other statutory requirements, such as

- those included in appropriations acts.
- c. 45 CFR Part 75.
- d. National Policy Requirements and all other requirements described in the NIH Grants Policy Statement, including addenda in effect as of the beginning date of the budget period.
- e. Federal Award Performance Goals: As required by the periodic report in the RPPR or in the final progress report when applicable.
- f. This award notice, INCLUDING THE TERMS AND CONDITIONS CITED BELOW.

(See NIH Home Page at <http://grants.nih.gov/grants/policy/awardconditions.htm> for certain references cited above.)

Research and Development (R&D): All awards issued by the National Institutes of Health (NIH) meet the definition of "Research and Development" at 45 CFR Part§ 75.2. As such, auditees should identify NIH awards as part of the R&D cluster on the Schedule of Expenditures of Federal Awards (SEFA). The auditor should test NIH awards for compliance as instructed in Part V, Clusters of Programs. NIH recognizes that some awards may have another classification for purposes of indirect costs. The auditor is not required to report the disconnect (i.e., the award is classified as R&D for Federal Audit Requirement purposes but non-research for indirect cost rate purposes), unless the auditee is charging indirect costs at a rate other than the rate(s) specified in the award document(s).

Carry over of an unobligated balance into the next budget period requires Grants Management Officer prior approval.

This award is subject to the requirements of 2 CFR Part 25 for institutions to receive a Dun & Bradstreet Universal Numbering System (DUNS) number and maintain an active registration in the System for Award Management (SAM). Should a consortium/subaward be issued under this award, a DUNS requirement must be included. See <http://grants.nih.gov/grants/policy/awardconditions.htm> for the full NIH award term implementing this requirement and other additional information.

This award has been assigned the Federal Award Identification Number (FAIN) U01AI151797. Recipients must document the assigned FAIN on each consortium/subaward issued under this award.

Based on the project period start date of this project, this award is likely subject to the Transparency Act subaward and executive compensation reporting requirement of 2 CFR Part 170. There are conditions that may exclude this award; see <http://grants.nih.gov/grants/policy/awardconditions.htm> for additional award applicability information.

In accordance with P.L. 110-161, compliance with the NIH Public Access Policy is now mandatory. For more information, see NOT-OD-08-033 and the Public Access website: <http://publicaccess.nih.gov/>.

In accordance with the regulatory requirements provided at 45 CFR 75.113 and Appendix XII to 45 CFR Part 75, recipients that have currently active Federal grants, cooperative agreements, and procurement contracts with cumulative total value greater than \$10,000,000 must report and maintain information in the System for Award Management (SAM) about civil, criminal, and administrative proceedings in connection with the award or performance of a Federal award that reached final disposition within the most recent five-year period. The recipient must also make semiannual disclosures regarding such proceedings. Proceedings information will be made publicly available in the designated integrity and performance system (currently the Federal Awardee Performance and Integrity Information System (FAPIIS)). Full reporting requirements and procedures are found in Appendix XII to 45 CFR Part 75. This term does not apply to NIH fellowships.

Treatment of Program Income:

SECTION IV – AI Special Terms and Conditions – 1U01AI151797-01 REVISED

Clinical Trial Indicator: No

This award does not support any NIH-defined Clinical Trials. See the NIH Grants Policy Statement Section 1.2 for NIH definition of Clinical Trial.

REVISED AWARD:

Subaward Agreement Requirements: The ECOHEALTH ALLIANCE, INC. must provide NIAID with copies of all (existing and newly established) subaward agreements established under this award, including descriptions of the biosafety monitoring plans, within 30 days of establishment.

Federal Funding Accountability and Transparency Subaward Reporting System (FSRS) Requirements: This award is subject to the Transparency Act subaward reporting requirement of 2 CFR Part 170, which must be reported through the Federal Funding Accountability and Transparency Subaward Reporting System (FSRS). The ECOHEALTH ALLIANCE, INC. must provide NIAID with proof of documentation of timely entries of subaward information into the FSRS within 30 days of submitting to FSRS.

Supersedes previous Notice of Award dated **06/17/2020**. All other terms and conditions still apply to this award.

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This award does not include funds to support research subject to the [Department of Health and Human Services Framework for Guiding Funding Decisions about Proposed Research Involving Enhanced Potential Pandemic Pathogens](#) (DHHS P3CO Framework) Therefore:

- For Aim 1: Identify, characterize and rank spillover risk of high zoonotic potential viruses from wildlife, the building of chimeric SARS-like bat coronaviruses will be based on the SHC014 or the pangolin coronavirus molecular clones and the building of chimeric MERS-CoV will be based on the HKU5 strain. Prior to further altering the mutant viruses you must provide NIAID with a detailed description of the proposed alterations and supporting evidence for the anticipated phenotypic characteristics of each virus.
- Alternative approaches to those referenced above, including building chimeras based on SARS-CoV-1, SARS-CoV-2, and MERS-CoV, may be subject to the DHHS P3CO Framework and must be submitted to NIAID for review and approval prior to the work commencing.

If any of the experiments proposed for Aim 1 result in a virus with a phenotype of enhanced pathogenicity and/or transmissibility, enhanced growth by more than 10 fold when compared to wild type strains, or if the mice display significant increases in weight loss, viral titer, or mortality when compared to wild-type strains, the recipient must immediately stop the work and notify the NIAID Program Officer, Grants Management Specialist, and appropriate institutional biosafety committee. Policy changes regarding the classification of these experiments or components used in these experiments may be subject to immediate halting of experimentation. No NIH funding can be used to perform such experiments until these experiments have been approved by NIAID with a revised NOA.

Dissemination of study data will be in accord with the Recipient's accepted genomic data sharing plan as stated on page(s) **373** of the application. Failure to adhere to the sharing plan as mutually agreed upon by the Recipient and the NIAID may result in Enforcement Actions as described in the NIH Grants Policy Statement.

This award includes human subject research studies and must conform to the DHHS policies for the [Protection of Human Subjects](#) research, which are a term and condition of award. Human subjects research is covered by the 2018 Common Rule, and may not be initiated until the associated protocols have received IRB approval as specified in [45 CFR 46](#). Failure to comply

with the terms and conditions of award may result in the disallowance of costs and/or additional enforcement actions as outlined in Section 8.5 of the NIH Grants Policy Statement.

The Research Performance Progress Report (RPPR), Section G.9 (Foreign component), includes reporting requirements for all research performed outside of the United States. Research conducted at the following site(s) must be reported in your RPPR:

Jeppesen Field Consulting Australia - AUSTRALIA
Conservation Medicine Ltd. - MALAYSIA
Duke-NUS Medical School - SINGAPORE
Chulalongkorn University - THAILAND

This award may include collaborations with and/or between foreign organizations. Please be advised that short term travel visa expenses are an allowable expense on this grant, if justified as critical and necessary for the conduct of the project.

This Notice of Award (NoA) includes funds for activity with **Conservation Medicine Ltd. - MALAYSIA** in the amount of **\$224,997** (**\$208,331** direct costs + **\$16,666** F&A costs).

This Notice of Award (NoA) includes funds for activity with **Duke-NUS Medical School - SINGAPORE** in the amount of **\$108,000** (**\$100,000** direct costs + **\$8,000** F&A costs).

This Notice of Award (NoA) includes funds for activity with **Chulalongkorn University - THAILAND** in the amount of **\$215,944** (**\$199,948** direct costs + **\$15,996** F&A costs).

This Notice of Award (NoA) includes funds for activity with **The University of North Carolina at Chapel Hill** in the amount of **\$194,375** (**\$125,000** direct costs + **\$69,375** F&A costs).

This Notice of Award (NoA) includes funds for activity **The Henry M. Jackson Fdn. for the Adv'mt. of Mil. Med., Inc.** in the amount of **\$114,373** (**\$75,000** direct costs + **\$39,373** F&A costs).

In accordance with the NIAID Financial Management Plan, NIAID does not provide funds for inflationary increases. Committed future year (s) funding was adjusted accordingly. See: <https://www.niaid.nih.gov/grants-contracts/financial-management-plan>.

This award is issued as a Cooperative Agreement, a financial assistance mechanism in which substantial NIH scientific and/or programmatic involvement is anticipated in the performance of the activity. This award is subject to the Terms and Conditions of Award as set forth in Section VI: Award Administrative Information of **RFA AI-19-028, "Emerging Infectious Diseases Research Centers,"** posted date **3/5/2019**, which are hereby incorporated by reference as special terms and conditions of this award.

This RFA may be accessed at: <http://grants.nih.gov/grants/guide/index.html>

This award is subject to the Clinical Terms of Award referenced in the NIH Guide for Grants and Contracts, July 8, 2002, NOT AI-02-032. These terms and conditions are hereby incorporated by reference, and can be accessed via the following World Wide Web address:

<https://www.niaid.nih.gov/grants-contracts/niaid-clinical-terms-award> All submissions required by the NIAID Clinical Terms of Award must be forwarded electronically or by mail to the responsible NIAID Program Official identified on this Notice of Award.

Select Agents:

Awardee of a project that at any time involves a restricted experiment with a select agent, is responsible for notifying and receiving prior approval from the NIAID. Please be advised that changes in the use of a Select Agent will be considered a change in scope and require NIH awarding office prior approval. The approval is necessary for new select agent experiments as well as changes in on-going experiments that would require change in the biosafety plan and/or biosafety containment level. An approval to conduct a restricted experiment granted to an individual cannot be assumed an approval to other individuals who conduct the same restricted experiment as defined in the Select Agents Regulation 42 CFR Part 73, Section 13.b (<http://www.selectagents.gov/Regulations.html>).

Highly Pathogenic Agent:

NIAID defines a Highly Pathogenic Agent as an infectious Agent or Toxin that may warrant a biocontainment safety level of BSL3 or higher according to the current edition of the CDC/NIH Biosafety in Microbiological and Biomedical Laboratories (BMBL)

(<http://www.cdc.gov/OD/ohs/biosfty/bmbl5/bmbl5toc.htm>). Research funded under this grant must adhere to the BMBL, including using the BMBL-recommended biocontainment level at a minimum. If your Institutional Biosafety Committee (or equivalent body) or designated institutional biosafety official recommend a higher biocontainment level, the highest recommended containment level must be used.

When submitting future Progress Reports indicate at the beginning of the report:

If no research with a Highly Pathogenic Agent or Select Agent has been performed or is planned to be performed under this grant.

If your IBC or equivalent body or official has determined, for example, by conducting a risk assessment, that the work being planned or performed under this grant may be conducted at a biocontainment safety level that is lower than BSL3.

If the work involves Select Agents and/or Highly Pathogenic Agents, also address the following points:

Any changes in the use of the Agent(s) or Toxin(s) including its restricted experiments that have resulted in a change in the required biocontainment level, and any resultant change in location, if applicable, as determined by your IBC or equivalent body or official.

If work with a new or additional Agent(s)/Toxin(s) is proposed in the upcoming project period, provide:

- o A list of the new and/or additional Agent(s) that will be studied;
- o A description of the work that will be done with the Agent(s), and whether or not the work is a restricted experiment;
- o The title and location for each biocontainment resource/facility, including the name of the organization that operates the facility, and the biocontainment level at which the work will be conducted, with documentation of approval by your IBC or equivalent body or official. It is important to note if the work is being done in a new location.

STAFF CONTACTS

The Grants Management Specialist is responsible for the negotiation, award and administration of this project and for interpretation of Grants Administration policies and provisions. The Program Official is responsible for the scientific, programmatic and technical aspects of this project. These individuals work together in overall project administration. Prior approval requests (signed by an Authorized Organizational Representative) should be submitted in writing to the Grants Management Specialist. Requests may be made via e-mail.

Grants Management Specialist: Shaun W Gratton

Email: (b) (6) **Phone:** (b) (6) **Fax:** 301-493-0597

Program Official: Jean Lois Patterson

Email: (b) (6) **Phone:** (b) (6)

SPREADSHEET SUMMARY**GRANT NUMBER:** 1U01AI151797-01 REVISED**INSTITUTION:** ECOHEALTH ALLIANCE, INC.

Budget	Year 1	Year 2	Year 3	Year 4	Year 5
Salaries and Wages	\$272,938	\$272,938	\$272,938	\$272,938	\$272,938
Fringe Benefits	\$96,627	\$96,628	\$96,628	\$96,628	\$96,628
Personnel Costs (Subtotal)	\$369,565	\$369,566	\$369,566	\$369,566	\$369,566
Consultant Services	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000
Materials & Supplies	\$7,918	\$7,918	\$7,918	\$7,918	\$7,918
Travel	\$72,225	\$72,225	\$72,225	\$72,225	\$72,225
Other	\$27,000	\$27,000	\$27,000	\$27,000	\$27,000
Subawards/Consortium/Contractual Costs	\$857,689	\$856,512	\$855,344	\$854,164	\$852,981
TOTAL FEDERAL DC	\$1,349,397	\$1,348,221	\$1,347,053	\$1,345,873	\$1,344,690
TOTAL FEDERAL F&A	\$197,347	\$157,347	\$157,347	\$157,347	\$157,347
TOTAL COST	\$1,546,744	\$1,505,568	\$1,504,400	\$1,503,220	\$1,502,037

Facilities and Administrative Costs	Year 1	Year 2	Year 3	Year 4	Year 5
F&A Cost Rate 1	32%	32%	32%	32%	32%
F&A Cost Base 1	\$616,708	\$491,709	\$491,709	\$491,709	\$491,709
F&A Costs 1	\$197,347	\$157,347	\$157,347	\$157,347	\$157,347

PI: DASZAK, PETER	Title: Understanding Risk of Zoonotic Virus Emergence in EID Hotspots of Southeast Asia	
Received: 06/28/2019	FOA: AI19-028 Clinical Trial: Not Allowed	Council: 01/2020
Competition ID: FORMS-E	FOA Title: Emerging Infectious Diseases Research Centers (U01 Clinical Trial Not Allowed)	
1 U01 AI151797-01	Dual:	Accession Number: 4323726
IPF: 4415701	Organization: ECOHEALTH ALLIANCE, INC.	
Former Number:	Department:	
IRG/SRG: ZAH EC-M (J2)	AIDS: N	Expedited: N
<u>Subtotal Direct Costs</u> (excludes consortium F&A) Year 1: 1,050,579 Year 2: 1,050,579 Year 3: 1,050,579 Year 4: 1,050,579 Year 5: 1,050,579	Animals: Y Humans: Y Clinical Trial: N Current HS Code: (b) (4) HESC: N Special Topics: Genomic Data Sharing	New Investigator: N Early Stage Investigator: N
<i>Senior/Key Personnel:</i>		
<i>Organization:</i>		
<i>Role Category:</i>		
PETER DASZAK	EcoHealth Alliance	PD/PI
Kevin Olival	EcoHealth Alliance	Co-Investigator
Ralph Baric	University of North Carolina	Co-Investigator
Linfa Wang	Duke-NUS Medical School	Co-Investigator
Hongying Li	EcoHealth Alliance	Other (Specify)-Epidemiologist
Thiravat Hemachudha	Chulalongkorn University Hospital	Co-Investigator
Timothy William	Gleneagles Hospital	Co-Investigator
Helen Lasimbang	Hospital Universiti Malaysia Sabah	Co-Investigator
Heng Gee Lee	Queen Elizabeth State Hospital	Other (Specify)-Senior Clinician
Giri Shan Rajahram	Queen Elizabeth State Hospital	Other (Specify)-Infectious Disease Epidemiologist
Jayaseelan Sekaran	Lintang Clinic, Kuala Kangsar District Health Office	Co-Investigator
Cheng Siang Tan	Unversiti Malaysia Sarawak	Co-Investigator
Anwarali Khan Faisal Ali	Unversiti Malaysia Sarawak	Other (Specify)-Zoologist and Biotechnician
Nadia Diyana Hamzah	Bario Clinic, Rural Area Service Ministry of Health Malaysia	Other (Specify)-Medical Officer and Clinician
Ahmed Kamruddin	Universiti Malaysia Sabah	Co-Investigator

Danielle Anderson	Duke NUS	Co-Investigator
Supaporn Wacharapluesadee	Chulalongkorn University Hospital	Co-Investigator
Tom Hughes	Conservation Medicine Ltd.	Co-Investigator
Eric Laing	Uniformed Services University	Co-Investigator
Christopher Broder	Uniformed Services University	Co-Investigator
Gerald Keusch	BU NEIDL	Co-Investigator
Ronald Corley	BU NEIDL	Co-Investigator
Amy Sims	University of North Carolina at Chapel Hill	Co-Investigator
Alice Latinne	EcoHealth Alliance	Other (Specify)-Bioinformatician
Kendra Phelps	EcoHealth Alliance	Other (Specify)-Field Scientist
Emma Mendelsohn	EcoHealth Alliance	Other (Specify)-Data Scientist
Patrick Dawson	EcoHealth Alliance	Other (Specify)-Epidemiologist
Stephanie Martinez	EcoHealth Alliance	Other (Specify)-Epidemiologist
Aleksei Chmura	EcoHealth Alliance	Other (Specify)-Senior Program Manager
Tsin Wen Yeo	Lee Kong Chian School of Medicine	Consultant
Andrew Hickey	Thailand MOPH-CDC	Consultant
Hume Field	Jeppesen Field Consulting	Consultant
Carloz Zambrana-Torrel	EcoHealth Alliance	Co-Investigator
Pasin Hemachudha	Chulalongkorn University Hospital	Other (Specify)-Immunologist and Clinician
Ingrid Ting Pao Lin	Hospital Miri	Co-Investigator

APPLICATION FOR FEDERAL ASSISTANCE
SF 424 (R&R)

3. DATE RECEIVED BY STATE		State Application Identifier
1. TYPE OF SUBMISSION*		4.a. Federal Identifier
<input type="radio"/> Pre-application <input checked="" type="radio"/> Application <input type="radio"/> Changed/Corrected Application		b. Agency Routing Number
2. DATE SUBMITTED	Application Identifier	c. Previous Grants.gov Tracking Number
5. APPLICANT INFORMATION		Organizational DUNS*: 0770900660000
Legal Name*: EcoHealth Alliance Department: Division: Street1*: 460 West 34th Street, Suite 1701 Street2: City*: New York County: State*: NY: New York Province: Country*: USA: UNITED STATES ZIP / Postal Code*: 10001-2317		
Person to be contacted on matters involving this application Prefix: Dr. First Name*: Peter Middle Name: Last Name*: Daszak Suffix: Position/Title: President Street1*: 460 West 34th Street, Suite 1701 Street2: City*: New York County: State*: NY: New York Province: Country*: USA: UNITED STATES ZIP / Postal Code*: 10001-2317 Phone Number*: (b) (6) Fax Number: 2123804465 Email: (b) (6)		
6. EMPLOYER IDENTIFICATION NUMBER (EIN) or (TIN)*		311726494
7. TYPE OF APPLICANT*		M: Nonprofit with 501C3 IRS Status (Other than Institution of Higher Education)
Other (Specify): <input checked="" type="radio"/> Small Business Organization Type <input type="radio"/> Women Owned <input type="radio"/> Socially and Economically Disadvantaged		
8. TYPE OF APPLICATION*		If Revision, mark appropriate box(es).
<input checked="" type="radio"/> New <input type="radio"/> Resubmission <input type="radio"/> Renewal <input type="radio"/> Continuation <input type="radio"/> Revision		<input type="radio"/> A. Increase Award <input type="radio"/> B. Decrease Award <input type="radio"/> C. Increase Duration <input type="radio"/> D. Decrease Duration <input type="radio"/> E. Other (specify) :
Is this application being submitted to other agencies?* <input type="radio"/> Yes <input checked="" type="radio"/> No What other Agencies?		
9. NAME OF FEDERAL AGENCY*		10. CATALOG OF FEDERAL DOMESTIC ASSISTANCE NUMBER
National Institutes of Health		TITLE:
11. DESCRIPTIVE TITLE OF APPLICANT'S PROJECT*		
Understanding Risk of Zoonotic Virus Emergence in EID Hotspots of Southeast Asia		
12. PROPOSED PROJECT		13. CONGRESSIONAL DISTRICTS OF APPLICANT
Start Date*	Ending Date*	NY-010
03/01/2020	02/28/2025	

14. PROJECT DIRECTOR/PRINCIPAL INVESTIGATOR CONTACT INFORMATION

Prefix: Dr. First Name*: PETER Middle Name: Last Name*: DASZAK Suffix:

Position/Title: President

Organization Name*: EcoHealth Alliance

Department:

Division:

Street1*: 460 West 34th Street, Suite 1701

Street2:

City*: New York

County:

State*: NY: New York

Province:

Country*: USA: UNITED STATES

ZIP / Postal Code*: 10001-2317

Phone Number*: (b) (6) Fax Number: 212-380-4465 Email*: (b) (6)

15. ESTIMATED PROJECT FUNDING

a. Total Federal Funds Requested* \$7,573,721.35

b. Total Non-Federal Funds* \$0.00

c. Total Federal & Non-Federal Funds* \$7,573,721.35

d. Estimated Program Income* \$0.00

16. IS APPLICATION SUBJECT TO REVIEW BY STATE EXECUTIVE ORDER 12372 PROCESS?*

- a. YES THIS PREAPPLICATION/APPLICATION WAS MADE AVAILABLE TO THE STATE EXECUTIVE ORDER 12372 PROCESS FOR REVIEW ON:
- DATE:
- b. NO PROGRAM IS NOT COVERED BY E.O. 12372; OR
- PROGRAM HAS NOT BEEN SELECTED BY STATE FOR REVIEW

17. By signing this application, I certify (1) to the statements contained in the list of certifications* and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances * and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)

I agree*

* The list of certifications and assurances, or an Internet site where you may obtain this list, is contained in the announcement or agency specific instructions

18. SFLL or OTHER EXPLANATORY DOCUMENTATION

File Name:

19. AUTHORIZED REPRESENTATIVE

Prefix: Dr. First Name*: Aleksei Middle Name: Last Name*: Chmura Suffix:

Position/Title*: Authorized Organizational Representative

Organization Name*: EcoHealth Alliance

Department:

Division:

Street1*: 460 West 34th Street, Suite 1701

Street2:

City*: New York

County:

State*: NY: New York

Province:

Country*: USA: UNITED STATES

ZIP / Postal Code*: 10001-2317

Phone Number*: (b) (6) Fax Number: 2123804465 Email*: (b) (6)

Signature of Authorized Representative*

Aleksei Chmura

Date Signed*

06/28/2019

20. PRE-APPLICATION File Name:**21. COVER LETTER ATTACHMENT** File Name: Cover_Letter_EIDRC_2019_SEA_FINAL.pdf

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Project/Performance Site Location(s)**Project/Performance Site Primary Location**

I am submitting an application as an individual, and not on behalf of a company, state, local or tribal government, academia, or other type of organization.

Organization Name: ECOHEALTH ALLIANCE, INC.
 Duns Number: 0770900660000
 Street1*: 460 W 34TH ST.
 Street2: SUITE 1701
 City*: NEW YORK
 County:
 State*: NY: New York
 Province:
 Country*: USA: UNITED STATES
 Zip / Postal Code*: 10001-2320
 Project/Performance Site Congressional District*: NY-010

Project/Performance Site Location 1

I am submitting an application as an individual, and not on behalf of a company, state, local or tribal government, academia, or other type of organization.

Organization Name: Conservation Medicine Ltd
 DUNS Number: 5344092560000
 Street1*: 13H Villamas Condo
 Street2: Villamas Jalan Villamas
 City*: Sungai
 Buloh
 County:
 State*:
 Province:
 Country*: MYS: MALAYSIA
 Zip / Postal Code*:
 Project/Performance Site Congressional District*:

Project/Performance Site Location 2

I am submitting an application as an individual, and not on behalf of a company, state, local or tribal government, academia, or other type of organization.

Organization Name: Duke-NUS Medical School
DUNS Number: 5951922530000
Street1*: 8 College Road
Street2:
City*: Singapore
County:
State*:
Province:
Country*: SGP: SINGAPORE
Zip / Postal Code*: 169857
Project/Performance Site Congressional District*:

Project/Performance Site Location 3

I am submitting an application as an individual, and not on behalf of a company, state, local or tribal government, academia, or other type of organization.

Organization Name: National Emerging Infectious Diseases Laboratories
DUNS Number: 0771630590000
Street1*: 620 Albany St.
Street2:
City*: Boston
County:
State*: MA: Massachusetts
Province:
Country*: USA: UNITED STATES
Zip / Postal Code*: 02118-2516
Project/Performance Site Congressional District*: MA-007

Project/Performance Site Location 4

I am submitting an application as an individual, and not on behalf of a company, state, local or tribal government, academia, or other type of organization.

Organization Name: University of North Carolina, Chapel Hill
DUNS Number: 6081952770000
Street1*: 135 Dauer Drive
Street2:
City*: Chapel Hill
County:
State*: NC: North Carolina
Province:
Country*: USA: UNITED STATES
Zip / Postal Code*: 27599-7400
Project/Performance Site Congressional District*: NC-004

Project/Performance Site Location 5

I am submitting an application as an individual, and not on behalf of a company, state, local or tribal government, academia, or other type of organization.

Organization Name: Uniformed Services University
DUNS Number: 1446765660000
Street1*: 4301 Jones Bridge Rd
Street2:
City*: Bethesda
County:
State*: MD: Maryland
Province:
Country*: USA: UNITED STATES
Zip / Postal Code*: 20814-4799
Project/Performance Site Congressional District*: MD-008

Project/Performance Site Location 6

I am submitting an application as an individual, and not on behalf of a company, state, local or tribal government, academia, or other type of organization.

Organization Name: Chulalongkorn University
DUNS Number: 6598088360000
Street1*: 254 Phayathai Road
Street2:
City*: Pathumwan,
Bangkok
County:
State*:
Province:
Country*: THA: THAILAND
Zip / Postal Code*: 10330
Project/Performance Site Congressional District*:

Additional Location(s)

File Name:

RESEARCH & RELATED Other Project Information

1. Are Human Subjects Involved?* <input checked="" type="radio"/> Yes <input type="radio"/> No	
1.a. If YES to Human Subjects Is the Project Exempt from Federal regulations? <input type="radio"/> Yes <input checked="" type="radio"/> No If YES, check appropriate exemption number: — 1 — 2 — 3 — 4 — 5 — 6 — 7 — 8 If NO, is the IRB review Pending? <input checked="" type="radio"/> Yes <input type="radio"/> No IRB Approval Date: 03-01-2020 Human Subject Assurance Number 00022431	
2. Are Vertebrate Animals Used?* <input checked="" type="radio"/> Yes <input type="radio"/> No	
2.a. If YES to Vertebrate Animals Is the IACUC review Pending? <input checked="" type="radio"/> Yes <input type="radio"/> No IACUC Approval Date: Animal Welfare Assurance Number None	
3. Is proprietary/privileged information included in the application?* <input type="radio"/> Yes <input checked="" type="radio"/> No	
4.a. Does this project have an actual or potential impact - positive or negative - on the environment?* <input type="radio"/> Yes <input checked="" type="radio"/> No	
4.b. If yes, please explain: 4.c. If this project has an actual or potential impact on the environment, has an exemption been authorized or an environmental assessment (EA) or environmental impact statement (EIS) been performed? <input type="radio"/> Yes <input type="radio"/> No 4.d. If yes, please explain:	
5. Is the research performance site designated, or eligible to be designated, as a historic place?* <input type="radio"/> Yes <input checked="" type="radio"/> No	
5.a. If yes, please explain:	
6. Does this project involve activities outside the United States or partnership with international collaborators?* <input checked="" type="radio"/> Yes <input type="radio"/> No	
6.a. If yes, identify countries: Thailand, Malaysia, Singapore 6.b. Optional Explanation:	
7. Project Summary/Abstract*	Filename Project_Summary_EIDRC_SEA_Daszak.pdf
8. Project Narrative*	Project_Narrative_EIDRC_RFA-AI-19-028.pdf
9. Bibliography & References Cited	EIDRC_SEA_Bibliography_FINAL.pdf
10. Facilities & Other Resources	Facilities_EIDRC_2019_SEA_FINAL.pdf
11. Equipment	Major_Equipment_FINAL.pdf

PROJECT SUMMARY/ABSTRACT

Southeast Asia is one of the world's highest-risk EID hotspots, the origin of the SARS pandemic, Nipah virus, and repeated outbreaks of influenza. This is driven by high diversity of wildlife and rapidly expanding demography that brings human and wildlife populations closer. This proposal will launch the **Emerging Infectious Diseases - South East Asia Research Collaboration Hub (EID-SEARCH), a collaboration among leaders in emerging disease research in the USA, Thailand, Singapore and the 3 major Malaysian administrative regions. These researchers have networks that span >50 clinics, laboratories and research institutions across almost all SE Asian countries and will use the EID-SEARCH as an early warning system for outbreaks involving exchange of information, reagents, samples and technology, and a collaborative power-house for fundamental and translational research. The EID-SEARCH will also act as **a significant asset to scale-up and deploy resources in the case of an outbreak in the region.** This EIDRC will conduct research to: **1) Identify, characterize and rank spillover risk of high zoonotic potential viruses from wildlife,** by analyzing previously-archived wildlife samples, conducting targeted wildlife surveillance, and using serology & PCR assays to identify novel viruses. These will be characterized to assess risk of spillover to people, and a series of *in vitro* (receptor binding, cell culture) and *in vivo* (humanized mouse and collaborative cross models) assays used to assess their potential to infect people and cause disease; **2) Collect samples and questionnaire data from human communities that live in EID hotspots and have high cultural and behavioral risk of animal exposure (e.g. wildlife hunting, bat guano collection).** These will be tested with serological assays to identify evidence of novel virus spillover, and analyzed against metadata to identify key risk pathways for transmission; **3) Identify and characterize viral etiology of 'cryptic' outbreaks in clinical cohorts.** We will conduct syndromic surveillance at clinics serving the populations in Aim 2, enroll patients with undiagnosed illness and symptoms consistent with emerging viral pathogens, and test samples with molecular and follow-up serological assays to identify causal links between these syndromes and novel viruses.**

This research will advance our understanding of the risk of novel viral emergence in a uniquely important region. **It will also strengthen in-country research capacity** by linking local infectious disease scientists **with an international collaborative network that has proven capacity to conduct this work and produce significant findings.** The large body of high impact collaborative research from this EIDRC leadership team provides proof-of-concept that EID-SEARCH has the background, collaborative network, experience, and skillset to act as a **unique early warning system for novel EIDs of any etiology threatening to emerge in this hottest of the EID hotspots.**

PROJECT NARRATIVE

This proposed EID Research Center (EID-SEARCH) brings leaders in emerging disease research from the US, Thailand, Singapore and the 3 major Malaysian administrative regions together to build an early warning system to safeguard against pandemic disease threats. This team will identify novel viruses from Southeast Asian wildlife, characterize their capacity to infect and cause illness in people, and use serological assays of samples from people in rural communities with high wildlife contact to identify the background rate of exposure, and risk factors that drive this. They will conduct in-depth surveillance of clinical cohorts at hospitals serving these communities to examine if 'cryptic' outbreaks are caused by these novel agents, and to build significant capacity to rapidly detect and respond should there be a major outbreak of a virus in the region.

Facilities and Other Resources

EcoHealth Alliance, New York, USA (Drs. Daszak and Olival)

EcoHealth Alliance is a New York-based 501(c) 3 non-profit institution that conducts scientific research on emerging zoonoses and global health capacity building. EcoHealth Alliance New York headquarters has (b) (4) square feet of office space including a meeting room and basic laboratory – freezer storage and light microscopy. The scientific staff (34 core scientists, 100+ field staff) is supported by a core admin staff of 18 who are available for work on this project and funded through private donor and federal support. EcoHealth Alliance does not support diagnostic facilities at its core headquarters and works in partnership with a network of leading diagnostic labs both in the USA and around the world.

EcoHealth Alliance is the headquarters of a global network of over 70 partners that provides exceptional leverage for the core scientists. This network includes staff from: academic institutions at leading national universities; intergovernmental agencies (WHO, OIE, FAO, DIVERSITAS, IUCN); infectious disease surveillance laboratories including BSL-3 and -4 laboratories; national government agency offices and labs; locally-based wildlife conservation organizations in Asia, Africa and Latin America. EcoHealth Alliance is the headquarters of: The Consortium for Conservation Medicine (CCM); the journal EcoHealth; an NSF Research Coordination Network (EcoHealthNET); the IUCN Wildlife Health Specialist Group; and the OIE Wildlife Health Network. EcoHealth Alliance is a voting member of the IUCN and a partner in Columbia University's Earth Institute Center for Environmental Sustainability (EICES) and all senior scientific staff members are Adjunct Faculty at Columbia University's Department of Ecology, Evolution, and Environmental Biology or at the Mailman School of Public Health.

Information Technology Access

EcoHealth Alliance is equipped with fiber optic Internet access and video conferencing facilities to facilitate easy communication between collaborators. EcoHealth Alliance employees have around-the-clock access to servers, VPNs, encryption software, IT support, and all necessary software including Git and Github (Hosted software revision/audit service), Sublime and Vim text editors, Vagrant and Oracle Virtualbox virtual machines, Google Apps (Hosted email and collaboration web-based software), Ansible (Server provisioning software framework), Python, NodeJS, and R programming languages, Meteor (Javascript framework), Bash shell scripts, Jenkins (Continuous Integration server), Microsoft Office and Adobe CS6 running on both Apple Mac OS X, Ubuntu linux, and Windows Operating Systems. EcoHealth Alliance has a dedicated quad-core Linux server and another dedicated dual quad-core Mac Pro Server - each with 4TB hard drives. Either server individually or in combination may be used for intensive computational modeling and/or database processing by all the grantees. Access to the cloud and supercomputing services (Amazon) is provided by core funding to EcoHealth Alliance.

Biological Sample Storage and Access

Regarding this proposal, EcoHealth Alliance will serve as the central location for project coordination, as well as data management and analysis. No biological samples, however, will be stored at the institution. All samples collected as a result of project activities will be stored at the laboratories of partner institutions (listed within this document) that are equipped with BSL-2, BSL-3 or BSL-4 level facilities. Further details regarding these laboratory facilities are included within the facility descriptions below.

University of North Carolina, Chapel Hill, USA (Drs. Baric and Sims)

The Department of Epidemiology is internationally recognized as a leader in epidemiologic research and training. The Department offers research training in most specialized areas including cancer, cardiovascular diseases, environmental and occupational health, health services/clinical epidemiology, reproductive health and infectious diseases. For the fiscal year 2018, the Department was awarded in excess of \$24 million in sponsored funding (research, training and public service) and ranks in the top five largest units at the University of North Carolina at Chapel Hill in the area of sponsored research awards. The Department's current faculty consists of 67 regular full-time faculty and 146 adjunct faculty members. The Department has 209 graduate students enrolled, including 11 in the MPH program, 20 in the MSCR program and 178 in the Ph.D. program.

The Department of Epidemiology is headquartered in the four-story McGavran-Greenberg Building adjacent to Rosenau Hall across the street from the School of Medicine. The epidemiology administrative and office space occupies (b) (4) sq. ft. and provides additional classroom space. Most of the department's research staff occupies a research annex consisting of approximately (b) (4) square feet of contiguous rental space in a commercial office building that is a 10-minute walk from McGavran/Greenberg Hall.

Information Technology Access

The Department of Epidemiology is equipped high speed internet access and has several IBM and Apple Pentium II/III computers with accompanying software. The university has an Information Technology Services department that dedicated to delivering reliable, secure and satisfying information technology capabilities and experiences to the University.

Biological Sample Storage and Access

Dr. Baric has three laboratories of (b) (4) sq. ft. equipped as BL2 space for the molecular biology, virology, immunology and recombinant DNA techniques proposed in the application in Hooker Research Center. Equipment includes gel electrophoresis equipment, power supplies, thermal cyclers, a programmable heat block, heat blocks, water baths, CO2 incubators (2), several -70oC freezers, one -140oC freezer, refrigerators, DNA documentation system, DNA sequencing and computer assisted sequence analysis programs, several microfuges, two Nikon microscopes with photographic and fluorescent capabilities, several class 2 environmental hoods, refrigerated water baths, several IBM and Apple Pentium II/III computers with accompanying software, three thermocyclers, a fume hood, Nuclisens reader, hybridization oven, real time thermocyclers, three fluorescent inverted scopes with computer software (Olympus IX51), and a spectrophotometer. A Roche Light Cycler 480II is available for real time measurements. The laboratory has an ELISA plate reader, an illuminometer, 200 cages for animal maintenance and breeding in Seal-Safe housing, Bio Rad low pressure chromatography system, ELISA plate washer, spectrophotometers, and other equipment that is routinely used in characterizing antibody-protein interactions.

The Baric laboratory contains an additional (b) (4) square feet of newly renovated or new BSL3 facilities with enhanced features including 1) shower in/shower out facility, 2) dual anteroom access, 3) Hepa filtered exhaust, 4) redundant exhaust fans, 4) Card key access, alarm system to Public Health/Campus Police, Lab controlled combination lock, and 5) Techniplast Sealsafe™ Hepa filtered animal housing for rodents (mice (~300 cages). PAPR and tyvek suits are worn at all times in the BSL3 facility. The BL3 facilities are in an adjacent, attached building (b) (4) or in (b) (4), the latter space is directly adjacent to Dr. Baric's BSL2 laboratory resources. Each facility is equipped with sterile hoods (BSCIIA), four CO2 incubators, gel electrophoresis equipment, thermal cyclers and power supplies, and related equipment necessary for virus cultivation and molecular genetic research. The facilities each house a -70C freezer, an inverted Nikon fluorescent microscope with an assortment of filters, magnifications and digital camera, an ELISA plate reader and illuminometer. Both facility contain rodent-sized Seal-Safe systems (~192 cages) for maintaining animals in a Hepa-filtered Air in/out environment, exhausted into the BSL3 Hepa-filtered exhaust system. An 8 chamber Buxco plethysmography system which allows for repetitive, noninvasive measures of the number of breaths, tidal volume, airway responsiveness, enhanced pause, respiratory gases, etc. from live control and infected mice in a contained system is available in the main BSL3 laboratory in (b) (4) (<http://www.buxco.com/FinePointe.aspx?Page=FinePointe>).

The Department of Epidemiology provides cold-room, autoclave, centralized dishwashing and a darkroom with an automated developer. The campus has central facilities for DNA oligonucleotide synthesis, histopathology, DNA sequencing, EM, light and confocal microscopy, automated PCR genotyping and Taqman facilities, and Fluorescent activated cell sorter facilities (FAC). As a member of the Department of Microbiology and Immunology and UNC Cancer center, our laboratory has access to these facilities and receives discounts. The University provides a variety of core services including: sequencing and deep sequencing cores, genomics cores, oligonucleotide synthesis cores, hybridoma cores, transgenic cores, structural biology cores, etc. typical of any world class research institution. Campus wide core facilities are available for oligonucleotide synthesis, Sanger and 454 sequencing, RNAseq, pathology and histology services, and Flow Cytometry. Approximately, 40,000 cages are available for CC RIX production in the (b) (4) on UNC Campus.

Duke-NUS Medical School, Singapore (Drs. Wang and Anderson)

The laboratory of One Health Approach to EID at Duke-NUS Medical School Singapore is headed by Professor Lin-Fa Wang. The lab consists of 8 post-doctoral fellows, 4 research assistants and 3 MD-PhD students. Professor Wang is Director, Programme in Emerging Infectious Diseases, Duke-NUS Medical School, Singapore. His proven track record in the field includes identifying the bat origin of SARS-CoV, and pioneering work on Henipaviruses. His work has shifted from identifying the bat-origin of pathogens to understanding basic bat biology and the mechanisms by which they can endure sustained virus infection. Professor Wang currently heads and administers a Singapore National Research Foundation grant entitled "Learning from bats".

Assistant Professor Danielle Anderson is the scientific director of the ABSL3 facility at Duke-NUS and is an expert in RNA virus replication. She has extensive experience in molecular biology, high throughput screening and animal models. Assistant Professor Anderson has performed both human and bat siRNA screens and personally implemented and transferred the siRNA screening protocols from the RNAi facility at Duke University, USA, to Duke-NUS in order to establish capacity in Singapore. Additionally, Assistant Professor Anderson has established pathogenesis models in Singapore, using different species (non-human primates, ferrets and bats) and inoculation routes (such as mosquito inoculation), and has performed animal trials in both ABSL2 and ABSL3 containment facilities.

Information Technology Access

Duke-NUS is supported by the National University of Singapore's dedicated IT department, NUS Information Technology, that employs over 200 staff providing reliable, high-performance IT infrastructure and services for NUS. Duke-NUS is well-equipped with high speed internet access and computers with relevant software.

Biological Sample Storage and Access

The Duke-NUS Animal Biosafety Level 3 Facility consists of three laboratories with support space occupying a gross floor area of (b) (4) square meters. The facility is fully equipped to conduct ABSL3 experiments ranging from in vitro experiments to large animal studies. The facility consists of three laboratories, one lab for in vitro and molecular work, one lab for housing small animals in isolator cages and one lab for large animals (non-human primates, ferrets, bats). The laboratory where the non-human primates are housed is equipped with Air Pressure Resistant doors to allow housing of large animals in open cage housing, and is the first of this kind in Singapore. The facility also contains of support areas including shower rooms, autoclaves, tissue digester and effluent decontamination system.

Duke-NUS Genome Biology Facility: This facility is setup to cater to the needs of researchers who are interested in using high end genomics technology such as microarray and next generation sequencing. The goal of the facility is to enhance biomedical research through genomic technology. Duke-NUS Genome Biology Facility is constantly upgrading to newer technology to provide researchers with more flexibility to choose the technology and platforms that best suit their projects. The core facilities and services includes: Human Genome U133 Plus 2.0 array and Gene Chip Mouse Genome 430 2.0 array expression profiling services, HumanHT-12 v4 and MouseWG-6 v2 Expression profiling services, HumanMethylation27 assay profiling service, Full RNA-Seq service, sequencing service, total RNA quality assessment service and Agilent Unrestricted Human Microarray miRNA v14 Rev.2 expression profiling service.

Uniformed Services University, Bethesda, USA (Drs. Broder and Laing)

Uniformed Services University (USU) is the medical school at which approximately half of the physicians in the Armed Services receive their graduate training. Research at USU is supported primarily by extramural grants, as in other medical schools. Dr. Broder is a tenured Professor in the Department of Microbiology and Immunology and is also the Department Chair, which includes 12 full-time Faculty members. The overall focus of the Department is mechanisms of infectious diseases and the host response/immunology. Faculty interests and active research programs at USU are diverse, with many nationally- and internationally-known investigators. Dr. Broder has had and is currently involved in active collaborations within the University, in areas of viral immunology and vaccine and antiviral therapeutics and animal model development (with Dr. Joseph Mattapallil and Dr. Brian Schaefer). USU is also physically located directly across from the main NIH campus in Bethesda, Maryland. The overall broad scientific environment at both USU and the NIH is highly conducive to productive collaborations. Dr. Broder often uses these resources to his advantage, both for his

research objectives and interests, but also in his role as Chair and as the former Director of the Emerging Infectious Diseases Graduate Program (for the Ph.D.) because he has activity recruited adjunct faculty appointments within the EID graduate program for both on and off-campus scientists interested in participating in graduate education and graduate student training. Dr. Broder submits such appointments requests through the Office of Dean of the Medical School (USU). The USU/EID program can accept 5 fully supported student positions per academic year, for 3 years, at which time the student's mentor begins support, and there is no tuition or fees associated with the EID program. The PI has an office separate from, but across from the laboratory. Two full-time administrative assistants and two full-time program managers are available to provide support within the department. Overall, the available technical resources (and University support for continually improving technical resources) is exceptional.

Information Technology Access

USU is equipped with a pentium computer, scanners and two laser jet printers in the PI's office and 9 windows based computers in the laboratories/offices are connected by a central server to each other and to the Internet. A variety of USU-supported software programs are available, including EndNote, Microsoft Office, Adobe Creative Cloud, Geneious 9.15 and Graph Pad Prism 6.0. The University also has an equipment repair service, central duplicating service, audiovisual service, and microcomputer support service. The University Learning Resource Center is a high quality medical and scientific library with additional microcomputers and support. A wide variety of scientific journals are available in print and via remote computer access.

Biological Sample Storage and Access

The PI's laboratories are divided into 3 rooms totaling (b) (4) sf, and are equipped with eight CO2 incubators for tissue culture, 4 inverted and 1 bright field microscopes, high speed and ultracentrifuges, four biological safety cabinets, 2 -20°C, 3 -80°C freezers, 4 liquid nitrogen freezers 6 refrigerator/freezers, 4 PCR machines, 2 ELISA plate reader, and various small equipment items (gel electrophoresis, circulating adjustable water baths, heat blocks). 2 complete GE-ATKA low pressure chromatography systems, with integrated UV detectors, fraction collectors, and pump systems, and gradient fractionator apparatus. A central autoclave/glassware washroom serves the Department of Microbiology and Immunology and is maintained through extramural grant support.

Animal: Animals if applicable are maintained in the University's laboratory animal facilities under the supervision of a full-time veterinarian. These facilities are a modern AAALC accredited, central animal tract of about (b) (4) sq. ft. The animal care and use program is managed by the Department of Laboratory Animal Medicine which is directed by a veterinarian who is an ACLAM Diplomat and staffed with one other veterinarian, a graduate animal husbandryman, and about 30 technicians.

National Emerging Infectious Diseases Laboratories (NEIDL), Boston, USA (Drs. Keusch and Corley)

The National Emerging Infectious Diseases Laboratories (NEIDL) is housed on the Boston University Medical Campus within close proximity to the School of Medicine, School of Dental Medicine and School of Public Health and their associated research facilities, and Boston Medical Center, the principal teaching hospital for the medical school. The Medical Campus also houses major Core facilities and includes an extensive Animal Science Center which includes animal facilities for BSL-2 and BSL-1 animal work. In addition to Basic Sciences and Clinical Departments, the Medical Campus also includes the Center for Regenerative Medicine, the Center for Network Systems Biology, and the Clinical and Translational Science Center. The Boston University Medical Campus is a short shuttle bus ride from the Boston University Campus on the Charles River. The BU campus includes the School of Engineering and its Biomedical Engineering Department and its Biologic Design ("synthetic biology") group, and the Hariri Institute for Computing and Computational Science. Major research programs in the Department of Chemistry and the Department of Biology are also of importance to the goals of the NEIDL, as is the Bioinformatics Graduate Program which is managed from the Charles River Campus. Boston University is a highly interactive and collaborative environment which is supported by the University administration to ensure that artificial barriers to success are removed and do not hamper innovation in research. Office spaces for faculty and staff are integrated throughout the NEIDL. Most faculty have offices in administrative spaces adjacent to the BSL-2 laboratories. Administrative support is provided and is supported by the administrative infrastructure of the University. All offices are accessible in an environment secured via proximity card and iris scan access.

Information Technology Access

All laboratories are serviced by the Boston University IS&T group, with the exception of those services that are uniquely required for work within the NEIDL and are managed by the IT Core staff dedicated to the NEIDL. This includes building automation systems and select agent inventory control which are managed in a safe and secure network environment. Computational resources for individual faculty and staff are augmented by the BU Shared Computing Cluster which is maintained by BU and its consortium in Holyoke, MA, site of the LEED Platinum certified MA Green High Performance Computing Center (MGHPCC). Two pairs of 10 Gigabit Ethernet network connections between the MGHPCC and the BU campus connect the two locations. The system currently includes over 2600 shared processors, over 5100 buy-in processors, a combined 244 GPUs, and petabytes of redundantly backed up storage.

Facility security: The Public Safety Core supports the NEIDL's mission by providing a safe and secure environment with particular attention to risks, threats and vulnerabilities. Public Safety personnel are well trained in the intricacies of a secure site, criminal applications and a significant amount of training pertaining to safety, facilities, emergency preparedness and response, biosafety incidents, animal rights activism and coordinated notification and response of external local, state and federal responders. The Public Safety Core monitors and audits all areas of access, and manages personnel suitability on a continual basis to ensure regulations are adhered to, as well as 24/7 management of the environment with police-academy-trained officers. Core managerial staff have developed a comprehensive set of Public Safety Standard Operating Procedures, consistent with BUMC-wide policies and procedures, which meet and/or exceed all applicable federal, state, and local regulations (NIH, BMBL, OSHA, CDC, NRC, MWRA, DEP, BFD, etc). In addition, they manage the process of background checks (CORI) and drug screening for staff in order to ensure that recruitments are consistent with security requirements.

Interfacing with other support offices at Boston University: The operational core services offered in the NEIDL benefit from the additional infrastructure on the Boston University Campus, which not only contribute significant expertise but also provide services that we do not need to duplicate. For example, the IT services in the NEIDL are supported by a large BU Information Services and Technology Team that insures expert IT services are provided, and we have in house IT experts who are also trained to work within the containment facilities. Similarly, our Environmental Health & Safety core is supported by a larger EH&S group within the University, and Emergency Response is supported by a University wide ER group which has long experience working with local, state, and national responders. The Community Relations Services are integrated with BU campus-wide services which include the Office of Government and Community Affairs, while our Occupational Medicine Program is supplemented by a larger Research Occupational Health Program at the University.

Biological Sample Storage and Access

The National Emerging Infectious Diseases Laboratories (NEIDL) is designed to provide safe working conditions for handling pathogens at every biosafety level, including biosafety level 2 (BSL-2; (b) (4) sq.ft.), BSL-3 (b) (4) sq.ft.) and BSL-4 (b) (4) sq.ft.). This includes laboratories and animal facilities for infectious diseases research at all containment levels. BSL-2 spaces include imbedded cell culture and pathogen propagation suites as well as BSL-2+ laboratory suites that can be upgraded to BSL-3 as needed. Support spaces includes shared rooms for instrumentation, chemical storage, cold rooms and dark rooms. The BSL-3 facilities include 5 independent suites that integrate into a central corridor from which 8 animal suites, each with its own procedure space, can be accessed. The BSL-4 facilities include 6 laboratory suites and 7 independent animal study spaces, each with its own procedure space for support of animal related experiments on emerging infectious diseases. Laboratory spaces are accessed by approved personnel and controlled through proximity card and biometric access.

Full-length cDNA clone laboratory (BSL-2): The NEIDL has dedicated laboratory space with secured access to conduct work with full-length cDNA clones of filoviruses and henipaviruses. This laboratory is equipped for all contemporary cloning work including growth of transformed bacteria. The full-length cDNA work at the NEIDL has been approved by NIH, Boston Public Health Commission, and BU IBC.

Animal: The Laboratory Animal Science Center (ASC) at Boston University has been an AAALAC accredited animal care program since 1971. Animals are housed in a state-of-the-art facility run by licensed veterinarians supported by a large technical staff. All individuals involved in animal research are trained in proper animal

handling, dissection, anesthesia and euthanasia techniques as described and approved by the Institutional Animal Care and Use Committee (IACUC) protocol(s). The Animal Services component of the NEIDL are integrated into the larger Animal Sciences Center, under the direction of the Attending Veterinarian.

Animal study rooms in the NEIDL are designed for use with multiple species of animals and can each accommodate 900 mice (in microisolators), 216 guinea pigs (in microisolators), 72 ferrets (in specially designed isolator housing) and 12-16 non-human primates.

Insectaries: The NEIDL includes spaces for the integration of insectaries into the containment laboratories. There is a functioning insectary for mosquito transmission studies at ACL-2 and ACL-3. The insectary has 4 dedicated rooms that permit the isolation of infection studies from the areas designed for rearing mosquitoes, and integrates with the necessary animal facilities. A 3 room suite for vector transmission studies using ticks can be activated in the future.

Transport of select agents: All biohazards that are shipped or received for these approved projects are mandated to meet the standards of the High Hazard Materials Management policy, which states that BUMC will meet or exceed all applicable shipping regulations under the requirements of the U.S. Department of Transportation (DOT) and the International Air Transportation Authority (IATA). The BUMC Office of Environmental Health and Safety and Public Safety have responsibility for managing the transportation process for select agents and have contracted with appropriate transportation vendors which utilize screened personnel and GPS tracking systems and which can provide an all-inclusive chain of custody document for each shipment.

Thai Red Cross Emerging Infectious Diseases Health Science Centre (TRC-EID), Faculty of Medicine, Chulalongkorn University Hospital, Thailand (Drs. Hemachudha and Wacharapluesadee)

TRC-EID is a Bangkok-based non-profit institution that conducts scientific research on emerging zoonoses and regional laboratory capacity building. TRC-EID has (b) (4) square feet of office space, including a meeting room, and fully equipped laboratory. The medical doctors (3) and scientific staff (17 core scientists/field staff) is supported by a core admin staff of 3 and one IT staff who are available for work on this project. TRC-EID supports diagnostic facilities at its laboratories for both infectious and non-infectious diseases.

TRC-EID has worked with over 20 partners. This network includes staff from: academic institutions at leading national universities; intergovernmental agencies (WHO, OIE, FAO, BTRP/DTRA); infectious disease surveillance laboratories; national government agency offices and labs; locally-based wildlife conservation organizations. TRC-EID is the government's reference laboratory for all emerging infectious diseases and is a WHO Collaborating Centre for Research and Training on Viral Zoonoses, responsible for capacity building and strengthening laboratories in the region.

Information Technology Access

Thai Red Cross Emerging Infectious Diseases - Health Science Centre (TRC-EID) have necessary software including Bioinformatic tools (Blast Standalone, SAMTOOL, GATK, AliVIEW, RaxML, FigTREE, MAFFT, Guppy, Megan, PoreChop, MEGA), Database (MySQL, MongoDB) Web, jQuery, Node.js, Express.js React, API, PHP, Ruby, Python, Java, C#, HTML5, Bootstrap, CSS, Responsive, Cloud, Linux Command, PACS (sample management system), Virtualbox virtual machines, R programming languages, Perl scripts, Bash shell scripts, Open source software, Microsoft Office running on both Apple Mac OS X, Ubuntu, Linux, and Windows Operating Systems. TRC-EID has a dedicated 16-core Ram 64GB Linux server with 4TB hard drives, dual quad-core Mac Pro Server with 2TB hard drives and another dedicated iMac Pro (Retina 4K, 21.5-inch, 2017) Processor 3.6GHz quad-core Intel Core i7 (Turbo Boost up to 4.2GHz) Ra, 16GB with 512GB hard drives. TRC-EID also has HPC Linux server CPU: 4 x 26cores Intel Xeon = 104 cores 2.1GHz with 52 TB HDD and 2x3.84TB SSD with GPU 2x Tesla v100 (CUDA core = 5120 cores/GPU, Tensor core = 640 cores/GPU). TRC-EID has a dedicated 10/100/1000 of LAN (Local Area Network), 2.4G / 5G Gigabit Wi-Fi 802.11ac.

Biological Sample Storage and Access

All samples collected as a result of project activities will be stored at TRC-EID. TRC-EID will be responsible for data management and analysis. TRC-EID is equipped with BSL-2 and BSL-3 level facilities.

Conservation Medicine Ltd, Kuala Lumpur, Malaysia. (Mr. Hughes, Ms. Lee, Mr. Lee)

Conservation Medicine Ltd. (CM), was incorporated in 2014 in Kuala Lumpur, Malaysia, and is run as a non-profit directed by Mr. Tom Hughes who has worked with EcoHealth Alliance (EHA) since 2005. CM employs a Lab Coordinator (Mei Ho Lee) and Field Manager (Jimmy Lee), who have worked together with EHA since 2009 to implement field and lab projects including activities under the USAID Emerging Pandemic Threats: PREDICT program and the USAID Infectious Disease Emergence and Economics of Altered Landscapes (IDEEAL) project. CM employs; 1 Administrative Assistant to help coordinate the logistics of projects, assist with data entry and communicate with partners; 5 rangers who have worked together with EHA since April 2017 and a Veterinarian who joined the team in November 2017 to carry out field work in PM and Sabah with our government partners; a lab manger to run the Wildlife Health, Genetic and Forensic Laboratory (WHGFL) established in collaboration with Sabah Wildlife Department (SWD) and 3 lab techs who conduct disease testing at our government partner laboratories.

Information Technology Access

CM is equipped with office space, laptop computers, internet, mobile phones, GPS units, and three 4WD vehicle fully equipped for field transportation to remote field sites (two in Peninsular Malaysia and one in Sabah). CM maintains wildlife capture equipment and supplies for biological sample collection from humans and animals and liquid nitrogen dry shippers for ensuring cold chain during transport of biological samples from field to lab for both PM and Sabah. CM has supplies of personal protective equipment for all field and lab staff, including PAPRs and N95 respirators, gloves and disposable coveralls. CM maintains close communication with Ministry of Health and the National Public Health Laboratory (NPHL), Department of Wildlife and National Parks (DWNP), Faculty of Veterinary Medicine Universiti Putra Malaysia (FVMUPM), Department of Veterinary Services, SWD, Sabah State Health Department, Kota Kinabalu Public Health Laboratory (KKPHL) and Universiti Malaysia Sabah on behalf of EHA, and CM staff work closely with government partners to implement PREDICT, IDEEAL and DTRA field and lab activities.

Biological Sample Storage and Access

CM helped establish and manages the SWD WHGFL (certified as a BSL- 2 laboratory according to the US standard for laboratory specifications) that has all the equipment necessary to store samples, run extractions, PCR and analysis on biological samples for disease surveillance. The lab is used to conduct health checks on rescued and relocated wildlife before being released into new areas or sanctuaries, to screen samples for the PREDICT and Deep Forest Project and for genetic research and forensic investigations. CM also helped establish the new molecular zoonosis laboratories (certified as a BSL- 2 laboratory according to the US standard for laboratory specifications), at DWNP's National Wildlife Forensic Laboratory. The lab is used to screen samples for the PREDICT & DTRA projects. In addition CM also has access to NPHL and KKPHL for screening human samples and the Virology lab at FVMUPM for screening Livestock samples.

Borneo Medical and Health Research Centre (BMHRC), Universiti Malaysia Sabah, (Dr. Kamruddin & Dr. Lasimbang)

Borneo Medical and Health Research Centre (BMHRC) is a centre of excellence that conducts teaching and scientific researches on communicable diseases, outbreak investigations, and ethnomedicine. BMHRC has offices space including a meeting room and seven laboratories which including preparation lab, parasitology lab, cell culture lab, bacteriology lab, natural product lab, virology lab, and molecular biology lab. BMHRC is supported by an administration staff, medical lab technologist, and research assistants who are available to work on projects. BMHRC leading research centre in Sabah that is internationally recognized for its excellent research on tropical endemic diseases and improving human health.

BMHRC has a global network of 10 research partners which are the Ministry of Health, Malaysia, Sabah State Health Department, Kota Kinabalu City Hall, Nagasaki University, Zunyi Medical University, National University of Singapore, Adtec Corporation, Oita University, Tottori Nursing College, and EcoHealth Alliance.

Information Technology Access

BMHRC equipped with LAN and wireless internet access. BMHRC users also have around-the-clock access to servers, VPN, encryption software, IT support, and all necessary software. Software such as Oracle Virtualbox virtual machine, Google Apps, Node JS, R programming languages, Bash shell script, Microsoft Office and Open Office can be accessed at the Centre. BMHRC dedicated ion torrent performance computer with 11 TB

hard drive, 49 GB of RAM, and dual Xeon processor with 24 cores. BMHRC has also Ubuntu Linux and Window Operating System.

Biological Sample Storage and Access

BMHRC has a laboratory equipment facility such as light microscopes, incubators, shaking incubator, magnifying lamp, -80°C freezer, refrigerator for reagents (4°C), refrigerated centrifuge, thermal cyclers, next generation sequencer (ion torrent), water bath, laminar air flow, digital droplet PCR, flow cytometer, and autoclave machine.

Queen Elizabeth Hospital (QEH), Kota Kinabalu, Sabah, Malaysia (Drs Heng Gee Lee and Giri Shan Rajahram)

The Infectious Diseases (ID) Unit and Clinical Research Centre (CRC), Queen Elizabeth Hospital conduct scientific researches on infectious diseases. The ID Unit consists of a twenty bedded ward and an infectious disease clinic. The unit is headed by an ID Consultant together with a Medical Specialist and six Medical Officers. The CRC staffs consist of two Medical Officers, 1 pharmacist, 2 research officers, 2 registered nurses, 1 administration assistant, and 1 operation assistant.

Information Technology Access

CRC QEH is equipped with internet access and video conferencing facilities to facilitate communication between collaborators. CRC QEH has important software including Microsoft Office and Stata 12 running on Windows Operating Systems.

Biological Sample Storage and Access

The CRC office space includes a meeting room and basic laboratory which contains a -86°C freezer, centrifuges x 2, refrigerated centrifuge x1, -20°C freezer x 1, a household fridge, pharmaceutical refrigerator x 2 (4-8 °C) and a portable incubator.

Sabah State Ministry of Health and Infectious Diseases Society of Kota Kinabalu, (A/Prof Yeo Tsin Wen)

The Sabah State Ministry of Health is responsible for the clinical care for the Malaysian State of Sabah which an estimated population of 3.5 million. Hospital care is provided by 14 Hospitals (2 Tertiary and 12 District Hospitals) and outpatient care through an extensive network of outpatient polyclinics. These facilities are located throughout the State including several in near proximity to primary and secondary rainforest with a high degree of biodiversity. These facilities can be selected for the clinical studies depending on the areas assessed to be at high risk for viral zoonotic crossover.

There is also a Clinical Research Centre (CRC) attached to the Sabah Ministry of Health which will assist in the conduct of clinical studies in these facilities, including ensuring it is done according to good clinical practice, (GCP).

The Infectious Diseases Society of Kota Kinabalu (IDSKK) is a non-governmental organization who in collaboration with the Sabah Ministry of Health conducts clinical infectious diseases research of relevance to Sabah.

Information Technology Access

The Sabah State Ministry of Health and Infectious Diseases Society of Kota Kinabalu both are equipped with high-speed internet access that allows for communication across international partners. The administrative office at IDSKK has Microsoft Office access and also access to clinical data management platforms such as REDCAP.

Biological Sample Storage and Access

IDSKK currently has 6 administrative and 4 laboratory staff and is based in Kota Kinabalu. The laboratory in Kota Kinabalu has a BSL-2 biosafety hood for sample processing, ultra-low freezers and liquid nitrogen freezers, multiple centrifuges, microscopes and PCR machines. Outside of Kota Kinabalu, it also has biosafety hoods, ultra-low/liquid nitrogen freezers and centrifuges which are mobile and can be located at selected health facilities within the state. The mobility was demonstrated in several collaborative studies funded by Australian and European funders where the laboratory facilities were relocated several times. The logistical

chain with the main laboratory in Kota Kinabalu was also demonstrated during these projects with samples transported back from various district hospitals using transport provided by the Sabah Ministry of Health and local means.

Nanyang Technological University (NTU) - Lee Kong Chian School of Medicine, Singapore (A/Prof Yeo Tsin Wen)

Nanyang Technological University, Lee Kong Chian School of Medicine currently employed about 400 staffs, which includes researchers and faculty members. It occupies two buildings, Experimental Medicine Building and Clinical Sciences Building, in which they are situated in Nanyang Technological University, 59 Nanyang Drive Singapore 636921 and at Novena, 11 Mandalay Road, Singapore 308232 respectively. The information technology available is similar to that detailed above for EcoHealth Alliance.

Information Technology Access

Nanyang Technological University, Lee Kong Chian School of Medicine is equipped Internet access and video conferencing facilities to facilitate easy communication between collaborators. The University provides IT and AV assistance through its Information Technology department.

Biological Sample Storage and Access

NTU has various facilities integrated in the school relevant for this study. They are namely multiple BLS-2 level facilities, dedicated samples processing rooms for viral and pathogens and multiple sequencers (Illumina Mi-SEQ and Oxford Nanopore Platforms) with bioinformatics support. The University also has a biobank facility that aims to provide a facility to aid researchers to store biological specimens for future clinical research purposes. The biobank currently holds several ultra-low freezers and liquid nitrogen freezer at Experimental Medicine Building and Clinical Sciences Building. These will all be available for the study if required for sample processing, sample storage and sequencing.

Other core facilities available for use include Flow Cytometry Facility, histology core facility and medical imaging.

Major Equipment

EcoHealth Alliance, New York, USA (Drs. Daszak and Olival)

EcoHealth Alliance is equipped with fiber optic Internet access and video conferencing facilities to facilitate easy communication between collaborators. EcoHealth Alliance employees have around-the-clock access to servers, VPNs, encryption software, IT support, and all necessary software including Git and Github (Hosted software revision/audit service), Sublime and Vim text editors, Vagrant and Oracle Virtualbox virtual machines, Google Apps (Hosted email and collaboration web based software), Ansible (Server provisioning software framework), Python, NodeJS, and R programming languages, Meteor (Javascript framework), Bash shell scripts, Jenkins (Continuous Integration server), Microsoft Office and Adobe CS6 running on both Apple Mac OS X, Ubuntu linux, and Windows Operating Systems. EcoHealth Alliance has a dedicated quad-core Linux server and another dedicated dual quad-core Mac Pro Server - each with 4TB hard drives. Either server individually or in combination may be used for intensive computational modeling and/or database processing by all the grantees. Access to the cloud and supercomputing services (Amazon) is provided by core funding to EcoHealth Alliance.

University of North Carolina, Chapel Hill, USA (Drs. Baric and Sims)

BSL2 Facility. Equipment includes gel electrophoresis equipment, power supplies, thermal cyclers, a programmable heat block, heat blocks, water baths, CO₂ incubators (2), several -70°C freezers, one -140°C freezer, refrigerators, DNA documentation system, DNA sequencing and computer assisted sequence analysis programs, several microfuges, two Nikon microscopes with photographic and fluorescent capabilities, several class 2 environmental hoods, refrigerated water baths, several IBM and Apple Pentium II/III computers with accompanying software, three thermocyclers, a fume hood, Nuclisens reader, hybridization oven, real time thermocyclers, three fluorescent inverted scopes with computer software (Olympus IX51), and a spectrophotometer. A Roche Light Cycler 480II is available for real time measurements. The laboratory has an ELISA plate reader, an illuminometer, 200 cages for animal maintenance and breeding in Seal-Safe housing, Bio Rad low pressure chromatography system, ELISA plate washer, spectrophotometers, and other equipment that is routinely used in characterizing antibody-protein interactions.

BSL 3 Facility. The BSL3 facilities are in an adjacent, attached building (b) (4) and in (b) (4), the latter space is directly adjacent to Dr. Baric's BSL2 laboratory resources. Each facility is equipped with sterile hoods (BSCIIA), four CO₂ incubators, gel electrophoresis equipment, thermal cyclers and power supplies, and related equipment necessary for virus cultivation and molecular genetic research. The facilities each house a -70C freezer, an inverted Nikon fluorescent microscope with an assortment of filters, magnifications and digital camera, an ELISA plate reader and illuminometer. Both facility contain rodent-sized Seal- Safe systems (~192 cages) for maintaining animals in a Hepa-filtered Air in/out environment, exhausted into the BSL3 Hepa-filtered exhaust system. An 8 chamber Buxco plethysmography system which allows for repetitive, noninvasive measures of the number of breaths, tidal volume, airway responsiveness, enhanced pause, respiratory gases, etc. from live control and infected mice in a contained system is available in the main BSL3 laboratory in (b) (4).

Duke-NUS Medical School, Singapore (Drs. Wang and Anderson)

Laboratory of One Health Approach to EID: It is fully equipped with 2 biological safety cabinets, cell culture incubators, RT-PCR, freezers, centrifuges that are required to conduct the experiments described in the proposal.

Duke-NUS Emerging Infectious Diseases Research Programme: The Emerging Infectious Diseases Signature Research Program provides common equipment for PIs for their research in emerging infections. The list of equipment is exhaustive, including but not limited to the following: Bio-Rad Bioplex 200, Cell Disrupter, Centrifuges, Cytospin, Electroporation system, ELISA reader, FPLC, Freezers, Gel Documentation system, incubators, microplate reader, microplate washer, inverted fluorescence microscope, upright fluorescence microscope, Real-Time PCR, refrigerator, pH meter, protein crystallography system, PryoMark Q96D, Rotor Gene Q, QIAextractor, Nanodrop, Speedvac system, 96 well thermocyclers, vacuum pump motor, vacuum aspiration system, Qiacube, Beckman Coulter Counter, Luminex, bacteria shaker incubators.

Duke-NUS Institutional shared resources: The shared equipment provided by Duke-NUS for use by any researcher in Duke-NUS includes but are not limited to: Applied Biosystems HT7900 RT-PCR, Beckman Coulter AcT Diff Automated Cell Counter, Beckman FC500 Flow Cytometer, Scintillation Counter, Biorad Benchmark Plus Microplate Reader, Biorad CFX96RT PCR, FACS analyser, Spectrophotometer, ImageQuant, Confocal Microscope, Nanodrop, Fluorescent Microscope, Stereozoom microscope, Cellomics high throughput microscope and ABSL3 containment facilities.

Uniformed Services University, Bethesda, USA (Drs. Broder and Laing)

The Biostatistics Consulting Center (BCC), a service of the Department of Preventive Medicine and Biometrics, provides statistical consulting to USUHS scientific investigators. We routinely consult with Cara Olsen, Research Assistant Professor (the full-time Biostatistics Consultant of the BCC), regarding proper design of experiments for statistical testing and for statistical analysis of the resulting data.

The USU Translational Imaging Facility (TIF) houses state-of-the art equipment for live animal imaging, including a Siemens Inveon SPECT/PET/CT Scanner, a Bruker Biospec 70/20 USR Magnetic Resonance Imaging system, and a Bruker In-Vivo Xtreme II bioluminescence and X-ray imaging system.

The USU Biomedical Instrumentation Center (BIC) houses core equipment for use by investigators throughout the University. Instrumentation is available either free or on a fee-for-service basis, depending on which instruments have annual service contracts (which are paid largely through per-hour use fees). The BIC Flow Cytometry Core includes two Becton-Dickinson (10- and 13-parameter) LSRII FACS analyzers, one 15-parameter FACSAria FACS sorter, and one Amnis Image Stream X Mark II imaging flow cytometer, as well as off-line analysis workstations.

The BIC Imaging Core houses three confocal microscopes, including a Zeiss 700 inverted system with 405/458/488/514/561/633 laser excitation; a Zeiss 710NLO inverted system with 405/458/488/514/561/633 conventional lasers and a Coherent Ultra2 Ti-Sapphire laser for multiphoton excitation, continuously tunable over the range of 690 to 1080 nm; and a Zeiss AxioExaminer-Z1 upright microscope equipped with a direct-coupled Coherent Chameleon tunable infrared laser for ex vivo and in vivo multiphoton imaging projects. A Becker-Hickl two-detector FLIM system (for FRET analyses) is connected to the inverted Zeiss 710NLO system. Recently, the BIC has also acquired a Zeiss Elyra PS.1 super-resolution microscope, which is capable of 4-parameter SR-SIM (super-resolution structured illumination) imaging, 3-parameter PALM (Photoactivation localization microscopy) and dSTORM (direct stochastic optical reconstruction microscopy), as well as 3D-PALM/dSTORM. The BIC also houses a Leica AF6000 system, consisting of an inverted microscope equipped with a fully motorized 3-axis stage plus atmosphere and temperature control, allowing extended term (days) live cell analyses. Additionally, there is a stereology system consisting of a Zeiss AxioImager.M2 upright microscope connected to MicroBrightField's Stereo Investigator software package. The facility also includes several additional wide-field fluorescence microscopes, and three offline data analysis stations with software packages including: Zeiss Zen software and full Physiology package; Media Cybernetics' 3D Constructor, Image Pro Analyzer, Autodeblur, and Autovisualize; Metamorph Basic. The Imaging Core also includes a transmission electron microscope (Philips CM100 transmission EM) and an ultramicrotome (Leica EM UC6 with EM FC6 cryo attachment).

The BIC Genomics core includes an ABI 3900 DNA synthesizer, an ABI3500xl Genetic Analyzer (for sequencing), a Roche LightCycler 480 for real-time PCR, and Systec Mediaprep and Plate Pourer instrument. There is also an integrated Fuji FLA-5000/LAS-3000 imaging system for many applications that involve fluorescence and chemiluminescence imaging of gels and blots. The BIC Proteomics Core includes two Agilent 1100 HPLCs, an AB SCIEX Voyager DSTR MALDI-TOF mass spectrometer, and an AB SCIEX Q-TOF tandem mass spectrometer.

The BIC Structural Biology Core includes a Rigaku HighFlux HomeLab X-ray diffraction system, with a MicroMax-007 HF microfocussing rotating anode generator, an R-Axis Imaging Plate detector, and an X-stream 2000 cryogenic system. Other available BIC instruments and services include histopathology and PET/CT instrumentation for small animal research.

National Emerging Infectious Diseases Laboratories (NEIDL), Boston, USA (Drs. Keusch and Corley)

The NEIDL has much of the major instrumentation necessary to carry out modern virology and microbiology, molecular biology, and immunologically related research. Included are imaging facilities containing a Leica Confocal Microscope, Zeiss 200M with conventional and oil immersion (100x, 63x) lenses and climate-controlled stage and time lapse, mosaic and optical sectioning capacities, a Nikon Ti2-E microscope (equipped with high quality objectives including 100x oil immersion lambda NA 1.45 lens and a Photometrics sCMOS camera), and Biotek Cytation high throughput imaging system with an automated plate loader and Autoquant software, EVOS fluorescent cell imager, and other standard compound and inverted microscopes. For immunological analysis, dedicated flow cytometer analyzers are available (BD LSRFortessa, LSR II), Biorad Bioplex 200 analyzers, automated ELISPOT readers, Beckman L90K ultracentrifuges at every biocontainment level, as well as superspeed, micro and tissue culture centrifuges, various plate readers (Tecan M200 and M100), Odyssey CLx infrared imager, ELISA readers, etc.

For nucleic acid analysis the NEIDL has real time PCRs (BioRad qRT-CFX-96, Quantstudio 6) as well as conventional PCR machines, gel box and purification systems, gel documentation systems and all essential molecular biology equipment. For RNA work, dedicated laboratory preparation stations are available, and there is access to Qiagen QiaCubes for automated RNA preparation, sequencers (Illumina MiSeq, MinION nanopore sequencer with two dedicated computers that allow parallel run-and-analysis), and nanodrop and a BioAnalyzer for nucleic acid analysis and RNA quality determination.

For work with animals, instrumentation includes clinical chemistry and hematology systems (Drew Scientific Hemavet 950 FS multi-species automated hematology system, Abaxis Vetscan VS2 and Clinical Chemistry Analyzers, Abaxis Piccolo Xpress Chemistry Analyzer, Abaxis VSpro for coagulopathies. The NEIDL also houses a Bruker 4.7T MRI, CT scan and IVIS scan instrumentation for live animal monitoring. An extensive aerobiology suite with instrumentation allows aerosol delivery of pathogens or therapeutics to animals from mice to non-human primates. Class III glovebox biosafety cabinet and animal transfer modules are in the facility as well.

Thai Red Cross Emerging Infectious Diseases Health Science Centre (TRC-EID), Faculty of Medicine, Chulalongkorn University Hospital, Thailand (Drs. Hemachudha and Wacharapluesadee)

TRC-EID has 28 deep freezers (-80°C), 10 -20°C refrigerators, and 11 standard refrigerators, and our own electric generator for backup. The laboratory is fully equipped with biosafety cabinet class IIs, centrifuges, conventional PCR systems, real-time PCR systems (including fast real-time systems), extraction machines, gel documentation system, dehumidifiers, electrophoresis and NGS (Illumina MiSeq). TRC-EID also has biosafety level III biological glovebox which increases efficiency in working with highly dangerous pathogens without delay. Further, TRC-EID has access to shared facilities with Chula Medical Research Center, Faculty of Medicine, Chulalongkorn University.

Conservation Medicine Ltd, Kuala Lumpur, Malaysia. (Mr. Hughes, Ms. Lee, Mr. Lee)

Conservation Medicine is equipped with office space, laptop computers, internet, mobile phones, GPS units, and three 4WD vehicle fully equipped for field transportation to remote field sites (two in Peninsular Malaysia and one in Sabah). CM maintains wildlife capture equipment and supplies for biological sample collection from humans and animals and liquid nitrogen dry shippers for ensuring cold chain during transport of biological samples from field to lab for both PM and Sabah. CM has supplies of personal protective equipment for all field and lab staff, including PAPRs and N95 respirators, gloves and disposable coveralls. CM maintains close communication with Ministry of Health and the National Public Health Laboratory (NPHL), Department of Wildlife and National Parks (DWNP), Faculty of Veterinary Medicine Universiti Putra Malaysia (FVMUPM), Department of Veterinary Services, SWD, Sabah State Health Department, Kota Kinabalu Public Health Laboratory (KKPHL) and Universiti Malaysia Sabah on behalf of EHA, and CM staff work closely with government partners to implement PREDICT, IDEEAL and DTRA field and lab activities.

Borneo Medical and Health Research Centre (BMHRC), Universiti Malaysia Sabah, (Dr. Kamruddin & Dr. Lasimbang)

Borneo Medical and Health Research Centre (BMHRC) is equipped with LAN and wireless Internet access and meeting room facility to facilitate easy communication between collaborators. BMHRC users have around-the-clock access to servers, VPN, encryption software, IT support, and all necessary software. BMHRC also has ion

torrent, high performance computer with 11 TB hard drive, 49 GB RAM, and dual Xeon processor with 24 cores. Along with other equipment or software, BMHRC has complete virtue Ubuntu 16.04 with support bioinformatic and the tools such as Oracle Virtualbox virtual machine, Google Apps, NodeJS, R programming languages, Bash shell script, Microsoft Office and Open Office. Ubuntu Linux and window operating system also provided by core funding to BMHRC.

BMHRC has a laboratory equipment facility such as light microscopes, incubators, shaking incubator, magnifying lamp, -80°C freezer, refrigerator for reagents (4°C), refrigerated centrifuge, thermal cyclers, next generation sequencer (ion torrent), water bath, laminar air flow, digital droplet PCR, flow cytometer, and autoclave machine.

Queen Elizabeth Hospital (QEH), Kota Kinabalu, Sabah, Malaysia (DrsHeng Gee Lee and Giri Shan Rajahram)

The QEH Clinical Research Centre (CRC) is equipped with Internet access and video conferencing facilities to facilitate communication between collaborators. QEH CRC has important software including Microsoft Office, Adobe, and Stata 12 running on Windows Operating Systems. CRC QEH is also equipped with office space, computers, internet, and phones. QEH has supplies of personal protective equipment for lab staff, including N95 respirators, gloves and disposable coveralls.

Sabah State Ministry of Health and Infectious Diseases Society of Kota Kinabalu, (A/Prof Yeo Tsin Wen)

The equipment located in Kota Kinabalu which will be available for the proposed studies include a dedicated research laboratory with the following: a BSL-2 biosafety hood for sample processing, multiple high speed/normal centrifuges, microscopes, PCR machines, ultra-low freezers and liquid nitrogen freezers. It also has a high speed internet access and dedicated laboratory computers for sample database documentation and record keeping. There is 4 laboratory staff based in Kota Kinabalu who are also rostered to attend to the freezers in case of any power outages or other emergencies.

Outside of Kota Kinabalu, there are additional biosafety hoods, ultra-low/liquid nitrogen freezers and centrifuges which are mobile and can be located at selected health facilities within the state which will be adequate for sample processing and storage for the clinical studies proposed for this project.

For shipment of the samples within the state of Sabah, there liquid nitrogen dry shippers for transport of samples from selected district hospitals or health facilities to the main laboratory in Kota Kinabalu. For overseas shipments, there are also liquid nitrogen dry shippers or commercial couriers available.

Technological University (NTU) - Lee Kong Chian School of Medicine, Singapore (A/Prof Yeo Tsin Wen)

The laboratories in Lee Kong Chian School of Medicine from both schools are equipped with a number of core equipment that are to be shared among the many researchers in the school. Big core equipment includes at least 2 biosafety cabinets on each floor of the 2 buildings, CO2 incubators from Nuaire and ESCO, drying ovens, electroporator, 1 flow cytometer, a number of gel doc system, high pressure homogenizer, a number of incubators from Incucell and Thermo Scientific, water purification system from MilliQ and 2 X-ray film processor. The laboratories are also equipped with transilluminators, spectrophotometers, sonicators, QRT PCR and PCR machines and 1 stereomicroscope from Leica.

Common equipment includes a number of autoclaves and cell counters, Bio-Plex multiplex array system, Cobas biochemistry and immunoassay analyser, a number of gyratory rocker, sufficient number of ice machines, a few of Eppendorf vacuum concentrator, quite a number of tissue culture microscopes from Leica for IVD phase contrast, 3 TS100 inverted brightfield and phase contrast from Nikon, 1 TS100 inverted brightfield without phase contrast. Water baths, tube rollers, shaking incubators, centrifuges (high speed, swing bucket and ultracentrifuge), orbital shakers and rotators are provided sufficiently to keep up with the use from each Principal Investigators in Lee Kong Chian School of Medicine.

Specialized equipment includes Histology equipment that includes equipment from Leica: 1 Flattening table, 1 Histology Water Bath, Microsystem – Automated Vacuum Tissue Processor, Tissue Embedding Instrumentation, Cryostat, Motorised Rotary Microtome. We have a few specialized microscopes and they include wide-field

fluorescent upright microscope from Leica, an upright Axio Z2 confocal microscope with LSM 800 2-PMT from Carl Zeiss, Inverted Axio Observer, Z1 confocal microscope with LSM 800 2-GaAsp detector from Carl Zeiss, Ti-E inverted spinning disk confocal system from Nikon as well as a high modality total internal reflection microscope from Nikon.