Accelerated Defense against Emerging Pathogen Threats

“Opinions, interpretations, conclusions, and recommendations are those of the author and are not necessarily endorsed by the U.S. Army.”
Parallel approaches; **all pieces move at the same time**

**Multiple rapidly-deployable technologies;** only platforms with that potential will be included

Amenable to implementation using the highest level of Biosafety & Biosecurity

**Product-driven; 100% focus on countermeasure development**

**Access to cutting-edge technology, equipment and throughput**

**Pathogen Agnostic** (applicable to known and unknown pathogens)

Use of **well characterized in vitro & in vivo** models when available

For novel pathogens, pre-established templates based on known pathogens to fill knowledge gaps

**Open access**, data shared in **real time**
<table>
<thead>
<tr>
<th><strong>New Paradigm</strong></th>
<th><strong>Current Model</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Integration by design</td>
<td>Lack of coordination</td>
</tr>
<tr>
<td>Top-down management</td>
<td>Individual projects</td>
</tr>
<tr>
<td>Parallel approaches</td>
<td>Non-parallel approaches</td>
</tr>
<tr>
<td>Pre-arranged funding</td>
<td>Use of academic R&amp;D timeline</td>
</tr>
<tr>
<td>Fast deployment after activation (all components in place)</td>
<td>Late engagement of R&amp;D resources</td>
</tr>
<tr>
<td>Flexible choice of approaches</td>
<td>Individual approaches</td>
</tr>
<tr>
<td>Early engagement of regulatory bodies</td>
<td>Erratic regulatory processes</td>
</tr>
<tr>
<td>Risk-benefit platform</td>
<td>No risk-benefit analysis</td>
</tr>
<tr>
<td>Pre-established handling of IP</td>
<td>Legal slow down due to IP concerns</td>
</tr>
<tr>
<td>Clinical protocols established under IND</td>
<td>Global controversy regarding appropriate clinical trial design</td>
</tr>
</tbody>
</table>
Lessons learned from the Ebola virus outbreak response

- R&D for neglected diseases remains inadequate
- No organized system exists for distributing new medical products world-wide as soon as they become available
- WHO’s interim report on the Ebola response highlighted several areas where improvement is needed; e.g.,
  - Earlier engagement for fast-tracking experimental vaccines and therapies
  - “WHO’s ability to partner with non-State actors in the Ebola crisis was not as strong as needed. These relationships cannot be established during crises, but need to be developed when building preparedness”
  - “…determination of a Public Health Emergency of International Concern (PHEIC) is a single binary decision” An intermediate level would alert and engage the wider international community at an earlier stage and facilitate preparedness

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1Assessment of the WHO Ebola Interim Panel into Research & Development during the Ebola Outbreak, WHO Report, 2015
**ADEPT**

**Phase I**
- 2 weeks
- Mobile Pathogen Discovery and Characterization Laboratory
  - Detection
  - Identification
  - Sequence Characterization
  - Sample acquisition

**Phase II**
- 1-7 weeks
- Synthetic Biology
  - Reverse Genetics
- Propagation
  - “In Vitro” Research Use Assay Development
- Challenge Stock Characterization
- Animal Model Development

**Phase III**
- 2-52 weeks
- Diagnostic Development Track
- Therapeutic Development Track
- Rapid Vaccine Development Track
- Passive Immunotherapy Development Track

**Phase IV**
- Infectious Disease Rapid Response Medical Team
  - Acquisition of clinical data to inform animal model & MCM development

**Human Clinical Trials**

**Plasmapheresis Mobile Unit**
- Plasma collection
- Treatment of Plasma for Viral Inactivation
- Pathogen Safety Testing

**Novel Pathogen Outbreak**

**Animal Model Development**
**ADEPT**

**Mobile Pathogen Discovery and Characterization Laboratory**
- Detection
- Identification
- Sequence Characterization
- Sample acquisition

**Infectious Disease Rapid Response Medical Team**
- Acquisition of clinical data to inform animal model & MCM development

**Plasmapheresis Mobile Unit**
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---

**Novel Pathogen Outbreak**

**Phase I**
- 2 weeks

**Phase II**
- 1-7 weeks

**Phase III**
- 2-52 weeks

---

Day 0 activates

Phase IV
Day 0
Activates
Mobile Pathogen Discovery and Characterization Laboratory
- Detection
- Identification
- Sequence Characterization
- Sample acquisition

Infectious Disease Rapid Response Medical Team
- Acquisition of clinical data to inform animal model & MCM development

Plasmapheresis Mobile Unit
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Synthetic Biology Reverse Genetics

Propagation “In Vitro” Research Use Assay Development

Propagation “In Vivo”

Challenge Stock Characterization

Animal Model Development

Phase I
2 weeks

Phase II
1-7 weeks

Phase III
2-52 weeks

Phase IV
Novel Pathogen Outbreak

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Diagnostic Development Track

Therapeutic Development Track

Rapid Vaccine Development Track

Passive Immunotherapy Development Track

Animal Model Development

Synthetic Biology Reverse Genetics

Propagation “In Vitro” Research Use Assay Development

Challenge Stock Characterization

Phase I
2 weeks

Phase II
1-7 weeks

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2-52 weeks

Phase IV

Day 0 activates ADEPT
**Novel Pathogen Outbreak**

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**Diagnostic Development Track**
- Real Time PCR assays
- Serological assays (Lateral flow assays and traditional ELISAs)
- Syndromic panel assays (for differential diagnosis)
- Companion assays (assays to facilitate Human Clinical research; like quantitative real time PCR assays for viral load monitoring; plaque neutralization assays for vaccine response evaluation, etc).

**Animal Model Development**

**Synthetic Biology Reverse Genetics**

**Propagation “In Vitro”**

**Challenge Stock Characterization**

**Phase I**
- 2 weeks
- Phase II
- 1-7 weeks
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- 2-52 weeks

Day 0 activates

**ADEPT**
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Synthetic Biology Reverse Genetics

Propagation “In Vitro” Research Use Assay Development

Propagation “In Vitro”

Challenge Stock Characterization

Therapeutic Development Track
- High Content Imaging Platform
  1. Qualified assays for all 8 WHO prioritized pathogens + Zika and CHIK
  2. Utilizes authentic BSL-3/4 pathogens
- Strength of biopharmaceutical relationships
  1. Source of high quality clinical candidates and libraries
  2. Robust supporting data (PK, safety, CMC, regulatory filings) and drug development experience
  3. Significant contributions of in-kind support (PK, tolerability, formulation)
  4. Legal agreements and active collaborations with multiple companies in place.

Animal Model Development
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Synthetic Biology
Reverse Genetics

Propagation “In Vitro” Research Use Assay Development

Propagation “In Vitro”

Challenge Stock Characterization

Passive Immunotherapy Development Track
Ongoing collaborations with commercial partners that have the capabilities to identify or generate human B cells specific for a pathogen of interest for the purpose of rapid generation of antibody treatment.

Mapp Biopharmaceutical, Chiome, Adimab, SAB Therapeutics and other commercial companies are partners in this line of research

Animal Model Development

Day 0 activates ADEPT

Phase I
2 weeks

Phase II
1-7 weeks

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2-52 weeks

Phase IV

Novel Pathogen Outbreak

Infectious Disease Rapid Response Medical Team

Mobile Pathogen Discovery and Characterization Laboratory

Plasmapheresis Mobile Unit

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Propagation “In Vitro” Research Use Assay Development

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**Rapid Vaccine Development Track**
Several platforms: DNA and RNA vaccines, vectored recombinant vaccines.

Plug&Play modular platforms

USAMRIID has tested these products against a wide range of human pathogens including all filovirus.

- Easily Manufactured
- Safe or moderately safe
- Successfully developed and performed pre-clinical testing on DNA vaccines for various biothreat agents including Arenaviruses, Bunyaviruses, Filoviruses, and Flaviviruses
- Experience in Phase 1 and Phase 2 clinical trials
- Existing collaborations with several industrial partners

**Animal Model Development**

**Propagation “In Vitro”**

**Challenge Stock Characterization**

**Synthetic Biology**

Reverse Genetics

**Research Use Assay Development**

**In Vitro” Research Use Assay Development**

**Day 0**
activates

**ADEPT**

**Phase I**
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**Phase IV**
ADEPT

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Diagnostic Development Track

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Challenge Stock Characterization

Human Clinical Trials
• **Stand-By: Pre-outbreak situation**
  - Table-top exercises
  - Readiness-level assessments
  - Maintenance of critical regulatory elements (IACUC protocols, human-subjects research exemptions)
  - Maintenance of animal colonies, critical reagents and challenge stocks
  - Preparation of plans of action for known especially dangerous pathogens (EDP) such as CCHFV, MARV, SUDV, etc.

• **Activation:**
  - Full deployment for a novel agent (“unknown unknown”)
  - Tailored deployment from prepositioned EDP response plans
Decision to activate:

- WHO’s interim report recommendation to establish an intermediate level of alert (prior to declaring a PHEIC) could trigger ADEPT

- Pre-arranged lines of funding identified

- The activation will be adopted by Public Health officials; not by subject-matter experts involved in R&D
USAMRIID & ADEPT

- USAMRIID has broad expertise in Emerging Diseases and EDP
- Strong programs in developing diagnostics, therapeutics, and vaccines for clinical use
- BSL2, BSL3, BSL4 containment, with increase dramatically BSL-4 space in the new facility
- Established relationships with regulatory bodies
- Ongoing partnerships with most major players in the commercial sector
- Integration of clinical, expeditionary and regulatory teams
- Can immediately employ extensive DNA vaccine technology in all ADEPT tracks
ADEPT MANAGEMENT STRUCTURE

GENEVA FOUNDATION
Scientific Advisory Board or Management Committee

Eight (8) internal members (Geneva & USAMRIID)
Four (4) External permanent members
Additional interim members during activation

External members:
WHO, CDC, E-CDC, MSF, ONG and Funding agencies representatives
On activation, Ministries of Health of the affected countries and Local SMEs will also be represented

Principal Investigator
(Day to Day activities; Handling interactions with other Agencies; Reporting)

Chief Operations Officer

Legal Counsel / IP issue
Assistant

Finance Counsel
Assistant

Administrative / IACUC / IRB
Assistant

IT Counsel
Open Access Implementer

Expeditionary Group
Program Coordinator

On site Activities
Program Coordinator

Clinical Activities
Program Coordinator
## ENGAGEMENT WITH INTERNATIONAL COLLABORATORS FROM LMIC

<table>
<thead>
<tr>
<th>Top Priority Agent</th>
<th>LMICs Country</th>
<th>International collaborator</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ebola</td>
<td>Liberia</td>
<td>Dr. Fatorma Bolay</td>
<td>Director Liberian Institute of Biomedical Research</td>
</tr>
<tr>
<td></td>
<td>Sierra Leone</td>
<td>Dr. Augustine Goba</td>
<td>Kenema Laboratory Director</td>
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<td></td>
<td>Turkey</td>
<td>Dr. Onder Ergonul</td>
<td>Professor of Infectious Diseases</td>
</tr>
<tr>
<td></td>
<td>Georgia</td>
<td>Dr. Gvantsa Chanturia,</td>
<td>Research scientists, National Center for Disease Control and Public Health of Georgia</td>
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<tr>
<td></td>
<td></td>
<td>Dr. Giorgi Babuadze</td>
<td></td>
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<tr>
<td></td>
<td>Greece</td>
<td>Dr. Anna Papa</td>
<td>Professor Department of Microbiology, Aristotle University Medical School, Thessaloniki, Greece</td>
</tr>
<tr>
<td></td>
<td>Slovenia</td>
<td>Dr. Tatjana Avsic-Zupanc</td>
<td>Professor, Faculty of Medicine, University of Ljubljana</td>
</tr>
<tr>
<td></td>
<td>Mongolia</td>
<td>Dr. Damdindorj Tserennorov</td>
<td>National Center for Zoonotic Diseases, Ulaanbaatar, Mongolia</td>
</tr>
<tr>
<td></td>
<td>Egypt</td>
<td>Dr. Emad Mohareb</td>
<td>Research Scientist</td>
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<tr>
<td></td>
<td>Bulgaria</td>
<td>Dr. Iva Christova</td>
<td>Professor, National Reference Tick-borne Infections Laboratory</td>
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<td></td>
<td>Ghana</td>
<td>LT Joe DiClaro</td>
<td>Ghana Detachment, NAMRU-3, Accra, Ghana</td>
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During periods of stand-by mode, ADEPT personal would develop and update “Agent specific R&D Plans” for each agent, based on available knowledge and recognized knowledge gaps.

The management committee would identify Knowledge gaps to fill during stand-by periods.

<table>
<thead>
<tr>
<th>Agents</th>
<th>Genomic Diversity available</th>
<th>Clinical data available</th>
<th>Potential for immunotherapy</th>
<th>Reverse Genetic System</th>
<th>Small animal model</th>
<th>NHP model</th>
<th>Relevant to the Human disease</th>
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<tr>
<td>Ebola</td>
<td>YES</td>
<td>Partial</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
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<tr>
<td>Sudan</td>
<td>YES</td>
<td>Minimal</td>
<td>YES</td>
<td>Yes/not at USAMRIID</td>
<td>YES</td>
<td>YES</td>
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**Expeditionary Phase I**

<table>
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<tr>
<th>Agents</th>
<th>Experimental / IND vaccines tested</th>
<th>Biologicals successfully tested</th>
<th>Experimental or IND therapeutic tested</th>
<th>Qualified Molecular Detection</th>
<th>Qualified Serological Detection (IgM/IgG)</th>
<th>Qualified Companion Assays (qPCR)</th>
<th>Clinical Trial model available for the Agent</th>
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DNA Vaccines: USAMRIID’s all purpose platform

- DNA vaccines for known or novel pathogens can be produced within a week
- Unnecessary to construct or maintain a manufacturing facility as existing commercial sources can rapidly and inexpensively produce laboratory or clinical grade DNA
- Well-established methods and regulatory processes for DNA vaccines can expedite human use approval
- DNA vaccines can also be used to produce antigens for diagnostics, to test immunogenicity of specific gene products, to generate immune sera for therapy, and to determine novel properties of pathogens
USAMRIID & ADEPT

USAMRIID has agreements in place with the following collaborators:
ADEPT is a state-of-the-art integrated team approach to rapid outbreak response. By using parallel research tracks and a real-time open access format, ADEPT will reduce the time-to-response while ensuring and facilitating communication and analysis by the whole scientific community.
BACKUP SLIDES

Examples of USAMRIID’s expertise and accomplishments related to ADEPT
USAMRIID’s DNA vaccines have proven utility in all four tracks

- **Vaccines:**
  - USAMRIID has developed and tested candidate DNA vaccines for numerous highly pathogenic viruses; e.g., HTNV, PUUV, VEEV, EEEV, WEEV, TBEV, LASV, JUNV, RVFV, CCHFV, EBOV, MARV, SUDV, VACV, ZIKV
  - USAMRIID has an effective regulatory group with extensive experience developing INDs for submission to the U.S. FDA
  - USAMRIID has conducted Phase 1 and Phase 2 clinical studies of DNA vaccines at USAMRIID, the WRAIR Clinical Trials Center, and at a CRO
  - USAMRIID has clinically evaluated gene gun, muscle electroporation, skin electroporation and needle free jet injection of DNA vaccines
USAMRIID’s DNA vaccines have proven utility in all four tracks

- **Reagents, therapeutics, assays, structural mapping:**
  - DNA vaccination of transchromal bovines used to generate human antibodies for passive protection
  - DNA vaccination of avians (ducks and geese) used to produce polyclonal antibodies for post exposure prophylaxis
  - DNA vaccination of mice to produce monoclonal antibodies and of rabbits to produce large quantities of polyclonal sera for diagnostics
  - DNA vaccine plasmids used to develop potency assays
  - DNA vaccine plasmids used to produce proteins for structural studies and monoclonal antibody mapping
  - DNA vaccine plasmids used to generate antigens and virus-like particles for diagnostic assays (e.g., VSV pseudovirion neutralization assays).
Years of Preparation Pay Off with Assay Used in Current Ebola Outbreak

As the world sees the deadly Ebola outbreak grip large parts of Africa, scientists working for DTRA CB/JSTO are racing to develop ways to rapidly diagnose and counter the disease. This race may be running quickly now, but years of careful preparation led to what is now a possible game-changing assay.

On August 5, 2014, the U.S. Food and Drug Administration (FDA) announced the Emergency Use Authorization (EUA) of the EZ1 Diagnostic Assay, a molecular diagnostic assay effective for diagnosing Ebola Zaire virus. The test is for the presumptive and qualitative diagnosis of the Ebola Zaire virus strain in the current West African outbreak. The assay is intended for use with whole blood (inactivated) or plasma from individuals with signs and symptoms consistent with Ebola virus infection, individuals who are deemed to be at risk for exposure or individuals who may have potentially been exposed to the Ebola Zaire virus strain based on epidemiological risk factors. This is the first case of any biothreat agent assay that was pre-positioned (pre-EAU) with the FDA prior to an outbreak. It is also the first case of a DTRA CB/JSTO-funded diagnostic assay being implemented for emergency use.

Work on the EZ1 assay was a collaborative effort solicited and funded by DTRA CB/JSTO, developed by the U.S. Army Medical Research Institute for Infectious Disease (USAMRIID) and transitioned and manufactured by the Joint Program Executive Office (JPEO)-Medical Countermeasure Systems (MCS). In 2011, as part of a bio-preparedness initiative to pre-position the Department of Defense (DoD) in the case of an outbreak, the EZ1 Diagnostic Assay was submitted to FDA for pre-EUA status along with 72 other diagnostic assays determined to have a high-

(continued on page 2)
Real time genomic sequencing generates actionable information for outbreak control and management.

April 19, 2015

**Sexual and reproductive health**

**Interim advice on the sexual transmission of the Ebola virus disease**

**May 8, 2015**

**Molecular Evidence of Sexual Transmission of Ebola Virus**

**Dec 17, 2015**

A suspected case of sexual transmission from a male survivor of Ebola virus disease (EVD) to his female partner (the patient in this report) occurred in Liberia in March 2015. Ebola virus (EBOV) genomes assembled from blood samples from the patient and a semen sample from the survivor were consistent with direct transmission. The genomes shared three substitutions that were absent from all other Western African EBOV sequences and that were distinct from the last documented transmission chain in Liberia before this case. Combined with epidemiologic data, the genomic analysis provides evidence of sexual transmission of EBOV and evidence of the persistence of infective EBOV in semen for 179 days or more after the onset of EVD. (Funded by the Defense Threat Reduction Agency and others.)
Therapeutic efficacy of the small molecule GS-5734 against Ebola virus in rhesus monkeys

Travis K. Warren1,2, Robert Jordan1, Michael K. Le1, Adrian S. Ray1, Richard L. Mackman1, Veronica Soloveva1,2, Dustin Siegel1, Michel Perron1, Roy Bannister1, Hon C. Hui1, Nate Larson1, Robert Strickley1, Jay Wells1, Kelly S. Struthman1, Sean A. Van Tongeren1, Nicole L. Garza1, Ginger Donnelly1, Amy C. Shurtleff1, Cary J. Retterer1, Dima Gharaibeh1, Rouzbeh Zamani1, Tara Kenny1, Brett P. Eaton1, Elizabeth Grimes1, Lisa S. Welch1, Laura Gombal1,2, Catherine L. Wilhelmsen1, Donald K. Nichols1, Jonathan E. Nuss1,2, Elyse K. Nagle1, Jeffrey R. Kugelman1, Gustavo Palacios1, Edward Doerrfler1, Sean Neville1, Ernest Garra1, Michael O. Clarke1, Lijun Zhang1, Willard Lew2, Bruce Rose1, Queenie Wang1, Kwon Chun1, Lynda Wolfe1, Darius Babaei1, Yoselin Park1, Kirsten M. Stray1, Iva Trancheva1, Ivy Y. Feng1, Ona Barakauskaite1, Yili Xu1, Pamela Wong1, Molly R. Braun1, Mike Flint1, Laura K. McMullan1, Shan-Shan Chen1, Rachel Farrants1, Swami Swaminathan1, Douglas L. Mayers1,2, Christina F. Spiropoulou1, William A. Lee1, Stuart T. Nicholl1, Tomas Cihlar1, & Sina Bavari1,2

doi:10.1038/nature17180
WHO Category A: Drugs already under Evaluation in Formal Clinical Trials
In West Africa (18 February 2015)

<table>
<thead>
<tr>
<th>DRUG / COMPANY</th>
<th>DRUG TYPE</th>
<th>EBOLA PRECLINICAL PROOF OF CONCEPT (USAMRIID)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zmapp</td>
<td>Small inhibitory RNA which catalytically cleaves Ebola RNA once inside the cell. Sequence-specific to this strain of Ebola.</td>
<td>NHP: 67-100% efficacy among NHP given 4 to 7 doses with treatment initiated 30 minutes post-challenge.</td>
</tr>
<tr>
<td>TKM-100802 Tekmira</td>
<td>Small inhibitory RNA which catalytically cleaves Ebola RNA once inside the cell. Sequence-specific to this strain of Ebola.</td>
<td>NHP: 67-100% efficacy among NHP given 4 to 7 doses with treatment initiated 30 minutes post-challenge.</td>
</tr>
<tr>
<td>AVI-7537 Sarepta Therapeutics</td>
<td>Antisense polymorpholino oligonucleotide. Inhibits Ebola virus replication by binding to RNA in sequence-specific manner to VP24 gene. Specific to this strain of Ebola.</td>
<td>NHP: 100% survival for Marburg virus (using Marburg sequence) and 50–60% survival for Ebola using Ebola sequence.</td>
</tr>
<tr>
<td>BCX-4430 BioCryst Pharmaceuticals Inc</td>
<td>Novel broad-spectrum direct-acting nucleoside analogue.</td>
<td>NHP: Marburg virus—treatment at 15mg/kg starting 1, 24, or 48 hours after infection: 80–100% protection. NHP: Ebola — efficacy when administered 30-120 minutes post infection. Not efficacious at 48–72 hours. Mice: Ebola — 100% protection.</td>
</tr>
</tbody>
</table>

5 of 7 Category A EBOV therapeutics had initial animal proof of concept demonstrated in USAMRIID labs.
## USAMRIID & ADEPT

### Therapeutics

**Guide to categories for clinical-stage therapies**

<table>
<thead>
<tr>
<th>Category</th>
<th>Treatment</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>ZMapp</td>
<td>Mapp Biopharmaceutical</td>
</tr>
<tr>
<td>D</td>
<td>Favipiravir (Avigan)</td>
<td>Toyama Chemical (subsidiary of Fujifilm)</td>
</tr>
<tr>
<td>D</td>
<td>TKM-130803</td>
<td>Tekmira</td>
</tr>
<tr>
<td>D</td>
<td>Brincidofovir</td>
<td>Chimerix</td>
</tr>
<tr>
<td>D</td>
<td>Convalescent Plasma</td>
<td>N/A—not a commercialized product</td>
</tr>
<tr>
<td>D</td>
<td>Convalescent Blood</td>
<td>Cerus Corp.'s INTERCEPT system(^2) used in 3 trials</td>
</tr>
<tr>
<td>D</td>
<td>Interferon beta 1a</td>
<td>Several(^1)</td>
</tr>
<tr>
<td>E</td>
<td>BCX4430</td>
<td>Biocryst</td>
</tr>
<tr>
<td>E</td>
<td>MIL77</td>
<td>Institute of Basic Medical Sciences (IBMS) &amp; MabWorks</td>
</tr>
<tr>
<td>F</td>
<td>Amiodarone</td>
<td>N/A—generic</td>
</tr>
<tr>
<td>F</td>
<td>Artesunate-amodiaquine</td>
<td>N/A—generic</td>
</tr>
<tr>
<td>F</td>
<td>Atorvastatin + irbesartan (+/- clomifene)</td>
<td>N/A—generic</td>
</tr>
<tr>
<td>F</td>
<td>FX06</td>
<td>F4 Pharma</td>
</tr>
<tr>
<td>F</td>
<td>ZMAb</td>
<td>Delyrus</td>
</tr>
<tr>
<td>F</td>
<td>Lamivudine</td>
<td>N/A—generic</td>
</tr>
</tbody>
</table>

1 Product used in trial donated from Biogen; 2 Licensed in U.S. and Europe for acquired coagulopathy; 3 marketed as Epivir in the U.S. by GSK

**NOTE:** Information for earlier-stage candidates can be found at: [http://www.who.int/medicines/ebola-treatment/cat_prioritization_drugs_testing/en/](http://www.who.int/medicines/ebola-treatment/cat_prioritization_drugs_testing/en/)

Source: Ebola R&D Landscape of clinical candidates and trials, WHO Oct. 2015

*Initial NHP proof of concept demonstrated at USAMRIID*
Delayed treatment of Ebola virus infection with plant-derived monoclonal antibodies provides protection in rhesus macaques


*Division of Virology, United States Army Medical Research Institute of Infectious Diseases, Frederick, MD 21702; 9Mapp Biopharmaceutical, Inc., San Diego, CA 92121; and *Kentucky BioProcessing, LLC, Owensboro, KY 42301

Edited by Charles J. Arztmon, Arizona State University, Tempe, AZ, and approved September 14, 2012 (received for review August 7, 2012)

Vesicular stomatitis virus-based vaccines protect nonhuman primates against aerosol challenge with Ebola and Marburg viruses


RESEARCH PAPER

Codon-optimized filovirus DNA vaccines delivered by intramuscular electroporation protect cynomolgus macaques from lethal Ebola and Marburg virus challenges

Rebecca J Grant-Klein, Louis A Altamura, Catherine V Badger, Callie E Bounds, Nicole M Van Deussen, Steven A Kwilas, Hong A Yu, Kelly L Warfield, Jay W Hopper, Drew Hannaman, Lesley C Dupuy, and Connie S Schmaljohn