Detecting, Responding and Preventing Epidemics in a Globalized World: Global First Requires Local Action

UCSIA Conference
22 March 2017

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Director, Center for Global Health
US CDC
Global...

- Movement – air links
- Urban movement – 54% in 2014 → 66% in 2050 expected
- Economies
- Commerce and trade
Global and Regional Displaced Populations in 2015*

3 countries where polio is still endemic

<40 children paralyzed by polio in 2016
Decades of civil unrest in all 3 countries

A Perfect Storm

Weak public health infrastructure/Lack of IPC in health facilities/
Unrecognized cases in crowded cities

Spotty border control
Cumulative Confirmed Ebola Cases in Guinea, Liberia, and Sierra Leone, 2014-2016*

*By district, by county (Liberia), district (Sierra Leone), and prefecture (Guinea)
Rapid Isolation and Treatment of Ebola (RITE): roll-out decreased duration of outbreaks in Liberia

Size of circle proportional to number of cases in cluster; colors indicate different districts.
EPSMG: Ebola Private Sector Mobilization Group

- Developed in 2014
- Educated employees
- Active messages for families and communities
- Maintained momentum in economy
- Direct support
- Raised international awareness
- Advocacy
# US CDC Ebola Response by the Numbers

<table>
<thead>
<tr>
<th>Overall</th>
<th>International</th>
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<tbody>
<tr>
<td><strong>3,522</strong></td>
<td><strong>1,448</strong> CDC staff have deployed to West Africa</td>
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<tr>
<td><strong>&gt;4,000</strong></td>
<td><strong>&gt;72,000</strong> CDC person work-days in West Africa</td>
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<tr>
<td><strong>&gt;36,970</strong></td>
<td><strong>&gt;27,000</strong> Samples tested at CDC’s lab in Bo, Sierra Leone</td>
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<tr>
<td><strong>Domestic</strong></td>
<td><strong>24,655</strong> Health workers trained in West Africa</td>
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<tr>
<td><strong>&gt;36,160</strong></td>
<td><strong>&gt;488,780</strong> Travelers leaving West Africa screened for Ebola</td>
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<tr>
<td><strong>1,483</strong></td>
<td><strong>&gt;600</strong> US health workers trained to work in West Africa</td>
</tr>
<tr>
<td><strong>55</strong></td>
<td><strong>8,680</strong> Health and frontline workers enrolled in Ebola vaccine trial</td>
</tr>
<tr>
<td><strong>57</strong></td>
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</table>

- Total CDC deployments
- CDC staff involved in the response
- Questions answered by CDC’s national contact center
- Travelers monitored by health departments
- Domestic clinical inquiries
- US hospitals designated as Ebola treatment centers
- US labs approved to test for Ebola
- CDC staff have deployed to West Africa
- CDC person work-days in West Africa
- Samples tested at CDC’s lab in Bo, Sierra Leone
- Health workers trained in West Africa
- Travelers leaving West Africa screened for Ebola
- US health workers trained to work in West Africa
- Health and frontline workers enrolled in Ebola vaccine trial

Last updated March 29, 2016
Ebola: What Might Have Been

West Africa Ebola outbreak
Confirmed cases as of Aug. 29, 2015

International flights originating from Nigeria
Ebola Outbreak in Nigeria was Stopped Quickly

**Nigeria Ebola response by the numbers**

- Local staff mobilized: 1020
- FETP residents/graduates responding: 80
- Sites decontaminated by trained teams: >70
- Travelers screened at airports: 150,000
- Local clinical staff trained in infection control: 2300
- Contacts identified: 894
- Home visits of contacts conducted: 19,000
- Suspect cases isolated and tested: 43
- Number of cases (from index case): 19
The Impact of Ebola

**Impact of Ebola on the Healthcare System**
- Healthcare providers were at highest risk
- 881 doctors, nurses, and midwives were infected with Ebola in West Africa
- 513 died because of Ebola
- 8% reduction of healthcare workforce from Ebola in Liberia
- 23% decrease in health services delivery in Sierra Leone

**Indirect Impact of Ebola on Health Care**
- Hidden impact on health care
- 1,091 additional estimated deaths due to HIV
- 2,714 additional estimated deaths due to tuberculosis
- 6,818 additional estimated deaths due to malaria

**Impact of Ebola on Children**
- 17,300 children lost one or both parents to Ebola
- More than 33 weeks of education were lost due to school closures
- 30% decline in childhood vaccination coverage
The Response

Cost of the Response

$2.369 B
US government

$1.66 M
Germany

$364 M
United Kingdom

$140 M
World Bank

S$3.6 B
Overall, more than $3.6 billion was spent to fight the epidemic by the end of 2015

Impact of the Response on the Healthcare System

24,655 healthcare workers were trained in infection prevention and control in West Africa

24 labs in Guinea, Liberia, and Sierra Leone became able to test for Ebola

Impact of the Response on Travel

More than 339,000 people were screened flying out of Guinea, Liberia, and Sierra Leone to prevent the spread of Ebola

3 new emergency operations centers were set up in Guinea, Liberia, and Sierra Leone
Ebola and the Economy

$2.2 billion in GDP was lost in Guinea, Liberia, and Sierra Leone in 2015, threatening not only macroeconomic stability but also food security, human capital development, and private sector growth.
Ebola Lesson #1: Countries Need Strong Public Health Infrastructure

• Each country has the responsibility to protect its people, and all countries need to be able to
  ▪ **Find** a threat when it emerges (DETECT)
  ▪ **Stop** it promptly (RESPOND)
  ▪ **Prevent** it wherever possible (PREVENT)

• Meeting WHO IHR core capacities by 2012
Ebola Lesson #2: Infection Prevention and Control are Critically Important

- Protect health care workers
- Identify and report diseases
- Prevent disease transmission
- Control disease spread

- Ebola, MERS, and SARS are *Indicator diseases*
  - They indicate what is happening silently all over the world along with spread every day of many other diseases including tuberculosis, health care-associated and drug resistant bacteria, measles, *C. difficile*, and more
Ebola Lesson #3: Global Safety Net and Surge Capacity are Critical

- The international community is also responsible – epidemics are the world’s problem, not only the problem of individual countries or regions
- When national capacities are overwhelmed, the world must move immediately and decisively
- Strengthening global capacity is not a short-cut to achieving Global Health Security
  - Country action is quicker, more efficient, and more cost-effective
  - Global action must strengthen and work through national systems to the greatest extent possible
Ebola Lesson #4: Need for Rapid, Ongoing Vaccine and Diagnostic Tests Development
A Tale of Two Outbreaks.....

March, 2014
- Host government and international response
- >28,000 cases, >11,000 deaths

March, 2016
- Greater role played by host governments
- 13 cases, 9 deaths
Enhanced VHF surveillance and diagnostics reduced filovirus cases and time to confirm

Uganda, 2000-2012
Zika: Latest in a Series of Unpredicted and Unpredictable Health Threats

- Unprecedented, extraordinary complexity, unique challenges
  - First time a mosquito-borne virus has been linked to microcephaly, other serious birth defects, and poor pregnancy outcomes
  - Sexual transmission occurs
  - Also associated with Guillain-Barré syndrome

- Top priority - protect pregnant women

- The sooner we act, the better we can protect
Countries and territories showing historical distribution of Zika virus, 1947 - 2016

[Map showing the world with various countries and territories marked with different years and colors indicating the period of Zika virus presence.]
Zika Transmission as of 5 January 2017
Mosquito Control is Key to Zika Prevention

- *Aedes aegypti* control is hard but essential
  - Need to control larvae and adults
  - Aerial spraying + biological control

- Comprehensive, sustained mosquito control needed
  - Surveillance of mosquito populations & resistance
  - Enhanced personal protection – **AND community-wide approaches are essential**
  - Organized community action to reduce larval habitats
  - Larval and adult control
  - New tools (biocontrol, traps, insecticides, more)
# Laboratory-confirmed Zika Virus Disease Cases Reported to ArboNET by States or Territories — United States, 2015–2017 (as of 15 Feb 2017)

<table>
<thead>
<tr>
<th>Route</th>
<th>States N=5,040</th>
<th>Territories N=37,023</th>
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<tbody>
<tr>
<td>Travel-associated</td>
<td>4,748 (94%)</td>
<td>141 (&lt;1%)</td>
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<tr>
<td>Locally acquired</td>
<td>220 (4%)</td>
<td>36,882 (99%)</td>
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<tr>
<td>Other routes*</td>
<td>72 (1%)</td>
<td>0 (0%)</td>
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</table>

*Includes sexual transmission (n=44), congenital infection (n=26), laboratory transmission (n=1), and person-to-person through an unknown route (n=1)

Sharing Lessons Learned: Local to Global

Guatemala: Lab training and capacity building

Puerto Rico: Risk communication and health promotion

Colombia: Understanding of adverse pregnancy outcomes

Florida: U.S. aerial spraying – experienced for other countries

Brazil: Innovations in vector control
## Zika Interventions

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<thead>
<tr>
<th>Prevent avoidable epidemics</th>
<th>Zika-specific interventions</th>
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<tbody>
<tr>
<td><strong>Mosquito control</strong> – Mexico, Brazil, Colombia, US, others piloting new means of tracking and controlling <em>Aedes aegypti</em></td>
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<tr>
<td><strong>Contraception</strong> – Acceleration of access in many countries</td>
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<tr>
<td><strong>Vaccine</strong> – Brazil, US, Colombia, other PAHO countries collaborating on trials</td>
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<tr>
<th>Detect threats early</th>
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<tr>
<td><strong>Diagnosis</strong> – laboratory materials and networks in &gt;100 countries (e.g., Thailand- capacity to test since 2013, identified cases promptly)</td>
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<tr>
<td><strong>Surveillance</strong> – Countries beginning/strengthening birth defect surveillance; Mexico best practices in mosquito surveillance</td>
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<th>Respond rapidly and effectively</th>
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<tr>
<td><strong>Travel advisories</strong></td>
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<tr>
<td><strong>Protection</strong> of pregnant women to prevent exposure and infection</td>
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<tr>
<td><strong>Vector control</strong> – Brazil, Colombia, Mexico and other countries trying new methods</td>
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</tbody>
</table>
Zika Diagnostics - Innovations

- Laboratory guidance, testing algorithms, technical assistance to build international laboratory capacity for Zika diagnostics

- Development of a rapid and specific assay for Zika
  - Validation with banked samples
  - Collaboration with Brazil

- Support Zika testing reagents in 118 countries
  - 1,179 Trioplex kits (500 tests/kit) to 117 countries; 70% in <10 days from request
  - MAC-ELISA reagents to 38 international laboratories
  - Ancillary reagents from International Reagent Resource (IRR) to >25 laboratories
What Have We Learned To Date?

- Established that **Zika is a cause** of microcephaly, serious brain defects, and is linked to potentially other birth defects.

- Estimated that among pregnancies with evidence of Zika infection in the 1st trimester, **about 11%** of fetuses and infants had birth defects.

- Recognized pattern of birth defects associated with Zika virus infection called **congenital Zika syndrome**.

- Identified that Zika infections during the 1st and 2nd trimester have been associated with birth defects.
Zika Guidance to Pregnant Women, March 2017

ECDC Guidance

CDC Guidance

WHO Guidance

1. Introduction

1.1 Background

The geographical distribution of Zika virus (ZDV) has expanded globally, particularly since 2014 in the Americas. Since 2015, a number of countries have reported cases of autochthonous transmission, and other localised transmission events have been associated with ZDV infections, as at 17 February 2017. The current knowledge gap around ZDV is a lack of temporal data on its vectors, transmission dynamics, and geographical distribution. Despite these challenges, there is a need to better describe the epidemiology of ZDV transmission in a given area, at a given time, in order to allow an assessment of the probability of ZDV transmission for the purposes of ZDV prevention and control. Public health communications need to be adapted accordingly.

The proposed definition of an area as infected and explore the need to develop a protocol for the addition of ZDV infection, epidemiological and environmental data. Further efforts of the government can also prove beneficial for understanding ZDV transmission.

1.2 Target audience

The primary audience for this guidance are public health officials and policymakers. Public health officials are expected to use this guidance to make decisions about outbreak investigations, the prevention, surveillance, and control of ZDV infections. It is important to consider the potential for ZDV transmission in a given area, at a given time, in order to allow an assessment of the probability of ZDV transmission for the purposes of ZDV prevention and control. Public health communications need to be adapted accordingly.

1.3 Classification scheme

For the purposes of classification, a region is considered to be an area at risk if there is evidence of ZDV transmission in another region. If a region has been found to be at risk, it should be considered to be an area at risk if there is evidence of ZDV transmission in another region at risk. If a region has been found to be at risk, it should be considered to be an area at risk if there is evidence of ZDV transmission in another region at risk. If a region has been found to be at risk, it should be considered to be an area at risk if there is evidence of ZDV transmission in another region at risk.

<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Category 1</td>
<td>Area with autochthonous transmission event</td>
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</table>
Measles
Measles Vaccine Prevented 15.6M Deaths
Reduced Infant Mortality Rates by 25% (2000-2013)
Gaps in Routine Coverage

Global immunization coverage with MCV1, MCV2, RCV 2000-2015

- MCV1
- MCV2
- RCV

Percent

Year

2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

85% 61% 46%

MCV1
MCV2
RCV
75 Countries Missing the GVAP MCV1 Coverage Target (>90%)

Immunization coverage with 1st dose of measles containing vaccines in infants, 2015

Global Measles and Rubella Laboratory Network (GMRLN)

- The GMRLN started in 2000, and is now the largest globally-coordinated laboratory network supporting surveillance in 191 countries.

- 723 GMRLN labs in 165 countries include:
  - 506 subnational
  - 180 national
  - 14 regional reference
  - 3 global specialized laboratories

- In 2015, 188 (97%) member states were implementing measles case-based surveillance.

- As of Mar 2016, the GMRLN sequence databases contained 27,984 entries for measles viruses and 1,555 entries for rubella viruses.
Large Outbreaks of Measles:
Reported Measles Incidence Rate*, September to August 2016

Data source: surveillance DEF file
Data in HQ as of 11 October 2016

*Rate per 1'000'000 population
Measles Cases, WHO European Region

2016*
N = 637

2017
N = 637

Number of measles cases

- 0
- 1 - 49
- 50 - 99
- 100 - 499
- 500 - 999
- >=1000
- No report

The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

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Sources:
- Centralized Information System for Infectious Diseases (CISID)
- Data as of 31 March 2017
- Map Production: Vaccine-preventable Diseases and Immunization (VPI), Division of Health Emergencies and Communicable Diseases (DEC), World Health Organization Regional Office for Europe.

*The Russian Federation did not submit any report since April 2016.
Prevent: 46 Measles Campaigns in 29 Countries reached 221 million children in 2014

35 of 46 campaigns integrated 1 or more other interventions

Measles (12)
Measles and Rubella (9)
Measles, Mumps and Rubella (8)
No SIA in 2014
Not Applicable

25/46 (54%) attained 95% administrative coverage
13/46 (28%) with coverage survey
1 survey document >95% coverage

Measles campaigns are the best example among vaccination mass campaigns (polio Men A, yellow fever, etc.) of integrating other health interventions with measles vaccination.
Innovation, Evaluation, Research “Game Changer”: Microneedle Patch

- **Thermostable** - reduced or no cold chain
- **Single-dose** - no reconstitution, minimal waste
- **Minimal training** - house-to-house campaigns
- **No sharps** - no sharps disposal or injuries
- **Small package size** - storage, transport, disposal
- **Increased immunogenicity** - potential dose-sparing
- **Cost-effective manufacturing** - cost similar to that of lyophilized vials
Global Health Security Agenda 2014
“Detect, Respond, and Prevent” is smart spending

**BY THE NUMBERS**

- **$6 Trillion**: Estimated cost of pandemics in the 21st century
- **$60 Billion**: Annual expected loss from potential pandemics
- **$0.65**: Annual cost per person for protection against current global health threats

Vision: A world safe and secure from global health threats posed by infectious diseases...

“This [the Global Health Security Agenda] is indeed a timely initiative. It raises the political profile of the threat from emerging and epidemic-prone diseases. And it energizes efforts to improve health security... in line with WHO International Health Regulations....”

World Health Organization
Director General Margaret Chan
February 13, 2014
INTERNATIONAL HEALTH REGULATIONS (IHR)
– from policy to people’s health security

What are the IHR?
The IHR are legally binding and help countries work together to protect lives threatened by the spread of diseases and other health risks, including radiation and chemical hazards.

5 reasons why the IHR matter

1. HEALTH THREATS HAVE NO BORDERS
   The IHR strengthen countries’ abilities to control diseases that cross borders at ports, airports and ground crossings.

2. TRAVEL AND TRADE ARE MADE SAFER
   The IHR promote trade and tourism in countries and prevent economic damage.

3. GLOBAL HEALTH SECURITY IS ENHANCED
   The IHR establish an early warning system not only for diseases but for anything that threatens human health and livelihoods.

4. DAILY THREATS ARE KEPT UNDER CONTROL
   The IHR guide countries to detect, assess and respond to threats and inform other countries quickly.

5. ALL SECTORS BENEFIT
   The IHR prepare all sectors for potential emergencies through coordination and information sharing.

Until all sectors are on board with the IHR, no country is ready.

www.euro.who.int/ihr
GHSA is the Roadmap for IHR

Global Health Security – “...the activities required, both proactive and reactive, to minimize vulnerability to acute public health events that endanger the collective health of populations living across geographical regions and international boundaries” (World Health Assembly Report, 2007)
More than fifty countries have committed to the Global Health Security Agenda (GHSA)

- GHSA launched in Feb 2014 with leaders from 28 countries, WHO, OIE and FAO
- G7 committed to assist at least 76 countries
- The GHSA drives a set of concrete and achievable actions to help actualize the International Health Regulations
- Countries committed to reaching public health goals through the prevent, detect and respond model
11 Global Health Security Action Packages
... across 3 priority areas
... to achieve 3 critical health security impacts

- Antimicrobial Resistance
- Zoonotic Diseases
- Biosafety & Biosecurity
- Immunization

Prevent avoidable outbreaks

- National Laboratory System
- Real-time Surveillance
- Reporting
- Workforce Development

Detect threats early

- Emergency Operations Centers
- Linking Public Health with Law Enforcement & Multisectoral Rapid Response
- Medical Countermeasures & Personnel Development

Respond rapidly and effectively
The US is Supporting GHSA in Regions and 32 Partner Countries

GHSA Phase I
- Bangladesh
- Burkina Faso
- Cameroon
- Cote d'Ivoire
- Guinea
- Ethiopia
- India
- Indonesia
- Kenya
- Liberia
- Mali
- Pakistan
- Senegal
- Sierra Leone
- Tanzania
- Uganda
- Vietnam

GHSA Phase II
- Cambodia
- Democratic Republic of Congo
- Georgia
- Ghana
- Haiti
- Jordan
- Kazakhstan
- Laos
- Malaysia
- Mozambique
- Peru
- Rwanda
- Thailand
- Ukraine
- CARICOM
Cameroon: EOC activated within 24 hours to respond to outbreak of avian influenza

Mali: Frontline responders immediately implemented vaccination campaigns for measles and suspected yellow fever

India: Better prevention and detection of AMR through systematic IPC, surveillance, and lab

Tanzania: Fighting cholera

Vaccination clinic for suspected Yellow Fever

Dr Purva from AIIMS and site investigators review HA1 data

Emergency responders atop a water truck collecting samples
US CDC Global Disease Detection: Operations Center and Surge Capacity

- Monitors 30-40 public health threats a day
- Detection and verification of international disease events and threats
- Operational support for rapid deployment of CDC assets and field teams
- U.S. compliance with International Health Regulations
- CDC’s liaison with the Global Outbreak Alert Response Network (GOARN)
Global Health Security Starts with Strengthening IHR Core Capacities and Progress is Measured through WHO/Joint External Evaluations (JEE)

- Transparent, independent, and objective
- Accountability and partnership
- Baseline to measure progress and identifies gaps
Joint External Evaluation Process

**Targets** guide the country capacity assessment and inform country action plans and partner commitments to improve health security.
Many countries are somewhat prepared – but none are 100% prepared

<table>
<thead>
<tr>
<th>Country</th>
<th>Overall</th>
<th>Prevent</th>
<th>Detect</th>
<th>Respond</th>
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<tbody>
<tr>
<td><strong>Joint External Evaluation</strong></td>
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<tr>
<td>Bangladesh</td>
<td>50%</td>
<td>58%</td>
<td>70%</td>
<td>33%</td>
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<tr>
<td>Ethiopia</td>
<td>52%</td>
<td>56%</td>
<td>59%</td>
<td>45%</td>
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<tr>
<td>Liberia</td>
<td>47%</td>
<td>42%</td>
<td>50%</td>
<td>49%</td>
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<tr>
<td>Mozambique</td>
<td>47%</td>
<td>46%</td>
<td>51%</td>
<td>46%</td>
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<td>Pakistan</td>
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<td>46%</td>
<td>51%</td>
<td>53%</td>
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<td>Tanzania</td>
<td>50%</td>
<td>51%</td>
<td>54%</td>
<td>48%</td>
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<tr>
<td>United States</td>
<td>87%</td>
<td>87%</td>
<td>91%</td>
<td>85%</td>
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<tr>
<td><strong>GHSA External Assessment</strong></td>
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<tr>
<td>Georgia</td>
<td>65%</td>
<td>72%</td>
<td>68%</td>
<td>51%</td>
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<tr>
<td>Peru</td>
<td>67%</td>
<td>59%</td>
<td>76%</td>
<td>67%</td>
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<tr>
<td>Portugal</td>
<td>88%</td>
<td>88%</td>
<td>79%</td>
<td>100%</td>
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<tr>
<td>Uganda</td>
<td>55%</td>
<td>44%</td>
<td>77%</td>
<td>42%</td>
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<tr>
<td>Ukraine</td>
<td>55%</td>
<td>58%</td>
<td>54%</td>
<td>51%</td>
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<tr>
<td>United Kingdom</td>
<td>96%</td>
<td>97%</td>
<td>98%</td>
<td>92%</td>
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Results from Liberia JEE show progress from GHSA baseline assessment
Country: Sustainability and Accountability

- Complete JEEs, implement corrective action plans, and begin follow up assessments
- Meet IHR core capacities and maintain accountability
- Enhance partnerships to strengthen multi-sectoral support to countries
- Globally support countries in closing gaps
Globally: Development, Accountability, and Surge

• Global safety net
  – WHO Health Emergency Programme
  – Regional institutions – “CDCs”

• G7 and G20 commitments

• GHSA Private Sector Roundtable, Non-Governmental Organizations, and Peer Network

• Innovation and development
  – CEPI
  – WHO R&D Blueprint
  – Diagnostics
Thank you