Introduction

The European Centre for Disease Prevention and Control (ECDC), in order to fulfill its mandate under Decision No. 1082/2013/EU, intends to identify both the strengths and the areas for improvement of public health emergency preparedness (PHEP) in the European Union (EU) Member States. As a first step towards that goal, this paper aims to develop a public health emergency preparedness logic model for the European context (ECDC logic model), focusing particularly on cross-border threats to health that can be used as the basis for identifying PHEP systems’ current level of preparedness. The paper begins with a summary of the salient aspects of the European public health emergency preparedness context. The following section describes the role of logic models in the development of measurement and assessment systems, particularly in distinguishing between capabilities and capacities. We then proceed to describe the method used for identifying both the critical capabilities and capacities in the European context.
The European Public Health Emergency Preparedness Context

Decision No. 1082/2013/EU focuses specifically on “cross-border threats to health.” This includes biological, chemical, and environmental threats, threats of unknown origin, and other events that may constitute public health emergencies of international concern under the International Health Regulations (2005). For infectious disease issues, the scope includes outbreaks arising in Europe, such as the 2011 *Escherichia coli* O104:H4 (*E. coli*) outbreak, those arising elsewhere in the world that have consequences for Europe such as Ebola, and ongoing issues such as antibiotic resistance. Decision 1082 is oriented towards Member States’ mutual responsibility to each other rather than their accountability to an external party, as well as quality improvement. The specific language regarding the scope of Decision 1082 is detailed in Box 1.

**Box 1. Scope of Decision No. 1082/2013/EU**

1) This Decision shall apply to public health measures in relation to the following categories of serious cross-border threats to health:
   a) threats of biological origin, consisting of:
      i) communicable diseases
      ii) antimicrobial resistance and healthcare-associated infections related to communicable diseases (hereinafter ‘related special health issues’)
      iii) biotoxins or other harmful biological agents not related to communicable diseases
   b) threats of chemical origin
   c) threats of environmental origin
   d) threats of unknown origin
   e) events which may constitute public health emergencies of international concern under the IHR, provided that they fall under one of the categories of threats set out in points (a) to (d)

2) This Decision shall also apply to the epidemiological surveillance of communicable diseases and of related special health issues.

The EU Member States are also signatories to the IHR and, as such, the core capacities of those regulations are important elements of the European PHEP context that should be incorporated into the ECDC logic model. Potential changes to the IHR, in the light of the 2014 Ebola experience, as well as

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current efforts to build core capacities under the Global Health Security Agenda (GHSA),⁴ should also be considered in the development of the ECDC logic model.

**Measuring and Assessing Public Health Emergency Preparedness Capabilities**

Assessing public health system preparedness is challenging for many reasons. First, serious public health emergencies are both rare and specific to the context in which they unfold. Thus, there are few opportunities to assess outcomes by direct observation. Moreover, public health emergencies’ relative infrequency and singular nature makes it difficult to identify activities that are effective for improving preparedness.

Second, an effective public health emergency response is broad, complex and multifaceted. In light of its complex nature, and given the fact that we cannot know the counterfactual scenario, it can be difficult to determine what the best response to a specific situation might have been. An effective approach in one community may be ineffective in others. Both the aspects of preparedness that should be measured and what levels of performance are required for improvement are unclear. For example, would greater laboratory capacity have enhanced the response to 2009 H1N1? If so, by how much would throughput or timeliness need to improve to see a measurable change?

Third, public health systems are multi-jurisdictional and multidisciplinary, so system-level preparedness is not necessarily just the sum of the parts. The public health infrastructure includes not only national efforts, but international organizations and subnational structures that vary markedly from country to country. In addition to the basic infrastructure, “systems” that support public health preparedness include partner agencies, such as the healthcare delivery sector; emergency medical services agencies; agricultural and environmental protection agencies; public safety agencies; and others that might not consider themselves as having a public health role. As a result of this diverse set of relationships, responsibility and accountability for public health preparedness is diffused across multiple parties. This can make it difficult to determine which partner’s performance to measure and how to assess each partnering entity’s contributions to the Europe-wide preparedness enterprise.

In order to address these challenges, we and our colleagues at Georgetown University, the Harvard T.H. Chan School of Public Health, and the RAND Corporation have taken a systematic approach to the

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development of PHEP measures modeled after the “science of measurement” methodology that is used in health care quality improvement efforts. From this perspective, measurement and assessment systems must begin with clear definitions of key concepts and result in the identification of specific activities and processes to measure. Beginning at the most general level, we have adopted the definition of PHEP developed by Nelson and colleagues, namely, “the capability of the public health and health care systems, communities, and individuals, to prevent, protect against, quickly respond to, and recover from health emergencies, particularly those whose scale, timing, or unpredictability threatens to overwhelm routine capabilities. Preparedness involves a coordinated and continuous process of planning and implementation that relies on measuring performance and taking corrective action.”

The core of this definition is the concept of the “public health emergency preparedness system,” a complex network of individuals and organizations that have the potential to play critical roles in creating the conditions for health. For example, the Institute of Medicine represents this system with the governmental public health infrastructure as the core, with the health care delivery system, civil protection agencies, employers and businesses, the media, academia, and other public and private community organizations as important components. While each of these actors is a separate entity, a robust PHEP system requires that all work together when necessary.

Logic models and measurement

One way to approach assessing a Member State’s preparedness system is to measure PHEP outcomes during actual events. However, for the reasons discussed above, assessment based on direct observation can be a challenging endeavor. An alternative approach, often used by health services and public health system researchers, is to rely on a logic model to identify factors that are considered (based on scientific evidence and practitioner experience) to contribute positively to response outcomes. Logic models specify the goals and objectives of public health preparedness, as well as the response capabilities and preparedness capacities needed to achieve those goals and objectives. Logic models allow PHEP systems to assess capabilities and capacities as proxies for outcomes, to the extent

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that there is evidence supporting the connection between capacities, capabilities, and outcomes. Observing outcomes of real responses can strengthen the evidence base supporting a logic model. However, even without a strong evidence base, logic models can be an effective method for identifying provisional measures based on a clear picture of what is currently known.

A logic model is not a measurement tool per se, but rather a theoretical framework for identifying what to measure. As is discussed below, capacity inventories, exercises, critical incident analyses, and other approaches describe how to measure both capacities and capabilities, and all of these methods can be implemented either with or without external peer review. Agreeing on a common set of capacities and capabilities to measure allows for making comparisons both over time and between Member States, which is important for enhancing learning and sharing results from all of these approaches.

An example of “systems thinking,” logic models represent the whole system, not just the gaps (as is the case with the GHSA framework). In order to be most useful, a logic model should be as simple as possible; the model should encompass the critical components of a system but does not every aspect of the system. In addition, capabilities should be specified in a way that is sufficiently general so they can be assessed in different situations and contexts, and yet have meaning in others.

In developing the proposed ECDC logic model, we began with a preparedness logic model originally developed to capture the elements of the preparedness enterprise in the United States\(^8\) and adapted it using the following approaches. First, in order to better understand the public health emergency capabilities that are required in the European context, we examined the results of a literature review of six cross-border events in Europe\(^9\). The events included hazards of biological origin (an outbreak of Shiga toxin producing *E.coli* in 2011 and pandemic influenza H1N1 in 2009 and 2010), hazards of chemical origin (the red sludge reservoir breach in 2010 in Hungary threatening the river Danube, and melamine milk contamination in 2008 in products imported from China), and hazards of environmental origin (a heat wave in several European countries in 2003 and a volcanic ash cloud originating in Iceland in 2010). The goal of this analysis was not to critique the response to these events, but merely to identify the PHEP capabilities that were called upon, or that would have enabled a more effective response.


\(^9\) Bazian. Literature review on the overlap between preparedness for communicable diseases and for other types of health threats. A report for: European Centre for Disease Prevention and Control (ECDC).
Second, we supplemented this analysis with a review of documents regarding the European response to Ebola in 2014, including reports of peer review visits conducted by the ECDC in three EU Member States. Finally, participants at the 2015 annual meeting of the ECDC National Focal Points for Preparedness and Response contributed their experience with Ebola and other cross-border events. In particular, meeting participants were asked to:

- Review their country’s experience with Ebola and MERS
- In the context of Ebola and MERS, consider whether there are any critical aspects of preparedness and response that are not represented in the draft ECDC logic model
- Discuss whether the draft logic model can be revised to better represent their country’s experience with Ebola and MERS.

Participants were asked not to judge the quality of their country’s response to these incidents, but rather to identify which capabilities were tested. The revised capabilities that resulted from this process are summarized in Box 3, and illustrated with examples from the six European cross-border events below.

**Capabilities vs. capacities**

Our proposed logic model (Figure 1) incorporates a fundamental distinction between capacities and capabilities that is implicit in Nelson and colleague’s definition of PHEP. Capacities represent the resources—infrastructure, policies and procedures, knowledgeable and trained personnel—that a public health system has to draw upon. Much of what public health preparedness organizations do on a day-to-day basis—planning, training, and acquiring equipment and supplies—is intended to build capacity for future emergencies. Capabilities, on the other hand, describe the actions a public health system is capable of taking to effectively identify, characterise, and respond to emergencies. For example, in the case of communicable diseases, having strong laboratories and skilled laboratorians may be insufficient if they cannot be mobilized in a timely manner, and/or if lab results cannot be shared with and acted upon by decision-makers. Similarly, having stockpiles of vaccines and other countermeasures is of limited utility if a community lacks the ability to transport and deliver them to the right people in a timely manner.

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Capacities typically refer to components of a PHEP system, whereas capabilities usually describe the entire system's performance in putting those capacities to work. Indeed, the failure to effectively deploy a capability during an event could reflect capacity gaps, such as the lack of laboratory equipment or inadequately trained staff. Budget constraints or inaction by political actors during a crisis can also prevent effective actions by an otherwise well-prepared system. Capabilities describe what a system should be able to do; why it did or did not perform as expected is an appropriate topic for a critical incident analysis.

Capacities and capabilities are both important for an effective emergency response; depending on the context, however, different kinds of capacities are needed to achieve the required capabilities. Thus, we propose focusing the measurement effort largely on capabilities, which allows different EU Member States the option of determining how best to achieve them in their own context. For instance, Member States with networked national electronic medical record systems in widespread use might rely on them for syndromic surveillance to identify disease outbreaks. Countries with less well-developed systems, on the other hand, might rely on more traditional surveillance methods.

We provide more information on measurement in the final section of the paper. It is worth emphasising that capabilities are latent characteristics of the PHEP system, best measured and assessed in actual emergencies.\(^\text{11}\) To assess a system’s capabilities during actual events, capabilities must be defined in a broad manner, such that they have a consistent meaning in different settings and incidents, and at the same time are specific enough to be measurable. For instance, analyses of the global public health system’s functioning during the 2009 H1N1 pandemic suggest that surveillance system must possess three critical capabilities: (1) the ability to detect outbreaks and determine whether they are of significant global concern, (2) the ability to describe the epidemiologic characteristics of the pathogen responsible, and (3) the ability to track the pathogen’s spread, both through national populations and around the world, and to measure the impact of disease control strategies.\(^\text{12}\)

Capabilities and capacities are not binary, they have multiple dimensions (timeliness, scale, scope, and consistency, etc.). Particular dimensions depend on the context, and may vary from one capability to another, and even, within a given capability, from one incident to another. When making a comparison between Member States or over time, capabilities may be assessed with a numerical or semi-


quantitative scale (e.g. green, yellow, red). However, at a fundamental level, the list of capabilities included in the logic model are a set of categories that can be used to organize critical incident and other analyses to ensure that all relevant issues are discussed, and to help translate findings to other incidents and contexts.

**Proposed ECDC logic model:**

Below we describe the proposed logic model that emerged from the process described above, beginning with capacities and then capabilities.

**Capacities**

The PHEP logic model begins with Potter and colleagues’ grouping of PHEP capacities into legal, economic, and operational (LEO) domains.\(^{13}\) Our research suggests the importance of adding “social capital,” which describes the intangible partnerships and informal relationships between individuals and organisations that are critical to effective emergency operations and community resiliency.\(^{14,15}\) Capacities are listed in Box 2.

**Capabilities**

Given the number of capabilities in the logic model, it is helpful to organise them into high-level categories. The first three categories – (1) assessment, (2) policy development and implementation, and (3) prevention and treatment in the health sector – correspond to the core functions of public health (IOM, 1988) and represent what the public health system must accomplish to respond effectively. The fourth and fifth categories represent a series of interrelated functions needed to ensure that the system fulfills its assessment, policy development and prevention and treatment roles. (4) Coordination and communication regards information sharing within the public health system, incident management and leadership. (5) Emergency risk communication focuses on communication with the public.

Evaluation and training are critical components of the preparedness cycle, but are not “response capabilities.” We recognize that conducting post-incident reviews, and sometimes research, in a timely way is of critical importance for system learning, and this can require performing these analyses, or at


minimum collecting the appropriate data, during or shortly after an event. Similarly, an effective response can include just-in-time training and exercises. However, despite the timing of these activities, they are more properly categorised as capacity development rather than response capabilities.

Box 2. Proposed ECDC public health preparedness capacities

Legal, regulatory, and budgetary authorities (global, EU, Member States, local)
- Accountability
- Organizational structure
- Policy development
- Delegation of authority
- Administrative preparedness, e.g. emergency use authorization

Infrastructure
- Financing (national, sub-national/regional, local, and private sector)
- Workforce development (public health, healthcare, volunteers)
- Facilities (laboratory equipment, pharmaceutical stockpiles and hospital supplies, personal protection equipment)
- Infrastructure (information and communications technology)

Operational measures
- Capacity assessment and planning
- Drills and exercises
- After Action Reports (AARs) and post-event evaluations

Social capital: partnerships within the public health system as well as between public health and
- Health care providers
- Emergency responders
- Law enforcement
- Community organizations

1. Assessment

As a whole, assessment capabilities enable Member States’ preparedness systems to recognise and characterise a threat, monitor its impact on the population, and evaluate the efficacy of interventions to control the threat. Assessment depends on having laboratory and surveillance capacities, including appropriate legal arrangements, in place before an event. Information flowing from assessment activities must be communicated to all segments of the public health preparedness system, as well as with the public, to support policy development and implementation, prevention and treatment efforts.

**Incident recognition.** Identifying that a cross-border threat to health has arisen, either in one or more of the member states, or elsewhere in the world that could affect Europe.
For example, the notification to the Robert Koch Institute (RKI) of a small cluster of paediatric haemolytic uraemic syndrome (HUS) cases in Germany acted as trigger for further investigation, which led to the recognition of a wise-spread *E.coli* outbreak. The contamination of infant formula with melamine was recognised as a threat to Europe when the International Food Safety Authorities Network (INFOSAN) emergency surveillance system published an alert.

**Risk characterization.** *For communicable diseases, identifying the (possibly novel) pathogen and its epidemiologic characteristics such as modes of transmission, risk of infection, virulence (e.g. case-fatality rate), intergenerational time, control strategies that are available, and so on. For other health risks, characterising the current and potential human health consequences in directly affected and other member states.*

For Ebola, the challenge was characterising the risks of transmission associated with repatriated healthcare workers and unknown imported cases. The ECDC’s Rapid Risk Assessment process was designed to provide this information at the European level, but Member States must also make their own assessments based on the context and conditions in their countries. For melamine, the European Food Safety Authority EFSA developed theoretical exposure scenarios for biscuits and chocolate containing milk powder for both adults and children to assess risk to individuals and populations. In the heat wave, the challenge was to identify the most vulnerable groups, such as the elderly.

**Epidemiological investigation.** *Developing case definitions, conducting outbreak investigations and case-control studies to validate and analyse case reports, identify pathogens and sources of exposure, and to aid in risk characterisation.*

In the *E.coli* outbreak, a RKI research team travelled to interview cases and conduct case-control studies to investigate infection risks and the transmission vehicle. During the same incident, the ECDC published standard case definition to coordinate investigations in multiple countries.

**Surveillance and epidemiological monitoring.** *Indicator- and event-based surveillance, including case reporting, and active surveillance, to identify outbreaks, characterise affected population groups, monitor disease trends and the impact of control strategies.*

In the Ebola outbreak, one of the challenges for ECDC member states was identifying imported cases through border screening. In the *E.coli* event, active surveillance was used to identify HUS cases beyond those that triggered the initial epidemiological investigation. In the sludge incident, the health status of inhabitants of contaminated villages was carefully monitored.
Box 3 (part 1 of 2). Proposed ECDC public health preparedness capabilities

Assessment

- **Incident recognition.** Identifying that a cross-border threat to health has arisen, either in one or more of the member states, or elsewhere in the world that could affect Europe
- **Risk characterisation.** For communicable diseases, identifying the (possibly novel) pathogen and its epidemiologic characteristics such as modes of transmission, risk of infection, virulence (e.g. case-fatality rate), intergenerational time, control strategies that are available, and so on. For other health risks, characterising the current and potential human health consequences in directly affected and other member states.
- **Epidemiological investigation.** Developing case definitions, conducting outbreak investigations and case-control studies to validate and analyse case reports, identify pathogens and sources of exposure, and to aid in risk characterisation.
- **Surveillance and epidemiological monitoring.** Indicator- and event-based surveillance, including case reporting, and active surveillance, to identify outbreaks, characterise affected population groups, monitor disease trends and the impact of control strategies.
- **Laboratory analysis.** Technical ability to identify (possibly novel) pathogens, monitor antimicrobial resistance, and to handle large numbers of samples submitted for diagnostic purposes.
- **Environmental monitoring.** Ability to monitor chemical, biological (including animal), and other contaminants in air, soil, and water.

Policy development and implementation

- **For infection control and treatment guidance.** Authority and practical ability to adapt existing policies and guidance (or develop new if necessary) both to prevent the spread of infection in health care and related settings and for treating affected individuals, including crisis standards of care.
- **For population-based disease control.** Authority and practical ability to adapt existing policies and guidance (or develop new if necessary) to prevent spread of communicable disease including personal hygiene, quarantine, social distancing, and border controls.
- **Enforcing laws and regulations.** Ability to enforce laws and regulations required for disease control and prevention including the IHR, EU regulations, and member states’ laws and regulations.
**Box 3 (part 2 of 2). Proposed ECDC public health preparedness capabilities**

**Health care services**
- Preventive services. The ability to provide vaccines and other prophylactic measures to the population.
- Medical surge. The ability to (1) evaluate and care for a markedly increased volume of patients and (2) manage patients requiring unusual or specialised medical evacuation or care.
- Management of medical countermeasures, supplies and equipment. The ability to procure, distribute, and manage counter measures, supplies and equipment, including personal protective equipment (PPE), during an incident.
- Care for health care workers and emergency responders. The ability to provide preventive and medical services to address the physical and mental health needs of health care workers and emergency responders.

**Coordination and communication** (within the public health emergency preparedness system)
- Crisis management. Ability to employ a systematic approach to organise and manage resources and responsibilities for addressing all aspects of emergencies, including continuity of operations.
- Communication with healthcare providers. Communication between public health agencies and healthcare providers, especially regarding surveillance protocols, prevention and treatment guidance, and other matters to ensure coordination of prevention and treatment efforts.
- Communication with emergency management, public safety, and other sectors. Communication between public health and other sectors to ensure coordination of prevention and treatment efforts.
- Communication with other public health agencies at the global, European, national, and subnational levels. Communication between public health agencies at all levels to ensure coordination of prevention and treatment efforts.

**Emergency risk communication** (with the public)
- Identification of public information needs. Monitoring conventional media, social media, and helplines to identify issues of concern to the population.
- Developing message content and delivering through appropriate channels. Identifying communications objectives, target audience information needs, and appropriate and trusted channels of communication.
Laboratory analysis. Technical ability to identify (possibly novel) pathogens, monitor antimicrobial resistance, and handle large numbers of samples submitted for diagnostic purposes.

This capability reflects a Member State’s ability to use existing laboratory capacity effectively during an incident in support of the other capabilities in the Assessment section. For example, in the Ebola outbreak, European mobile laboratories were used to support Member States’ efforts. In the E. coli outbreak, the EU Reference Laboratory for E. coli (EU-RL) and its associated networks were essential in characterising the Shiga toxin-producing E. coli (STEC) strain. During the 2009 H1N1 pandemic, laboratory capacity for conducting a high volume of diagnostic tests was essential.

Environmental monitoring. Ability to monitor chemical, biological (including animal), and other contaminants in air, soil, and water.

An effective response to the volcanic ash event required extensive geophysical monitoring of the Eyjafjallajökull volcano before, during and after the eruption. Similarly, the sludge incident required extensive post-event monitoring of water quality, fish, and other environmental aspects.

2. Policy development and implementation

The group of policy development and implementation capabilities reflect Member States’ abilities to adapt existing authorities and policies to the new and emerging circumstances of a cross-border threat to health, and to enforce existing and new laws and regulations needed to implement these policies and regulations. The focus of these capabilities is at the national level, although it is recognised that a lack of consistency within Member States, or among bordering Member States, can erode the public’s confidence. All of these activities require communication and coordination with a variety of actors at the global, European, national, and sub-national levels, and these supporting capabilities are described below. The capabilities in this section deal with the development and implementation of substantive policies, regulations, and official guidance regarding infection control and disease treatment in clinical settings to population-based disease control activities.

For infection control and treatment guidance. Authority and practical ability to adapt existing policies and guidance (or develop new if necessary) both to prevent the spread of infection in health care and related settings and for treating affected individuals, including crisis standards of care.

For example, during the Ebola outbreak, infection control practices for the use of personal protective equipment (PPE) and for use in hospitals, medical transport, emergency departments (EDs), and primary
care settings had to be developed and disseminated on a just-in-time basis. Treatment guidelines also had to be developed, updated, and disseminated as knowledge grew.

**For population-based disease control.** Authority and practical ability to adapt existing policies and guidance (or develop new if necessary) to prevent spread of communicable disease including personal hygiene, quarantine, social distancing, and border controls.

During the Ebola outbreak, border screening policies and procedures consistent with evolving knowledge about epidemiological risks had to be developed, updated, and implemented. For example, during the H1N1 pandemic, policies and procedures regarding antiviral and vaccine priorities had to be developed and implemented. Advice about hand washing and other aspects of personal hygiene needed to prevent spread of the virus in the population also had to be developed and disseminated to the public.

**Enforcing laws and regulations.** Ability to enforce laws and regulations required for disease control and prevention including the IHR, EU regulations, and member states’ laws and regulations.

Effective implementation of disease control policies, regardless of whether policies were in place before the event or need to be developed during it, depends on the existence of appropriate laws and regulations, as well as procedures for modifying and implementing them. During the H1N1 pandemic, EU member states reviewed but did not implement social distancing policies. The volcanic ash event required airspace closures, relaxation of noise restrictions so planes could be re-routed to different airports, and efforts to ensure passengers’ rights. The melamine event required import restrictions on contaminated products.

### 3. Health care services

This group of capabilities addresses prevention and treatment services delivered to individuals by the Member States’ health sector. This includes provision of vaccines and other countermeasures to the general public and to healthcare workers, as well as physical and mental health treatment for those affected by a mass-casualty and long-running incidents. The medical countermeasures, supplies and equipment needed to provide these services are considered capacities, but procuring, stockpiling, and distributing them on an emergency basis during a crisis are critical capabilities, and thus included in this section. The most effective and efficient means for delivering health care services to individuals – whether preventive or therapeutic – will depend on the nature of the threat and on the way that public and private sector is organised, as the organisation of the health sector varies markedly among Member
States. Thus, these capabilities focus on what must be accomplished during an event, rather than on how to accomplish it. The WHO Regional Office for Europe’s Toolkit for assessing health-system capacity for crisis management\textsuperscript{16} provides more detail on how to assess and improve Member States’ preparedness in this regard.

**Preventive services.** *The ability to provide vaccines and other prophylactic measures to the population.*

When available, preventive measures typically must be rapidly delivered to large numbers of individuals at risk, typically requiring collaboration between the public and private sectors. For example, a challenge during the H1N1 outbreak was administering a newly developed pandemic vaccine to the public as soon as it became available, which occurred in the Autumn of 2009. Member States accomplished this through a variety of approaches including public health vaccination clinics, established primary care providers, and other means, as their health systems permitted.

**Medical surge.** *The ability to (1) evaluate and care for a markedly increased volume of patients and (2) manage patients requiring unusual or specialised medical evacuation or care.*\textsuperscript{17}

Mass-casualty incidents, defined as an event that generates more patients at one time than locally available resources can manage using routine procedures, require either high volume or specialised physical and mental health treatment for those affected, or in the most severe cases, both. The health sector challenge during the Ebola event, for instance, focused much more on specialised care: the evacuation, internal transport, and treatment of healthcare workers who were infected while working in West Africa. In some Member States, this was accomplished primarily through public health sector Medevac and ambulance services. The number of Ebola patients treated in Europe was limited, and therefore they were successfully able to treat them at specially prepared hospitals. However, the event did remind hospital officials that treating more than one case per hospital would put an enormous strain on healthcare resources. This capability also includes provision of temporary shelter to individuals evacuated from affected sites, as was necessary during the sludge and volcanic ash events.

http://www.euro.who.int/__data/assets/pdf_file/0008/157886/e96187.pdf

\textsuperscript{17} Strengthening health-system emergency preparedness: Toolkit for assessing health-system capacity for crisis management. WHO Regional Office for Europe, 2012.  
http://www.euro.who.int/__data/assets/pdf_file/0008/157886/e96187.pdf
Management of medical countermeasures, supplies and equipment. The ability to procure, distribute, and manage counter measures, supplies and equipment, including personal protective equipment (PPE), during an incident.

Supplies and equipment *per se* are capacities, but Member States’ ability to use them effectively where needed during a crisis is a response capability. For instance, even though the number of Ebola cases in Europe was small, the outbreak highlighted challenges in limited availability of specialized ambulances and other equipment.

Care for health care workers and emergency responders. The ability to provide preventive and medical services to address physical and mental health needs of health care workers and emergency responders.

Health care workers and emergency responders have special needs for preventive and medical care because of their exposure to pathogens and environmental contaminants. Moreover, because they put themselves at risk voluntarily and are necessary to maintain continuity of operations, these workers may deserve priority when there are shortages. Priority for responders and their families for prophylaxis and treatment can also be an important to ensure that they respond during a crisis. The 2009 H1N1 outbreak, for instance, highlighted the priority health care and emergency workers received for antivirals and pandemic vaccine when it became available. During the sludge incident, workers required gloves, protective dust masks and footwear for use during the cleanup operation.

4. Coordination and communication (within the public health emergency preparedness system)

This group of capabilities comprises efforts to communicate within the public health emergency preparedness system to coordinate and manage a complex system’s response to a cross-border threat. The first three groups of capabilities describe what must be accomplished during a crisis; the capabilities are not ends in themselves, but rather describe how Member States achieve these ends. Effective leadership and governance structures are clearly important for crisis management, but because these factors vary across Member States, the focus here is on key aspects of coordination and communication needed during an emergency. Similarly, it is recognised that existing regulations and resource constraints limit the amount of coordination that is possible, but these and other factors that explain why a Member State was not able to coordinate their efforts are appropriate topics for a critical incident analysis.

Crisis management. Employing a systematic approach to organise and manage resources and responsibilities for addressing all aspects of emergencies, including continuity of operations.
Crisis management is a comprehensive category, applying to a Member State’s overall ability to balance the demand for immediate short-term actions with the maintenance of long-term operations. The Ebola event, for instance, provided a good test of national response platforms and coordination efforts, which are essential for effective crisis management, as well as the importance of leadership and governance. During the heat wave, in contrast, communication signals got lost, communiqué writing took days, and officials were slow to organise meetings and set up networks in order to take decisions and act. During the heat wave scientific organisations struggled to modify their response from the usual methodology of carefully designed studies to rapid turnaround analyses to inform the immediate response.

**Communication with healthcare providers.** Communication between public health agencies and healthcare providers, especially regarding surveillance protocols, prevention and treatment guidance and other matters, to ensure coordination of prevention and treatment efforts.

During the Ebola outbreak, for example, public health agencies communicated regularly with hospitals and health care providers regarding risk characterisation, case definitions, infection control practices, and treatment protocols. During the H1N1 pandemic, Italian public health officials and primary care providers had different views about prevention strategies, complicating efforts to involve primary care providers in mass vaccination efforts. During the heat wave, an individual instructed some hospitals to implement emergency measures outside of official channels, causing confusion.

**Communication with emergency management, public safety, and other sectors.** Communication between public health and other sectors to ensure coordination of prevention and treatment efforts.

During the H1N1 pandemic, public health agencies worked with other agencies to coordinate vaccine distribution points, delegation of prescribing, and other logistical matters. Member States also reported using just-in-time drills and simulations to prepare for Ebola cases.

**Communication with other public health agencies at the global, European, national, and subnational levels.** Communication between public health agencies at all levels to ensure coordination of prevention and treatment efforts.

The focus of this capability is on communication within Member States, but effective response to cross-border threats requires communication and coordination at both the global and European levels. Member States must be able to participate in these discussions, translate and tailor the results to their

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own situations, and communicate them to the relevant national and subnational parties. For example, during the E.coli outbreak, a European working group was established early in the response. ECDC issued rapid risk assessments and epidemiological updates, with ECDC’s Food and Water Borne Disease network playing an essential role. During the Ebola outbreak, a EU Task Force was established through the EU Commission's Emergency Response Coordination Centre.

5. Emergency risk communication (with the public)

The focus of this group of capabilities is on communicating with the public during a crisis, ensuring that everyone, especially members of vulnerable and hard-to-reach populations, receives the information that they need. The messages are intended to not only minimize fear and panic, but to also provide information that individuals need to protect themselves.

Identification of public information needs. Monitoring conventional media, social media, and helplines to identify issues of concern to the population.

Communication is a two-way process, consisting of both announcements to the public and monitoring the information environment to help determine what are the main topics of public concern. For instance, during the heat wave, officials realized – and addressed – the concern that persistent media coverage was “based on a response to recorded deaths rather than to promoting preventative action.” During the 2009 H1N1 pandemic, Member States realized that the public was concerned about not having sufficient stockpiles of antivirals and vaccines, so sought to reassure them that the necessary supplies were available.

Developing message content and delivering through appropriate channels. Identifying communications objectives, target audience information needs, and appropriate and trusted channels of communication.

Effective emergency risk communication depends on the existence of established communication channels (especially for vulnerable and hard-to-reach groups), standard message templates, and many other capacities. What is communicated is determined by the assessment, policy development and implementation, and health care services capabilities. Depending on the event, the content may include information about the nature of the threat, recommendations for prevention and personal protection, and locations individuals can go to seek health care if needed. For example, during the Ebola outbreak, the key message in one Member State was to advise citizens to first contact a hotline for orientation and guidance, instead of heading directly to health services. During the H1N1 pandemic, Member States
used telephone, radio, leaflets, the Internet, and other channels to disseminate online self-assessment tools, and set up a phone help-line for people for both advice and signposting to services.

**Discussion**

This paper represent the first step in ECDC’s plans to develop and eventually to deliver competency-based training programs to assist Member States fulfill their responsibilities under Decision No. 1082/2013/EU. The ECDC logic model presented in this paper, with its associated capabilities and capacities, represents a theoretical framework for identifying what to measure in capacity inventories, exercises, critical incident analyses, and other approaches to assessing public health emergency preparedness, not how to measure them. Focusing on a common set of capacities and capabilities to measure allows for comparisons both over time and between Member States, which is important for enhancing learning and sharing results from all of these approaches, and ultimately for identifying both the strengths and the areas for improvement of public health emergency preparedness in the EU and its Member States.

Since training budgets, time, and personnel backfill resources are all limited, public health officials need an efficient and highly practical educational approach that effectively addresses core readiness competencies. However, competencies are characteristics of individuals who work in the PHEP system, whereas capacities and capabilities are system level characteristics. To bridge this gap, our subsequent work will review the strengths and weaknesses of approaches such as drills and simulation exercises as well as critical incident analyses for assessing countries’ capabilities and capacities, as specified in the ECDC logic model. We will then develop detailed competencies and related knowledge, skills, and abilities (KSAs) for specific staff roles and capabilities. In this way, EU member states will be able to identify training needs and ECDC deliver training where it is most needed.

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Figure 1. Proposed ECDC Logic Model for PHEP

Capacities

- Legal Measures
  - Accountability
  - Organisational structures
  - Policy Development
  - Delegation of authority
  - Administrative preparedness

- Economic Measures
  - Financing
  - Workforce development
  - Facilities
  - Infrastructure

- Operational Measures
  - Capacity assessment and planning
  - Drills and exercises
  - After Action reports and post-event evaluation

- Social Capital: partnerships between public health and
  - Health care providers
  - Emergency responders
  - Law enforcement
  - Community organisations

Response Capabilities

- Assessment
  - Incident recognition
  - Risk characterization
  - Epidemiological investigation
  - Surveillance and epidemiological monitoring
  - Laboratory analysis
  - Environmental monitoring

- Policy development and implementation
  - For infection control and treatment guidance
  - For population-based disease control
  - Enforcing laws and regulations

- Health care services
  - Preventive services
  - Medical surge
  - Management of medical countermeasures, supplies and equipment
  - Care for health care workers and emergency responders

- Coordination and communication (within the public health emergency preparedness system)
  - Crisis management
  - Communication with healthcare providers
  - Communication with emergency management, public safety, and other sectors
  - Communication with other public health agencies at the global, European, national, and subnational levels

- Emergency risk communication (with the public)
  - Identification of public information needs
  - Developing message content and delivering through appropriate channels

Objectives

- Earliest possible identification of event
- Early and effective response
  - Minimising morbidity and mortality
  - Limiting spread of disease
  - Minimising social disruption
  - Minimising infrastructure and environmental damage
- Earliest possible recovery and return to normal